CIMMYT REPORT ON MAIZE IMPROVEMENT
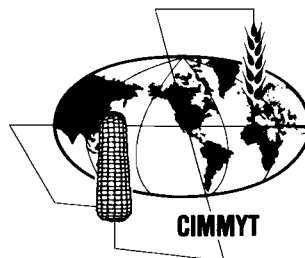
CIMMYT

1978-79

CIMMYT REPORT ON MAIZE IMPROVEMENT 1978-79

A REPORT ON THE MAIZE IMPROVEMENT PROGRAM OF THE
INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER
EL BATAN, MEXICO

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CONTENTS

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i

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[2] Post Doctoral to Staff 1979
[3] Left 1978
[4] Left 1979
[5] To Regional Post 1978
[6] To Regional Post 1979
[7] To Mexico from Regional Post 1978

INTRODUCTION

This 1978-79 report on maize covers the research and training activities of CIMMYT scientists and presents data from international testing program activities during these years. The progress we report is the result of a collective effort involving scientists in more than 80 countries. Through the work of this fraternity of scientists, improved maize varieties continue to be developed which offer higher yield potential and greater environmental stability for conditions in cooperating countries.

CIMMYT's efforts in maize improvement are directed toward the development and maintenance of broad-based gene pools and populations. Toward this end we have designed and implemented a continuous improvement system in which a wide range of materials to serve the major maize-producing areas of the developing world are assembled into gene pools, which in turn are improved to the point that they are genetically ready to contribute superior and new germ plasm to more advanced populations to meet specific production objectives. Superior selections from these advance populations are, in turn, "fine-tuned" to produce high-yielding varieties which can provide farmers with materials capable of high and dependable yield performance.

Testing plays a major role in this international and collaborative improvement system. Materials are tested at several stages of development but only after a judgment is made that each material offers superior germ plasm to cooperating countries and will serve national program needs. National collaborators play a key partnership role in the development of these Advanced-Unit populations, which are recombined on the basis of their progeny performance in replicated yield trials in the agroclimatic conditions where the population will be used. These on-site selections form the basis of future experimental varieties for a particular production situation; and across-site experimental varieties are also made, based on families with superior performance across all sites in which a particular population is tested.

CIMMYT, with its mandate to assist national maize programs throughout the developing world, emphasizes population improvement for a wide range of production circumstances and consumer preferences. In this system, we emphasize open-pollinated varieties as the end product, given the circumstances of the majority of maize farmers in the tropics and subtropics and because of weaknesses in the seed production and distribution systems in most developing countries. CIMMYT populations have also proven beneficial to national hybrid breeding efforts in those collaborating countries where the requisite infrastructure exists to sustain more sophisticated hybrid development programs.

As our scientists complete the decade of the 1970s, we believe that we have a research and training program that can (a) effectively serve the many different maize-growing countries around the world whose research systems are at different stages of development; (b) permit the continuous development and improvement of maize germ plasm to meet current and future needs; (c) provide an efficient linkage system to and from national programs; (d) meet the needs for exploratory and innovative maize research; and (e) provide important backstopping in the manpower development activities of cooperating national maize research programs.

As our staff looks towards the 1980s, we are confident that superior germ plasm is available to improve vastly the maize production levels in most developing countries. At the same time, we are concerned that many national research and production systems lack the necessary resources and organizational structure to deliver improved technology to the farmer. While no blueprint can fit all circumstances, some key elements can be identified. First, the circumstances of farmers must be clearly ascertained in areas targeted for research attention. Interdisciplinary team work is a key ingredient for successful research and production efforts. A strong production and farmer orientation within research and extention organizations is essential to developing improved varieties and production practices. Scientists and extension workers cannot have such an orientation without the means and mobility to interact with farmers on a continuing

basis. This mobility is being seriously impaired by the lack of transportation and fuel within many national research and production programs. A successful seed industry is also essential to any national effort to transform maize production. Without the ability to produce and distribute the seed of improved varieties to farmers, the efforts of maize improvement researchers do not reach farmers.

Finally, without a set of policies and agricultural development strategies which stimulate increased production, the efforts of researchers and extension agents cannot achieve their full impact. Discontinuity in funding and staffing of integrated and well-targeted research and production programs continues to be a major obstacle in most countries which are in desperate need of production increases.

As developing countries look toward the 1980s to devise strategies to feed their growing populations, we believe that the maize crop possesses the greatest biological potential among cereals to substantially raise food production in the developing world. Our efforts during the 1980s will be directed toward the goal of realizing the tremendous biological potential of maize for tropical and subtropical production conditions.

BACK-UP UNIT

CIMMYT's maize Back-Up Unit continues to evaluate and use promising maize materials (introductions) identified from around the world. A working germ plasm bank is maintained and gene pools are created and improved for specific maturities, grain colors, and textures. Superior introductions and bank accessions are systematically evaluated and added to the appropriate gene pools to improve the pools and extend their genetic variability or genetic base. The best performing materials of the gene pools are identified and either transferred to the corresponding Advanced Unit populations for use by collaborators, or used to form new Advanced Unit populations.

MAIZE GERM PLASM BANK

The maize germ plasm bank now maintains more than 12,000 maize accessions, which represent the vast amount of variation found within this species in the Americas and parts of Asia.

Regeneration of Materials

Seed is frequently removed from the bank for use at CIMMYT and elsewhere around the world, necessitating the regeneration of an accession when the stored amount falls below the level of 500 gm. In 1978, 232 tropical and temperate accessions were regenerated. In 1979, 224 accessions were regenerated from the tropical and temperate areas. To rejuvenate each material, 256 plants of an accession are bulk pollinated.

Bank Observation Nurseries

The germ plasm bank's major utility to maize improvement research is through the provision of new sources of genetic variation. To use these materials efficiently, multi-site observation nurseries are invaluable for identifying promising materials. Materials are grown with suitable pools as checks, and data are taken at each site throughout the growing season. Maturity, disease reactions, plant and ear height, and other characteristics of each accession are considered together with its yield. At harvest, accessions are selected on the basis of their across-site performance. The materials selected during 1977 were introduced into appropriate gene pools in 1978.

Seed Shipments

Maize workers throughout the world request material from the germ plasm bank and a quantity of seed sufficient for evaluation and increase is sent in reply. The germ plasm bank filled 103 seed requests in 1978 and 1979, sending 1,891 samples to 32 different countries (table 1). These accessions have been used for studies in maize evolution, breeding, chemotaxonomy, identification of chromosome knobs, and disease resistance.

INTRODUCTION NURSERIES

Maize introductions from various national programs are evaluated at several CIMMYT stations within Mexico in one-row plots, five meters long. These materials are studied for various agronomic attributes, including maturity, height, yield potential, and reaction to insects and diseases.

During 1978-79, over 2,000 introductions from tropical lowland areas, temperate areas, and tropical highlands were evaluated, with appropriate pools as checks, and the promising materials were incorporated into the appropriate gene pools (table 2). Materials with earlier maturity and insect and disease resistance are of special importance.

GENE POOLS

A gene pool is a mixture of diverse germ plasm undergoing continuous recombination, from which materials can be taken out or added to as required. CIMMYT is developing gene pools for three broad ecological zones: the tropical lowlands, subtropical-temperate areas, and the tropical highlands. Within each of these zones, pools are characterized in terms of general maturity range (early, medium and late), grain colors (white and yellow), and grain textures (flint, dent, and floury). (For more information on the classification and composition of various gene pools, refer to the *CIMMYT Report on Maize Improvement 1973.*) There are 12 gene pools for the tropical-lowland zone, eight for the subtropical-temperate zone (with the omission of the late maturity group), and seven for the tropical highland areas (table 3).

Two guidelines are followed in the recombination and improvement of gene pools: (1) the selection intensity applied to the within gene-pool component of improvement

1

is maintained at a low level, and (2) provision is made for the systematic introgression of additional new promising germ plasm into the pool.

The half-sib method of selection is used, as modified by CIMMYT. Approximately 500 half-sib families making up a gene pool are planted in a structure of 2 female:1 male. All female rows and undesirable male plants are detasseled. In the summer season, when each pool is grown at more than one site, superior families are identified at each location by a team of scientists from various disciplines. Yield potential, plant height, maturity, lodging, disease and insect reaction, and uniformity are taken into account at appropriate stages of plant development. At each location, the best plants are identified among those families that have performed well at all locations. At harvest, the best ear(s) is chosen from the selected plants from each pool at each site. The individually-selected ears form the half-sib families planted as female rows, and the balanced mixture of most superior ears forms the male rows of the next cycle's planting.

In addition, those ears from plants which were superior at only one site also are retained to provide superior recombinants for the future. These are planted as female rows only and their seed is not included in the male composite. In a visual evaluation of the performance of male and female selections in several pools in the winter of 1979, the plant and ear height of the male selections were found to be superior to those in the female selections. Pools generally are planted in Mexico at only one site, in the winter cycle, and the selection intensity is relatively mild.

Introductions and the additions from the germ plasm bank are planted only as female rows. This avoids the possibility of unproven materials contaminating the pool and provides the opportunity for comparison of the introductions being crossed to the pool. The superior progenies are harvested and the seed from these progeny are again planted as the female rows in the next cycle to obtain an indication of the combining ability of the introduction with the pool. Promising introductions are thus identified and incorporated in the next cycle, using either remnant seed or seed of crosses with the pool.

Tropical Gene Pools

The tropical lowland gene pools were planted at Poza Rica (lat. 21°N; alt. 60m) during the summer and winter, and at Obregon (lat. 28°N; alt. 39 m) during the summers of 1978 and 1979. Early tropical pools had completed six cycles of improvement by the end of summer 1979. In these pools, approximately 1,500 of the earliest silking plants were identified in each season. At harvest, the best and relatively drier ears were selected—the intent being to select genotypes with faster rates of grain filling and drying down. The male rows were completely detasseled, when 70 per

cent of the females had silked, to ensure that selected female plants did not receive pollen from late male plants. In addition, late female plants which produced no grain were automatically eliminated by this system. Thus, if insufficient ears were available from selected plants, more could be selected from other plants without fear of retaining late germ plasm in the pool.

Early materials should be planted at higher plant densities to realize their true economic potential. However, planting at high density can produce barrenness and increased lodging. Thus, these early tropical materials require improvement for their tolerance to high plant density. In the winter of 1979 at Poza Rica, and in the summer of the same year at Ciudad Obregon, these pools were planted with a ratio of 2 female: 1 male. The males, however, were planted at double the density of the females, and tall, late, lodged, diseased, or plants with poor synchronization of pollen shed and silking were detasseled. At harvest, ears were selected from only the agronomically superior plants from the female rows.

In the summer of 1979, these earlier-maturing pools were planted at a density of 53,000 plants/ha. Then, at pollination time, agronomically superior plants with good synchronization between pollen shed and silk emergence were identified and bulk pollinated. Selection for tolerance to high plant density is continuing in these pools. Some plants with only fair synchronization also were pollinated, but were later artificially inoculated with stalk rot-causing pathogens. Stalk rot resistance is another useful character to have in these early materials.

Tropical gene pools of intermediate and late maturity had undergone ten cycles of improvement by the end of 1979, with the exception of Pool 22, which completed 11 cycles of improvement. In addition to improve these pools for general agronomic characteristics and resistance to various diseases, a program was initiated in the summer of 1978 to upgrade the level of resistance in each of these pools to a specific disease or insect. The insect or disease chosen for improvement in a pool is that most likely to cause damage to that pool in the area of its adaptation. The pests, and the procedures followed to improve resistance, are discussed later in this report.

Subtropical-Temperate Gene Pools

The subtropical-temperate gene pools were planted at Tlaltizapan (lat. 19°N; alt. 940 m) during the summer and winter, and at Ciudad Obregon during the summer season. Pools 27, 32, 33, and 34 had been improved through 11 cycles by the end of 1979; Pools 29, 30, and 31 through six cycles; and Pool 28 through five cycles. The method for handling these early pools was similar to that used for early tropical pools. These pools also were planted at Poza Rica during the winter of 1979 to broaden their adaptation.

CIMMYT's Back-Up Unit creates and improves gene pools constituted on the basis of climatic adaptation, grain type, maturity characters, and grain colors and textures. Superior germ plasm in these pools is identified and transferred to CIMMYT's corresponding advanced maize populations.

Highland Gene Pools

A major portion of the world's tropical highland maize-growing area lies in the high altitudes of Ecuador, Peru, Bolivia, and Colombia. Most of this area is grown to large-seed floury types, with a small proportion to *Morocho* (semi-hard) varieties. The maize types now grown are late in maturity, and earlier varieties would offer more flexibility in cropping patterns as well as reduce damage due to frost.

Taking the above considerations into account, the highland maize program was reorganized in 1979 and the following gene pools were formed: Highland Early White Floury (Pool 1); Highland Late White Floury (Pool 2); Highland Early Yellow Floury (Pool 3); Highland Late Yellow Floury (Pool 4); Highland Early White Morocho (Pool 5); Highland Early Yellow Morocho (Pool 6); Highland Late White-Yellow Morocho (Pool 7).

Table 4 lists the materials constituting these pools, which effectively serve the present needs of the tropical highland maize-growing areas. However, more pools may be constituted as needed.

The highland gene pools are being improved in collaboration with the maize program of INIAP (Institu-

to Nacional de Investigación Agropecuaria), Ecuador, and the CIMMYT maize scientist posted there. Ear rot and ear worms are two of the major maize pests in the Andean highlands. The pools are grown once each year at El Batan (lat. 20ºN; alt. 2249 m) and Toluca (lat. 20ºN; alt. 2640 m), with planting during the last week of March and the first week of April. At El Batan, half of each half-sib family is artificially infested with ear worms (*Heliothis zea*), and at Toluca half of the same families is artificially inoculated with ear rot-causing pathogens.

The early pools are harvested in Mexico in September and sent to Ecuador for planting. They are harvested in March—April in Ecuador and sent back to Mexico for immediate planting. Thus, under this program of multi-location recombination and selection, the highland materials undergo two cycles of improvement each year.

The late gene pools also are infested and inoculated in Mexico and planted in both Mexico and Ecuador as outlined above, but their growing cycle is too long to obtain two cycles a year. Thus, selections from one country are merged with those of the other after a delay of approximately one year (figure 1).

3

FIGURE 1. Handling of highland pools.*

* In a given year, the top and bottom boxes represent the months of planting and harvesting, repectively.
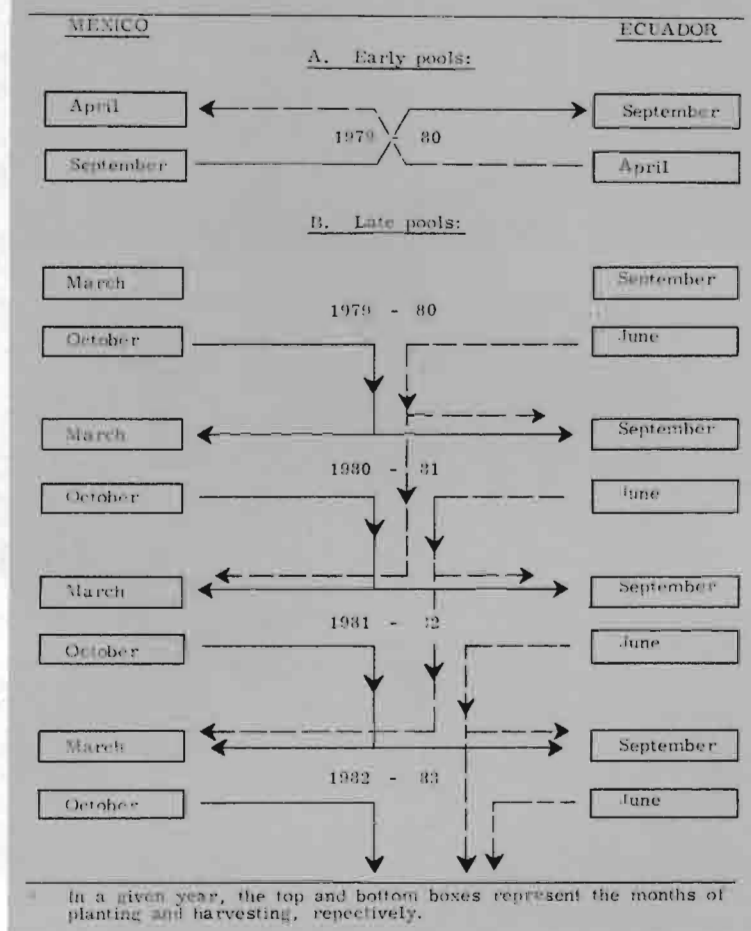
Promotion of Materials from the Back-Up Unit to the Advanced Unit

A bulk mixture of corresponding Advanced-Unit populations is planted as female rows in the pools and used as a base for selection of superior families from the pool. The selected families are further improved and evaluated in IPTTs, alongside the families of the Advanced-Unit populations. The families identified as superior in these evaluations are merged with the appropriate populations (table 5).

In addition to providing useful variation for the existing Advanced-Unit populations, superior fractions of the gene pools are also used to form new advanced-unit populations (table 6). These linkages between the Back-Up and Advanced Units allow CIMMYT to serve cooperators in the international testing program more effectively.

Use of the Brachytic-2 Gene

The brachytic-2 dwarfing gene reduces plant height by reducing the length of the lower internodes, but does not change other major plant parts. This reduction in plant height improves resistance to lodging, but causes reduced yield, late maturity, and increased barrenness as compared with these characteristics in normal maize counterparts. However, increased resistance to lodging

in high-yielding materials would be useful in countries where maize is grown under conditions of high winds (e.g., Colombia, Ecuador, Philippines, etc.).

Selection for improved plant morphology (smaller and narrower leaves, better spatial arrangement of leaves above the ear, greater angle between the stalk and the ear, etc.) in a large br_2 population could overcome the negative attributes of the gene, while retaining its positive attributes. Fortunately, the br_2 materials have a tremendous amount of genetic variation for these traits.

A brachytic-2 population with broad genetic base was assembled in the summer of 1976, using the materials listed in table 4. After a few cycles of initial recombination, selection began for improved plant morphology. Plants with desirable phenotypes were selected prior to pollination and recombined through plant-to-plant crossing. Significant progress has been made in reducing the negative attributes of this gene, and considerable variation still remains in the population to exploit for these morphological traits.

New Gene Pools

In the USA and Europe, where the major portion of the world's maize is produced each year, most maize materials are based on a rather narrow genetic base. This

makes the crop more vulnerable to unforeseen problems and also limits the scope for its improvement. Better exchange of improved materials among the scientists and introgression of exotic germ plasm into their breeding materials would certainly alleviate some of the problems of this narrow gene base.

These concerns were discussed by maize researchers at the EUCARPIA meetings held in 1977 at Krasnodar (U.S.S.R.) and led CIMMYT to form three broad-based gene pools: one for the Northern Temperate Region (NTR), one for the Southern Temperate Region (STR), and one for the Intermediate Temperate Region (ITR). Similar regions in the southern hemisphere correspond to the northern hemisphere, but in reverse order.

The gene pool for the NTR is based on materials from the U.S. Corn Belt, the pool for the STR is comprised of materials from the U.S. Corn Belt and the tropical lowland and highlands, and the pool for the ITR is made up primarily of maize materials from Europe. Table 4 lists the materials in these pools.

Plant-to-plant crosses among the entries making up a pool were made at Tlaltizapan during both seasons of 1978, with the aim of using every entry in the crosses. During both seasons of 1979, the pools were handled in half-sib recombination blocks at Tlaltizapan. At El Batan, plant-to-plant crosses were made among the selected families in 1978, and half-sib blocks were used for recombination in 1979. The ITR pool also was planted by scientists of Cornell University in 1978 and the selections made there were merged in 1979 with CIMMYT selections. Bulks of these pools were planted at Toluca and Ciudad Obregon in 1979. Although no ears were harvested at Toluca, several selections were made at Ciudad Obregon for inclusion in the respective pools in 1980. After these pools have been thoroughly recombined, they will be evaluated and selected at many additional sites in the areas of their utilization. The multi-location selection would broaden the adaptation of these materials.

The CIMMYT-German Maize Exotic Gene Pool, with the same objectives, was initiated in 1976 in a joint effort with the University of Hohenheim. Table 4 lists the materials in this pool.

During the summer of each year, this pool is evaluated and recombined in various countries of Europe and at several sites in Mexico, the USA, and Canada. Selections are made at each site for several characters, including earliness, standability, cold-tolerance, and yield. These selections are then recombined in the winter of each year at Tlaltizapan. Excellent progress has been made in improving traits of this pool during recent cycles and the material grows successfully at every site tested. Such gene pools will serve as new sources of variation for the temperate areas and provide a mechanism for transfer of genes from tropical to temperate germ plasm, and vice versa. These pools could also be used as such by many cooperators in Asia and Africa.

Insect and Disease Resistance in Pools

As noted, several pools were infested or inoculated in 1978 and 1979. Artificial infestation or inoculation allows for more uniform and timely applications of inoculum than can be achieved under natural conditions. Using these artificial methods, scientists can make more rapid progress toward the development of more resistant materials. Pools 33 and 34 were chosen for improving resistance to ear rots, and Pool 32 for improving resistance to south-western corn borer (SWCB), *Diatraea grandiosella* (Dyar.). Tropical Pools 22 and 23 were inoculated with stalk rot, and Pools 20 and 25 with ear rot pathogens. Pools 24 and 26 were infested with fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith), and Pools 19 and 21 with sugarcane borer (SCB), *Diatraea saccharalis* (F.), Figure 2 outlines the selection scheme.

Half-sib selection, as modified by CIMMYT, permits application of selection pressure in the male rows for all characters that can be identified prior to flowering. This is accomplished by detasseling the plants in male rows that are considered undesirable. Pools infested with FAW, SWCB, and SCB were handled with this procedure.

The FAW infestation was made at the seedling stage in male rows, using two plants per hill. At thinning, two to three weeks after infestation, the more susceptible plant was removed from each hill. In this way, approximately 50 per cent of the susceptible plants were eliminated from the male rows before the shedding of pollen. Half of each female row (8 hills, 16 plants) also was infested. The protected half of the row served as a check for comparing the effects of insect damage on agronomic characters such as plant height, maturity, and yield within each family.

All infestations were made with newly-hatched larvae (first instar), which were mixed with ground corn cobs as an inert carrier and applied in the plant whorls with a "bazooka." Applications were made at a rate of about 40 larvae per plant when the plant showed three to four leaves fully extended. Split applications were made to achieve better uniformity.

Approximately two weeks after infestation, visual ratings for insect damage were made on a family basis and the more susceptible families were eliminated. Within the remaining superior families, plants that showed little or no damage were tagged as resistant. At harvest, ears were selected from both halves of the families (the protected as well as infested). Selection of ears from superior plants in the protected half of an otherwise susceptible family reduces the chances of eroding the broad genetic base of the pool, if a single character should be favored too strongly. Emphasis was given to selecting ears from tagged plants, if they were acceptable for other characters. However, ears also were selected from non-tagged plants (those not previously selected as more resistant) if ear size indicated that the plant was able to tolerate the feeding damage. Thus, selection among and within families included plants

FIGURE 2. Breeding for insect and disease resistance in pools.*
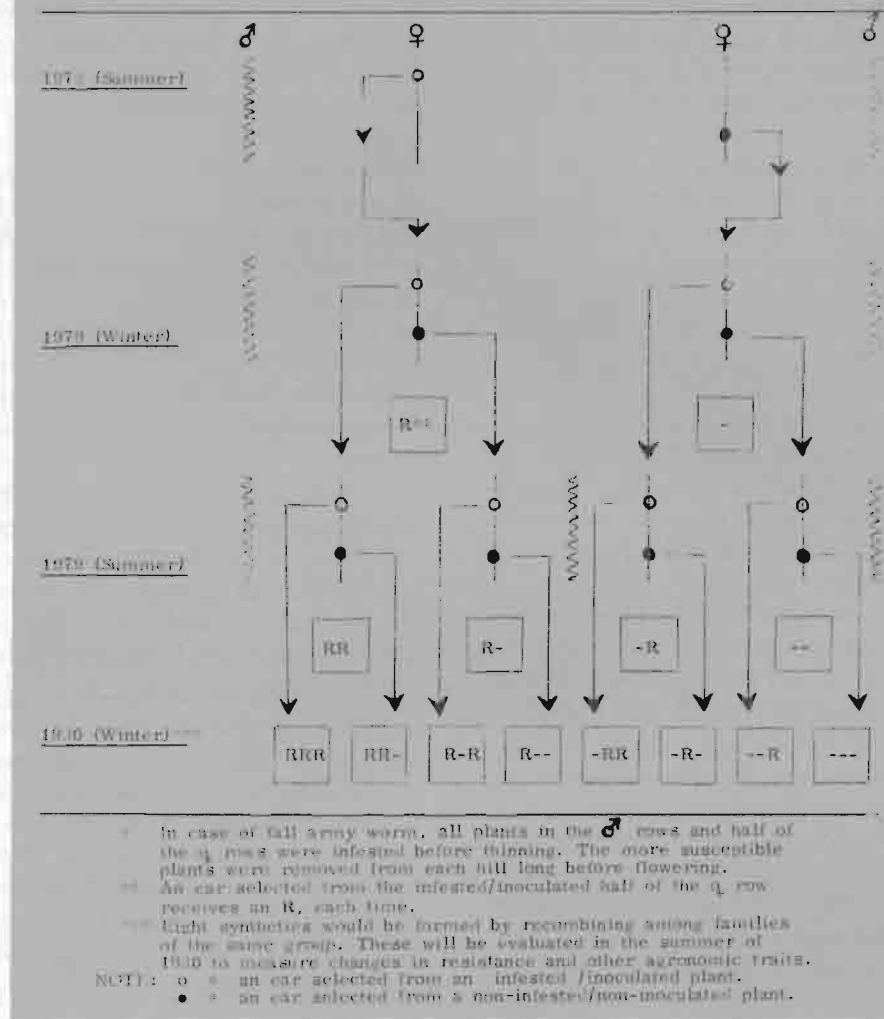
with both types of resistance: those which had less feeding damage (antibiosis) and those which were able to recover and produce well in spite of some damage (tolerance).

The borer infestation was made when the plants had six to eight fully extended leaves—well past the thinning stage. Thus, only one plant in each hill was infested with about 30 larvae. The procedure for infestation was similar to that used with FAW. Visual ratings for damage were made three weeks after infestation and the criteria of selection also were similar to those used with FAW. In addition to selecting for less leaf-feeding by the borers, leaves were stripped and the stalks split to allow selection for less damage from stem tunneling, if the variation encountered seemed to justify the effort.

Insect resistance work has been initiated more recently in highland maize, where resistance to the corn ear worm (CEW), *Heliothis zea* (Boddie), could be of great benefit for farmers in the highlands of Central and South America. The infestation technique for CEW was similar to that described above. About 20 larvae were placed on the ears after they had produced well-extended fresh silks. Because CEW damage occurs after pollination, selection is done only in female rows. Again, only half of the plants in the female rows were infested. At harvest, the less-damaged ears from infested plants and the ears from agronomically superior non-infested plants were saved for the next generation. Pools 1, 3, and 6 were infested and selected in this manner in 1979.

In pools chosen for improving resistance to rot-causing pathogens, half of each family (8 plants) was inoculated. As the inoculations are carried out in the field where environmental factors affecting rots cannot be controlled, this eliminates the posssibility of drastic genetic erosion in the pools as a result of complete or nearly complete rotting of the plants inoculated.

The fungi *Diplodia maydis* (Berk.), Sacc. and *D. macrospora* (Earle) were chosen as pathogens to induce ear rot. The inoculum was raised on sterilized oat kernels in one-liter jars, incubating both species in the same vessel, but on opposite sites. Spore suspensions were prepared in water supplemented with a few droplets of a detergent (Tween 80). Then, after adjusting the spore concentration to 50,000—150,000 spores/ml (according to the susceptibility of the material to be inoculated), the plants were inoculated

In recent years, CIMMYT has placed emphasis in improving insect and disease resistance in pool materials. After artificially inoculating this pool with disease-causing organisms, this CIMMYT scientist is screening material to select resistant families.

when the silks began to dry. The main ear of the plant was inoculated using plastic spray bottles calibrated at two ml/shot. One shot was applied on the silk, another between the husk leaves.

Taking into account the variation in maturity and the growth rate of the plants, inoculations were made at appropriate intervals to ensure timely inoculation of the ear. Plants were marked with different tags for each inoculation date to aid in recognition of variation in the development of rot on different days, with dissimilarities taken into consideration at harvest time. For determination of those differences, a number of plants were inoculated in male rows representing the mean of the populations. In some cases, all plants of the male rows were inoculated with the inoculum at concentrations equal to or higher than those used in female rows. Clean ears selected from agronomically superior plants were added to the pool as female entries in the following cycles. These additional selections serve to upgrade the improvements for rot resistance. In the female rows, only relatively clean ears were retained from agronomically acceptable plants. The ears from more susceptible progenies (as indicated by

family readings) were discarded, or were used as female entries only in the following cycle. In the half-sib families of Pool 33 that were evaluated under these inoculation conditions, the ear rot reaction was found to be normally distributed. This suggests that the resistance is polygenic and that it can be improved by using the available inoculation technique (figure 3).

A mixture of two fungi, *Fusarium graminearum* (Schwabe) and *F. moniliforme* (Sheld.), was used for the stalk rot inoculations. The two fungi were grown on toothpicks which were inserted into holes drilled into the first elongated internode of the plant. Inoculations were made at the same physiological stage of the plant as that used for ear rot inoculations. Stalks were split at harvest, and as many ears as possible were retained from agronomically acceptable plants that were rot free. Otherwise, selections were based on ear aspect. Ears were rejected that had poorly-filled tips and loose kernels (an indication of stalk rot infection).

All pools that complete three cycles of reliable infestations or inoculations by the end of 1979 will be tested in 1980 to measure effectiveness of selections in

7

FIGURE 3. Distribution of ear rot infection among the half-sib families of pool 33.
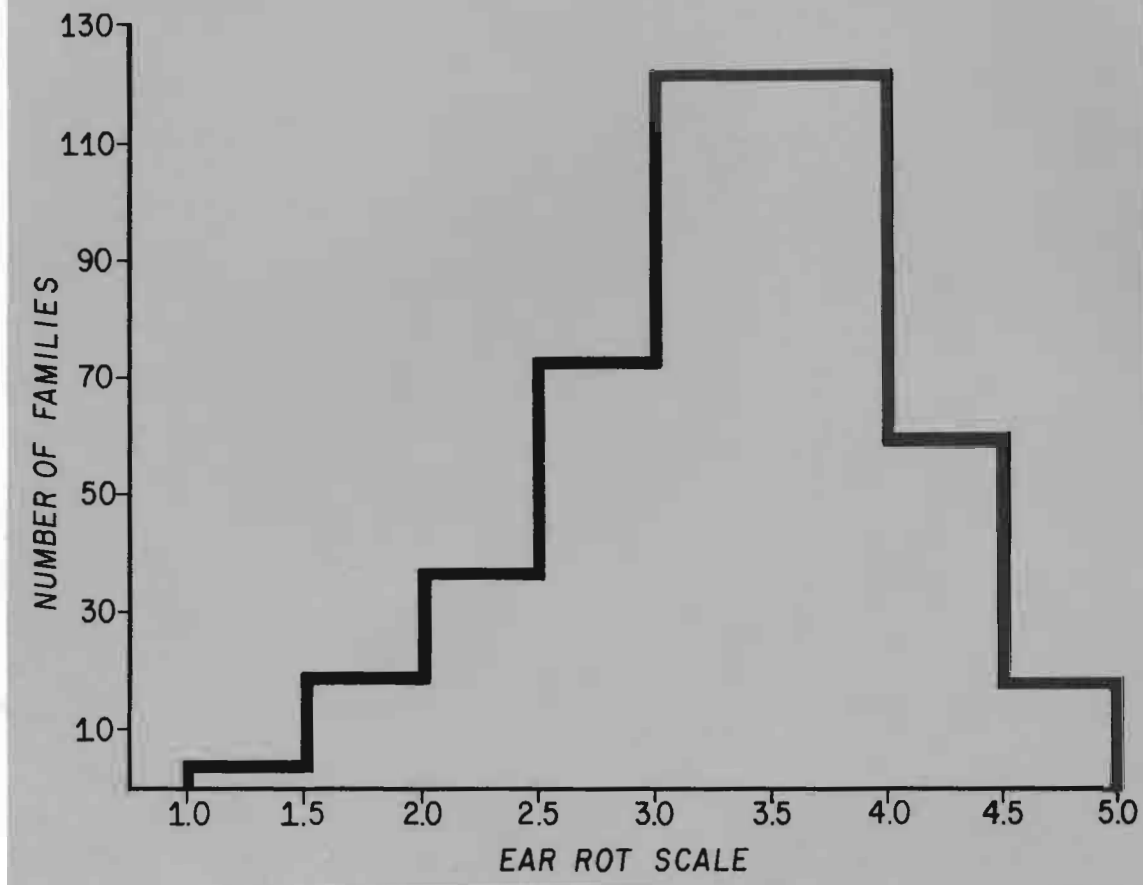
improving for resistance, as well as the possible changes in agronomic characters such as yield. Eight groups of families identified in each of these pools will be intermated within the group in the winter of 1980 and the resulting *synthetics* evaluated that summer (figure 3).

Progress from Selection in Pools

All tropical and subtropical-temperate pools were evaluated in both growing seasons of 1979 to determine progress from selection. Table 7 lists the cycles compared in various pools. A randomized complete block design with eight or ten replications was used for each cycle. The cycles of a pool were planted as female rows at the end of the half-sib recombination block of the pool and detasseled. Each plot consisted of 2 rows, 5 m long, planted side-by-side. Row-to-row spacing was 75 cm, and plant-to-plant spacing was 33 cm. Each plot was bordered by the male rows in the pool. Earlier cycles were slightly later to silking than were later cycles; hence, they were hand-pollinated in the summer of 1979 to provide better comparisons.

The cycles in early tropical pools (Pools 15, 16, 17, and 18), and early subtropical-temperate pools. (Pools 27, 28, 29, and 30) were not compared during the summer, as these pools had been planted in the breeding nursery with hand-pollinations to improve synchronization in their pollen-shed

and silking. Thus, the combined analysis data for these pools are not reported.

No analysis was conducted for yield in Pools 25 and 26, as they lodged badly due to high winds that occurred approximately a month after pollination in the winter, with resultant low yields. However, these pools were analyzed for silking and plant and ear height.

A randomized complete block design was used in analyzing individual site data, with a split-plot-in-time format used for the combined analyses.

Table 8 shows the performance of various cycles of the early tropical and subtropical-temperate pools that were evaluated during the winter of 1979. These pools, except for Pool 27, had undergone three to four cycles of recombination with only slight selection pressure. Mild selection intensity during the early cycles of recombination is expected to provide better recombination among the entries making up a pool, with greater progress from selection in later generations. Despite the very mild selection pressure, significant progress was made in every pool in reducing days-to-flowering and plant and ear height. The yields remained virtually unaffected, except for Pools 18 and 30, which showed substantial yield increases. Pool 27, which had undergone nine cycles of recombination and selection, showed a reduction of 4.6 days in flowering; plant height

8

was reduced by 33.8 cm and ear height by 20.0 cm. Tables 7 and 8 show the performance of different pools by season.

The analysis of variance of the combined data revealed that the two seasons differed significantly in their effects on the traits studied. These differences could be the result of differing hours of daylight and/or temperatures in the two seasons. In the winter of 1979, a severe incidence of tar spot (Phyllachora maydis) occurred at Poza Rica. This could account for part of the highly significant seasonal effects in the tropical pools. Only Pools 26 and 32 showed highly significant interaction between cycles and seasons for the characters studied. Otherwise, the interactions did not seem to be associated with the expression of the traits.

In all pools where combined analysis was performed, the yields of later cycles were significantly higher than those of the initial cycles (table 9). This improvement in yield was accompanied consistently by a substantial reduction in maturity and in plant and ear height. Pool 31 was an exception in that days-to-silking and plant and ear height were reduced, but yield remained unchanged. (This pool had completed only the initial cycles of recombination at the time of these evaluations.)

Table 10 shows that, on average, the later cycles had 16.1 per cent (595.8 kg/ha) higher yields; were 3.7 per cent (2.7 days) earlier in 50 per cent silking; had 16.2 per cent (20 cm) lower plant height; and 14.6 per cent (16.2 cm) lower ear height. The greatest progress in the reduction of plant height was obtained in Pool 32, while Pool 26 showed the greatest reduction in ear height. Pool 34 showed the greatest yield improvement, with Pool 31 having the lowest. In most pools, gains were also associated with slightly lower weight per seed and higher number of grains/m^2.

The various cycles were evaluated at the same plant density, although the optimum plant density for shorter and earlier materials is considered to be greater than that for taller and later materials. Therefore, the true progress made in these materials is perhaps greater than evidenced by the data.

In all pools, selections were made and new germ plasm introduced as described previously; thus, progress could be a result of both of these activities. However, the new materials were generally not superior to the pools and were introduced only to add new genetic variation to the pools. Thus, it would seem likely that they played only an indirect or limited role in the improvement of these pools.

These findings do not support the general notion that selection for shorter and earlier plants in a population will necessarily reduce yield per plant if selection is practiced in a large and heterogeneous population for height, maturity, and yield simultaneously. In fact, yield per plant can be improved if proper selection for reducing other negative characters is practiced.

Preliminary Evaluation Trials (PETs)

PETs were tested internationally during 1979 primarily to evaluate the performance of promising materials that had not been included in the international testing program. These promising materials are at various stages of development in Mexico and their evaluation in national programs can help identify potential areas of adaptation, as well as to help establish priorities for their improvement. Populations being evaluated in the international testing program also were included in these trials to better establish the correspondence between such populations and their back-up pools.

The three separate PETs tested were PET-1, consisting of seven tropical early materials currently under improvement; PET-2, 28 tropical medium-and-late-maturing entries; and PET-3, 15 subtropical and temperate materials of various maturities. There were three local checks in PET-1 and PET-3, and two local checks in PET-2. A randomized complete block design with four replications was used, having four-row plots with 75 cm between rows and 50 cm between hills. The stand was thinned to two plants per hill. Table 11 shows the distribution of trials. In Mexico, the grain-filling period and rate of dry matter accumulation were examined in every material. Yield-per-day also was calculated to define the efficiency of various materials.

The method of collecting and analyzing data is similar to that used in the EVTs of the international testing program. Data for the trials that were sent in 1979 cannot be compiled until late in 1980; thus, the detailed analysis and interpretation of data will be reported in 1981. However, the data collected in Mexico can be discussed briefly.

The materials in PET-1 are divided into two broad groups: "early" and "very early" materials. The "early" materials include Pools 15, 16, 17, and 18, Antigua x República Dominicana, Tropical Amarillo Cristalino-2, Antigua x Rep. Dom. x Pairumani, and Selección Precoz. The "very early" materials include Indonesian Composite, Mata Hambre x Guajira (Blanco), Compuesto Zapalote Chico, and Mata Hambre x Guajira x Pakistan.

On average, the "early" materials yielded more and were taller and later than the "very early" materials. The "early" materials yielded 2280 kg/ha (90 per cent) more; were taller in plant height by 24 cm (11.8 per cent); were 17 cm (21.8 per cent) taller in ear height; and reached physiological maturity five days later than did the "very early" materials (table 12). Although Mata Hambre-Guajira (Blanco) was much earlier than the materials in the "early" group during the winter cycle, it was nearly as late as the "early" materials during the summer cycle.

Table 13 shows duration of grain filling, yield per day, and grain growth (mg/day) of the PET-1 materials. While the "very early" materials required fewer days to reach physiological maturity than did the "early" materials, they did not differ in duration of grain filling. The "early" materials yielded nearly twice as much per day as compared to "very early" materials—based on number of days from planting to physiological maturity (39.3 vs 21.6 kg/day), as well as on number of days from flowering to physiological maturity

(91.4 vs 48.0 kg/day). Of the "early" group, Antigua-Rep. Dom.- Pairumani had the lowest yield per day, whereas yields of other entries did not differ greatly.

Yield is a function of seed size (wt) and number of kernels/m^2. Size of seed is dependent upon the rate and the duration of grain filling. Because there was little difference in the grain-filling period of the two groups of materials, yield differences can be attributed to the differences in the rate of grain filling and the number of kernels/m^2. While the "early" materials yielded nearly twice as much as the "very early" materials, their rate of grain filling was only 24 per cent greater (4.67 vs 3.77 mg/day). Thus, 76 per cent of the yield differences can be attributed to the difference in grain numbers/m^2 of the two groups, which in turn is confounded with the optimum plant population for each material. The best yields from early materials would be obtained at higher plant densities than would be optimum for medium and late materials. In the findings noted here, the two groups did not differ in maturity during the summer cycle; thus, this consideration is not important. However, evaluation of both groups at the same plant density (50,000 plants/ha) probably put the "very early" group at a slight disadvantage in the winter cycle.

If grown in winter, the "very early" materials would require 10-12 days less to produce a crop than would the "early" materials. In the summer, the two groups would be equal in their requirements of number of days to produce a harvestable crop. While "very early" materials might be the only alternative under certain situations, their yield of only 50 per cent of that of "early" materials must be given due consideration in any production program.

The PET-2 materials were classified into 4 groups based on their grain color and texture. The white flint group consisted of seven materials; the white dent group, ten materials; the yellow flint group, four materials; and the yellow dent group, seven materials. Of the white flint group, Pool 19 was the earliest and did not differ significantly in yield from Pool 23, which was the highest yielder. Both materials were only slightly taller than ETO Blanco; the materials in this group did not differ greatly in their yield per day. ETO Blanco had the highest rate of grain growth and Blanco Cristalino-I the lowest.

Among the white dent materials, La Posta was the tallest and the latest; Tuxpeño Caribe was the highest

yielder, followed closely by Mezcla Tropical Blanca. Pool 24, which yielded only slightly less than these two materials, was shorter and earlier. Mezcla Tropical Blanca had the highest yield per day and the highest grain growth rate, whereas Tuxpeño P.B. C-15 had the lowest performance in these two traits.

Pool 21 appeared to be the best performer among the yellow flint group. It was the highest yielding, the earliest, and was only one centimeter taller than the shortest entry in the group. It also had the highest yield per day of all the entries. Amarillo Cristalino-I had the fastest rate of grain growth.

Pool 26 was the highest-yielding material in the group of yellow dent materials. It also was one of shortest and the earliest entries. Cogollero was the tallest and was exceeded in days to maturity only by Amarillo Dentado (0.5 day), which outyielded Cogollero by over 300 kg/ha. Amarillo Dentado and Pool 26 seemed to be the best entries with respect to yield per day. The T.Y.F.D. C$_3$ (stunt resistant) had the fastest rate of grain growth, and Antigua x Ver. 181 the slowest (tables 14 and 15).

The PET-3 materials consisted of two maturity groups—"early" (group 1) and "medium-to-late" (group 2). Pools 27, 28, 29, 30, Indonesia Comp.—Corn Belt, and Comp. de Hungary form Group 1. Group 2 is formed by the rest of the materials in the trial (table 16).

Group 1, on the average, was six days earlier in reaching physiological maturity and seven days earlier to silking, as compared to Group 2. The grain-filling period for Group 1 was one day longer than that of Group 2. Although Group 1 was 16 cm shorter in plant height and 21 cm shorter in ear height, it yielded 1711 kg/ha (35.9 per cent) less than did the Group 2 materials.

Group 2 yielded 31.6 per cent more than did Group 1, based on the number of days from planting to physiological maturity; and 38.6 per cent more based on the number of days from flowering to physiological maturity. Group 2 also had a rate of grain growth 16 per cent faster than that of Group 1. Because the two groups of materials do not differ in their duration of grain filling, and because rate of grain growth accounts for only 16 per cent of the differences in yield, the number of kernels/m^2 must be the major cause for the difference in the yields (84 per cent) between the two groups (table 17).

Table 1. Destinations and number of seed shipments sent by CIMMYT's maize germ plasm bank during 1978 and 1979.

Country	1 9 7 8		1 9 7 9	
	No. shipments	No. items	No. shipments	No. items
Argentina	1	9	2	119
Bangladesh	-	-	1	1
Belgium	1	5	-	-
Brazil	-	-	2	3
Canada	-	-	3	19
Colombia	1	8	-	-
Egypt	1	190	-	-
England	2	13	2	28
France	-	-	2	16
Germany (Fed. Rep.)	1	1	1	1
Guatemala	-	-	1	8
India	1	7	1	2
Ivory Coast	3	14	1	9
Japan	1	19	2	28
Jordon	-	-	1	27
Kenya	1	1	-	-
Mexico	11	368	13	141
Nigeria	1	1	-	-
Pakistan	1	4	-	-
Perú	-	-	1	7
Poland	-	-	1	22
Portugal	1	11	-	-
Saudi Arabia	1	20	-	-
South Africa	2	332	-	-
Spain	-	-	1	10
Tanzania	1	24	-	-
Thailand	-	-	1	10
The Netherlands	1	24	-	-
U. Rep. Camaroon	1	8	-	-
Uruguay	1	2	-	-
U.S.A.	13	103	19	267
Yugoslavia	1	9	-	-
TOTAL	43	1,173	55	718

Table 2. Materials added to gene pools during 1978-79.

Pool 15:	El Salvador 85; Honduras 46; Honduras 32; Nicaragua 80; Nic. 64; Jalisco 282; Uruguay 720; Pool 15- Selections from Colombia.
Pool 16:	El Salvador 56; Guatemala 93; Guat. 94; Honduras 33; Hond. 60; Pool 16- Selections from Colombia.
Pool 17:	Puerto Rico 5; Uruguay 665; Antigua 1; Antigua 5; Guadalupe 15; Uruguay 691; Uruguay 747; Pool 17- Selections from Colombia.
Pool 18:	Dom. Rep. 246; Pool 18- Selections from Colombia.

11

Table 2. (Continued)

Pool 19:	Honduras 46; El Salvador 52; Pool 19- Selections from Colombia.
Pool 20:	Guatemala 90; Hond. 58; El Salvador 46; El Salvador 59; Honduras 54.
Pool 21:	Costa Rica 47; St. Vincent 4, St. Vincent 6; St. Vincent 8; Cuba 9; Cuba 11; Guatemala 73; Guadalupe 6; Guadalupe 16; Surinam 796; Uruguay 699; Pool 21- Selections from Colombia.
Pool 22:	Puerto Rico 7; Brazil 1280; Rep. Dom. 119; Rep. Dom. 248; Brazil 3024; Rep. Dom. 245; Cuba 22; Rep. Dom. 45; Rep. Dom. 237; Rep. Dom. 238; Rep. Dom. 38; Rep. Dom. 169; Rep. Dom. 241; Rep. Dom. 249.
Pool 23:	Trinidad 34, White Flint segregates - Selections from Colombia.
Pool 24:	Guatemala 88; Guatemala 104; Pool 24- Selections from Colombia.
Pool 25:	Costa Rica 71; Cuba 2; Cuba 3; Cuba 13; Cuba 65; Panama 64; Surinam 800; Cuba 16; Pool 25- Selections from Colombia.
Pool 26:	Puerto Rico 2; Trinidad 20; Cuba 25; Cuba 47; Cuba 56; Cuba 95; Cuba 107; Cuba 121; Dom. Rep. 150; Dom. Rep. 206; Brazil 820; Cuba 33; Puerto Rico 9; Cuba 167; Haiti 30, St. Vincent 2; Pool 26- Selections from Colombia.
Pool 27:	Pai Pao Mi; King Ting Tse; Shiao Sui Hua; Ki Tan 102-SC; Ki Shun 83-DC; Ki Shun 107-DC; Ian Shan No. 6-TC; Pe Rhe Su; Hsiao Pai Chi; NEMP-3, BK-FS (Early); NEMP-3, BK-FS (Sel.); NEMP-2, BK-FS (Mount Lebanon); NEMP-2 BK-FS; NEMP-1, BK-FS (Bekaa 1); NEMP-1, BK; White flint segregates (Argentina 565, Arg. 567, Guatemala 246, Guat. 317, Guat. 313); Mex. Mix.; Super Mix.; Exotic Gene Pool; BS-8; IDRN-Cornell; Pennsylvania Gene Pool; USA 342; GR-9; PRMP-1; GR-8; GR-10; YB-8430; B-58; YB-8431; CBC-77; Pai Syn. 5; 71 SAPB-581; HIYF; Largo del Día; Am. Subtropical; 71 SA PB-579; Andaluz, Perla; Local var. of Zala; Samsun 63; INRA 310; Queixale; Tremesino; 63A; Yellow Dent of Mindszentpuszta; 61A; 65A; F.B. of Martonvasar; HMV 979; 71A; Bannu Yellow; Blanco; Hembrilla Norteña; INRA 400; MV-MSC 342; Kohat #1; 14A; Germany 504; Swabi White; Changez; HMV 833; 105A; Cuña; Norteño; Daxa; Enano Levantino; 12A; Basta; Avanyoson; "F" early yellow dent; 108A; MV-SC 429; MV-MSC 342; Rastrojero; MV-TC 281; 22A; 27A; MV-TC 610; MV-SC 620; Puenfeareas; HMV 979; Fino; Grano de Trigo; Rosero; Germany SCQ; MV-TC 596; Germany TC 182; Bierre; 191-13; Syn. Ct. Fd. 741; GC 4; MK-1-2-1; MK-3, VSH; Micca; MK-1-2-2; German Pool - White flint segregates.

Table 2. (Continued)

Pool 28:
Pai Pao Mi, King Ting Tse; Shiao Sui Hua; Ki Tan 102-SC; Ki Shun 83-DC; Ki Shun 107-DC; Ian Shan No. 6-TC; Pe Rhe Su; Hsiao Pai Chi; NEMP-3, BK-FS (Early); NEMP-3, BK-FS (Sel.); NEMP-2, BK-FS (Mount Lebanon); NEMP-2, BK-FS (Sel.); NEMP-1, BK-FS-Sel.(Bekaa No. 1); NEMP-1, BK; (Argentina 565; Guatemala 246; Guat. 317; Guat. 313; Arg. 567; Mex. Mix.; Super Mix.) - White Dent Selections; CBC; Gr-6; Minn. Syn. AS3; BS-8; GR-7; GR-5; YB 8432; B-58; GR-9; YB 8431; Exotic Gene Pool; YB 8429; Florida Syn.; GR-2; BS-7; Pennsylvania Gene Pool; Illinois-high oil-protein; Hawaii 5; Westigua; 77: SJ-3300, 3374, 3286, 3271, 3718, 3533, 3702, 3443, 3207, 3422; BSUL-1; Funk's "F"; DDCAD1C-2; DDCH1C-2; DDCH1C-1; DDCKZ1C-1; Andaluz; Hembrilla; Vasco; MVSC 370; INRA 402; INRA 310; MVMSC 291; Puenfeareas; Fino; 16A; Gallego; Bannu Yellow; 59A; 45A; 105A; 106A; 108A; 121A; 53A; 40A; 63A; 76A; 81A; 102A; 12A; 105A; 115A; 118A; 7A; Blanco; Rosero; Avanyoson Yellow Dent; MVTC 540; MVSC 370; Queixale; Tremesino; HMV 719; "F" Early Y-D; MVTC 540; Local Var. of Zala; MVDC 460; Daxa; HMV 832; Dent of Szeged; AT 633; Kohat; Swabi White; Changez; Perla; Molledo; F-2. F-1256; F-1615. F-1772; 364; 9; 1307; Z.P.-SK 28T; Yuzp DC94; Pau 564; 3216/2-8; Zplt 193; Concorde 560; 1318; MV-21; 129-16; 165-17; 164-2; 138-1; USA Pool - White Dent segregates.

Pool 29:
Pai Pao Mi; King Ting Tse; Shiao Sui Hua; Ki Tan 102-SC; Ki Shun 83-DC; Ki Shun 107-DC; Ian Shan No.6-TC; Pe Rhe Su; Hsiao Pai Chi; NEMP-3, BK-FS (Early); NEMP-3, BK-FS (Sel.); NEMP-2, BK-FS (Mount Lebanon); NEMP-2, BK-FS-Sel.; NEMP-1, BK-FS-Sel.(Bekaa 1); NEMP-1,BK; Yellow Flint Segregates (Argentina 565, Arg. 567, Guatemala 246, Guat. 317, Guat. 313); Mex. Mix.; Super Mix.; GR-5; GR-4; GR-8; GR-11; GR-13; YB 8432; B-58; Exotic Gene Pool; BS-8, YB 8430; Pennsylvania Gene Pool; Minn. Syn. ASA; YB 8431; CBC 77; HEWF; Andaluz; Perla; Local var. of Zala; HMV 719; MVDC 59; MVTC 281; MV SC 587; MV MSC 342; MVTC 540; MVSC 429; MV SC 587; HMV 978; 69A; 60A; 61A; 101A; 115A; 19A; 125A; 22A; Kohot; Queixale; Tremesino; AT 633; FB of Martonvasar; Basto; Enano Levantino; INRA 188; Vasco; Cuña; Bannu Yellow; Blanco; Perla; Dent of Szeged; Norteño Largo; Rosero; Hembrilla; "F" Early Yellow Dent; Swabi White; Puenfeareas; Grano de Trigo; Yellow Dent of Mindszentpuszta; German Pool - YF segregates.

Pool 30:
Compuesto Colorado Precoz de Argentina; Eta; Tau; Pai Pao Mi; King Ting Tse; Shiao Sui Hua; Ki Tan 102-SC; Ki Shun 83-DC; Ki Shun 107-DC; Ian Shan No.6-TC; Pe Rhe Su; Hsiao Pai Chi; NEMP-3, BK-FS (Early); NEMP-3, BK-FS (Sel.); NEMP-2, BK-FS (Mount Lebanon); NEMP-2, BK-FS-Sel.; NEMP-1, BK-FS (Bekaa 1); NEMP-1, BK; Yellow Dent segregates (Argentina 565, Arg. 567; Guatemala 246, Guat. 317, Guat. 313); Mex. Mix.; Super Mix.; CBC 62A; GR-4; GR-12; GR-3; GR-7; GR-5; GR-8; GR-13; YB 8429; YB 8430; CBC 77; Minn.Syn. AS3; Pennsylvania

Table 2. (Continued)

	Gene Pool; IDRN-Cornell; BSCB (R); USA 342; BS-7; Exotic Gene Pool; Westigua; 77: SJ 3120, 3080, 3443, 3773; Funks "D"; DDCSR1C0; DDCHT2C2; Tremesino; Queixale; 71A; Kohat; Bannu Yellow; Andaluz; Dent of Szeged; Rosero; Basto; MVMSC 342; MVSC 370; MVTC 635; MVSC 620; 47A; 74A; Gallego; Vasco; Puenfeareas; Blanco; "F" Early Yellow D; Red King; Samsun 63; INRA 240; Seg. from 4; FB of Martonvasar; INRA 310; Hembrilla Norteña; Cuba; Enano Norteño; AT 209; BT; AT 633; Local var. of Zala; HMV 424; Germany 504; USA Pool - YD segregates.
Pool 31:	Hua Ma Ya; Kun Lung Pai; Ki Tan 101-SC; Lu Shan No.9-TC; Lu Tan No. 31-SC; Lu Tan No. 33-SC; Lu Tan No. 34-SC; Liao Tan No. 2-SC; Shen Tan No. 1-SC; Ian Shan No. 10-TC; Cheng Tan No.1-SC; Huan-1-1; Wu 102; Wu 105; Hsiang Yuan Huang; Ta Ba Tang; Liao Tung Pai; Tun Liao Huang Ma Ya; Sha Ling Tse Pai Ma Ya; Huang Hua Tsuo; NEMP-3, BK-FS (Early); NEMP-3, BK-FS-Sel.; NEMP-2, BK-FS (Mount Lebanon); NEMP-2, BK-FS-Sel.; NEMP-1, BK-FS (Bekaa 1); NEMP-1, BK; Venezuela 568; Guatemala 143; Guat. 151; Guat. 232; Sonora 141.
Pool 32:	Compuesto Blanco Dentado de Argentina; Hua Ma Ya; Kun Lung Pai; Ki Tan 101-SC; Lu Shan No. 9-TC; Lu Tan No. 31-SC; Lu Tan No. 33-SC; Lu Tan No. 34-SC; Liao Tan No. 2-SC; Shen Tan No. 1-SC; Ian Shan No.10-TC; Cheng Tan No.1-SC; Huan 1-1; Wu 105; Wu 102; Hsiang Yuan Huang; Ta Ba Tang; Liao Tung Pai; Tun Liao Huang Ma Ya; Sha Ling Tse; Pai Ma Ya; Pai Ma Ya; Huang Huo Tsuo; NEMP-3, BK-FS (Early); NEMP-3, BK-FS (Sel.); NEMP-2; BK-FS (Mount Leb.); NEMP-2, BK-FS (Sel.); NEMP-1, BK-FS (Bekaa 1); NEMP, BK; (Guatemala 143; Guat. 151; Guat. 232; Sonora 141; Coahuila 12) - White Dent Selections.
Pool 33:	Hua Ma Ya; Kun Lung Pai; Ki Tan 101-SC; Lu Shan No.9-TC; Lu Tan No. 31-SC; Lu Tan No. 33-SC; Lu Tan No. 34-SC; Liao Tan No.2-SC; Shen Tan No.1-SC; Ian Shan No. 10-TC; Cheng Tan No. 1-SC; Huan 1-1; Wu 102; Wu 105; Hsiang Yuan Huang; Ta Ba Tang; Liao Tung Pai; Tun Liao Huang Ma Ya; Sha Ling Tse Pai Ma Ya; Pai Ma Ya; Huang Huo Tsuo; NEMP-3, BK-FS (Early); NEMP-3, BK-FS (Sel.); NEMP-2, BK-FS (Mount Lebanon); NEMP-2, BK-FS; NEMP-1, BK-FS (Bekaa 1); NEMP-1, BK; Guatemala 242; Honduras 49; Sonora 141; Venezuela 336; Guatemala 151.
Pool 34:	Hua Ma Ya; Ku Kung Pai; Ki Tan 101-SC; Lu Shan No.9-TC; Lu Tan No. 31-SC; Lu Tan No.33-SC; Lu Tan No.34-SC; Liao Tan No. 2-SC; Shen Tan No.1-SC; Ian Shan No. 10-TC; Cheng Tan No. 1-SC; Huan 1-1; Wu 105; Wu 102; Hsiang Yuan Huang; Ta Ba Tang; Liao Tung Pai; Tun Liao Huang Ma Ya; Sha Ling Tse Pai Ma Ya; Pai Ma Ya; Huang Huo Tsuo; NEMP-3, BK-FS-(Early); NEMP-3, BK-FS (Sel.); NEMP-2, BK-FS (Mount Lebanon); NEMP-2, BK-FS (Sel.); NEMP-1, BK-FS (Bekaa 1); NEMP-1, BK; Guatemala 143; Guat. 242; Honduras 49; Sonora 141; Chile Z 30; Guat. 279.

Table 3. The gene pools stage of development and the number of families planted in 1979:

Pool No.		Stage of development (Summer)	No. of families	
			Batan	Toluca
	HIGHLAND			
1	Early White Floury	C_0	1658	1728
2	Late White Floury	C_0	802	500
3	Early Yellow Floury	C_0	1910	929
4	Late Yellow Floury	C_0	554	-
5	Early White Morocho	C_0	1631	1391
6	Early Yellow Morocho	C_0	3086	2906
7	Late White Yellow Morocho	C_0	1720	1720

Pool No.		Stage	Summer		Winter
			Poza Rica	Obregon	Poza Rica
	TROPICAL:				
15	Early White Flint	C_6	464	416	326
16	Early White Dent	C_6	450	408	339
17	Early Yellow Flint	C_6	484	428	376
18	Early Yellow Dent	C_6	413	389	261
19	Intermediate White Flint	C_{10}	384	384	405
20	Intermediate White Dent	C_{10}	321	321	417
21	Intermediate Yellow Flint	C_{10}	391	372	496
22	Intermediate Yellow Dent	C_{11}	316	316	364
23	Late White Flint	C_{10}	394	420	510
24	Late White Dent	C_{10}	533	533	542
25	Late Yellow Flint	C_{10}	380	372	503
26	Late Yellow Dent	C_{10}	413	413	663

Pool No.		Stage	Summer		Winter	
			Tlalt.	Obregon	Tlalt.	Poza Rica
	TEMPERATE:					
27	Early White Flint	C_{11}	448	431	326	286
28	Early White Dent	C_5	416	400	431	381
29	Early Yellow Flint	C_6	416	432	517	480
30	Early Yellow Dent	C_6	512	528	551	511
31	Intermediate White Flint	C_6	541	528	466	466
32	Intermediate White Dent	C_{11}	454	454	493	489
33	Intermediate Yellow Flint	C_{11}	454	454	512	512
34	Intermediate Yellow Dent	C_{11}	501	468	414	414

	Stage	Summer		Winter
		Tlaltizapan	Batan	Tlaltizapan
SPECIAL POOLS				
Gene Pool for the:				
Northern Temperate Region	C_0	514	506	1070
Intermediate Temperate Region	C_0	1264	1025	2433
Southern Temperate Region	C_0	825	539	742
CIMMYT Germany Exotic Pool	C_3	436	436	763

15

Table 4. Composition of pools formed during 1978 and 1979.

1. Highland Early White Floury (Pool 1)

Blanco Harinoso Precoz Andino; Cacahuacintle; San Jerónima; Kullu perico; Maiz Concebido; Huaraz Cuzqueño; Huaca Lurum; Cuzco; Holandes; Cabaña; Grupo Zona Andina Harinoso; Maiz Ancho; Pisankalla; Shima; Mishca; Titicaca 1,4,5,6,7,8,9,10; Parba Amarilla; Caraz Morado; Uchuquillo; Palta Waltace; Amarillo Cochabamba; La Paz Cuzco; Huillcaparu - Ckara, Paulla; Overo Chico; Holandes 1,2,3 & 4; Blando Arquile; Amarillo Chico; Soleanero Blanco; Krug; EC 466; HM-1, 18; Cun. 365; RV-7; Montaña B-84; Syn. 4; V503; Nariño 373; V553; Hickory King; H401, 402; Planta Corta Grano Morado, Amarillo y Blanco, Amarillo Harinoso; Morocho Caraz; Cun. 431; Comp. floury o_2; Pachia; Precoces de Bolivia; Comp. Grano Grande; HEWF; HEWD; HEYF; INIAP 101; Chuncula; Puca Checchi; Paro I; Rabo de Zorro I; Pura Capuli; Amarillo de Oro; Am. Ancash; PMC 631; PMV 661, 662; Omo o Kosñi; Oque; Huamanpacpan; Chaque Sara; HEYD; Chupan Huanta; Luricocha Huanta; Ayacucho; Huanta Bajo; Pampas Huanca Velica; Ccasaccoha Huanta; Variedad Colcabamba; Uripa; Paucalbamba; Churcampa Tayacaja; Mezcla de Andahaylas; Mezclas de Chincula Blanco y Amarillo; Am. Comun Churcampa Tayacajas; Cajamarca Maiz Chochoca 8; Maiz Chochoca Variante Hso. 4; Maiz Chochoca 6 y 5; Hualtaco Bolivia; Mamanaca Tarata; Huilcaparu; Chincula; Blanco Morocho Bolivia; Terciopelo; Huascaran o_2; Comp. Choclero Carahuaz; PMV 461; High alt. o_2; Comp. I o_2; Pairumani Ancho; Sabanero; Grupo E; Durango 201; 177; 178; 185; 27; Chihuahua - 209; 213; 212; 242; 243; 186; 191; 202; 165; 159; 174; Zacatecas - 175; 170; Chihuahua 153.

2. Highland Late White Floury (Pool 2)

Cuzco Gigante - PMV 560; Choclero 1,2; Hualtaco; PMC 561; Grano Grande; Cuzco-hijos; Maiz Blanco (Cuenca); Chincheros; Blanco (Penipe); Huantabajo; Paraquilla Bolivia; Maíz Blanco (Cuzco); Maiz Blanco (Saraguro); Maiz Blanco (Cajamarca); Chochoca; Chochoca Variante Hijo-2; Blanco Imperial; Agricultor 3; Sintetico B.W.I. Cubano; Olmos; Colección Chillos #7; Amaguaño; Zona de San Pablo (blanco); Zona de Atuntagui (Blanco); San Luis (Blanco); Morocho Caraz; Cacahuacintle; San Jerónimo; Amarillo Harinoso; Selecciones Tardías de HEWfl$_1$ & HIWfl$_1$; Materiales de Kenya; Blanco Mercado de Otavalo; Loja Maiz Blanco; Loja Blanco Ligero; Zona de Atuntagui Maiz Blanco; Zona de San Pablo Blanco; Zona de Bolivar Blanco Tipo Chillo; Blanco Bolivar Ensayo de Inhery; Amaguaña Maiz Blanco; Chunchi Mezcla; Zona de Cayambe Blanco; Penipe Blanco; Zona de Cayambe; Santa Rosa Flores Blanco; San Isidro San Luis Blanco; Cebadas Blanco; Cecel diron blancos; Blanco Huaraz Mercado; Comp. Amilaceo; Sint. B.W. y Cubano; Olmos; Piscorunto E.E. Taray; Blanco

Urubamba E.E. Huayacari; Mamanaco Tarata; Chupan Huanta; Casaceoha; Uchunquilla; Maiz Pairumani Ancho; Pampas Huancavelica; Chuncula; Paro 1; Rabo Zorro 1; Maiz Blanco; HEYD; Cacahuacintle; Rojo Huaratambo 2; Chuta; Maiz Gris 1; Morocho Rojo; Kapia; Maiz Pintado; Umutu; Colorado Oña; Checchí; Cuenca Maiz Blanco; Parroquia de Bolivar; Blanco Ligero Rojo; INIAP 101; Blanco Harinoso Precoz.

Table 4. (Continued)

3.   Highland Early Yellow Floury (Pool 3)

Comp. Amarillo Harinoso; PMC 631; PMS 635; Terciopelo;
Rojo Huarotambo; Piscorunto; Compuesto Paro; Har. Precoz
Chico; Comp. Muy Precoz de Altura; Sabanero; Sacchasa;
Checchi; Pura Capulli; Kulli Morado; Mishca Pura; Am. de
Oro; Am. Ancash; PMS 631; PMV 661; Almidon; San Geronimo;
Huancaveli Cano; Omo o Kosñi; Rojo Huaratambo; Puca Sara;
Oque; Ancashino; Huamanpacupan; Comp. Grando Grande;
HEWfl$_1$, HEYD; HIWfl$_1$; Planta Corta Grano Morado; Chuta
Precoz Morado Azul; Poucabamba Mezclas; Chincheros
Andahuaylas; Alequileña Bolivia; Chupan Huanta; Luricocha
Huanta; Am. Har. de Bolivia; INIAP 126; Huascaran o$_2$;
HEYF; Materiales de Cuba; Comp. Cuzco Crist. Am.; Boyaca
399; HLYD; Cacahuacintle o$_2$; Chillos; ICA V505; Pool-9*;
10*; Precoces de Bolivia; Pachia; Negros de Bolivia y Peru.

4.   Highland Late Yellow Floury (Pool 4)

INIAP 125; Colecciones de Chillos; INIAP 126; Umutu; ICA
V506; MB 54; MB 52; HLWF; HLWD; HLYF; HLYD; Sabanero
Blanco; Grano Grande; Materiales de Kenya; INIAP 128; Chi-
llo Huandango; Chancho Huandango; Huandango; Chillo; Comp.
Tolerante al Frio; Comp. Internacional Tolerante al Frio; Comp.
Ancashino Tardío; Comp. Marañon 2; Comp. Rabo de Zorro;
Comp. Paro; MB 51; MB 56; Mishca; ICA V505; Zona de
Bolivar Chinclintina; Zona de Bolivar Am. Hso. Tipo Chillo;
Zona de San Pablo Am. Hso; Zona de Natabuela Chaucho Am.;
Zona de Atuntagui Am.; Chulpi; Zona de Cayambe Am.; Zona
de Cayambe los Chillos Am.; Zona de Imbabura Am. Mishqui;
Mercado de Ibarra Am. Hso.; Mercado de Otavalo Am.;
Parroquia de Bolivar Am.; Am. Bolivar Ensayo de Inhery;
Amaguaña Maiz Amarillo; Tena Colección Chillos # 7; Maiz
Chinclintina Zona del Tena; Mishca Coleccion # 5; Am. Hso.
Quito Colección # 3; Comp. Am. Hso. Quito Km. 15; Mishca
Rumiloma Colección # 4; Am. Comp. # 2 and 1; Mercado de
Cuenca Am.; Penipe Maiz Amarillo; Flores Am.; Mercado de
Natabuela Am. Hso; Maiz Am. Prov. Imbabura Chachinviro;
Cajamarca Agricultors - 1; 2; 3; Cajamarca 78 negro - 1; 2;
6; Rojo Huaratambo Mercado; Huaraz Mercado; Caraz Merca-
do; Maiz Comun Mercado Huaraz; Terciopelo-2; Terciopelo;
Amilaceo Ancashina; Capio Carhuaz; PMC 572; Morocho;
Snt. Americano; Comp. Piurano; Morocho Ayacuchano; Comp.
Am. Ancashino; Comp. Ancashino Tardío; Shajatu Precoz;
Comp. Am. Morocho; Am. Duro Precoz; Cajamarca Negro
-3; 4; Casca Kulli; Chulpi; Chaminco Am. de Oro; Am. Calca
Sint. II; San Geronimo; Am. Sahuayaco; Poulcalbamba; Hualtaco;
Kellu; Huantaco Bajo; Huilcaparu; Paro II; Kulli Morado; Am.
Oro; Am. Ancash; Harinoso Precoz Chicos; Planta Corta Grano
Morado; Cacahuacintle; Rojo Huarotambo; Morocho Am. #1;
Morocho Rojo; Paccho; Tablas Monte; Amarillo de Potosi; Am.
de la Remonta; Mez. Am., Lineas Illinois; Amarillo Harinoso;
Grano Grande; Sapieta; INIAP 128.

5.   Highland Early White Morocho (Pool 5)

INIAP 151; HEWF; HEWD; HIWD; Durango 159; Chihuahua 153;
Durango-27; 203; Planta Corta Grano Morado; Comico Amari-
llo; Blanco Sabanero de Colombia; Comp. Hungria; Criollo
Barraza; Titicaca; UNCAC 242; Grano Grande; Comp. Muy

Table 4. (Continued)

Precoz; Bolivia Negro Precoz Morado; Chuto; Huaraz Morado;
Precoz Blanco; Precoces Tropicales; Sabanero Muy Precoz;
Comp. Cristalino Blanco; Cun. 431; Diacol 551; Gaspe; ICA
553; Uchuquillo; Zhima; INIAP 153; Chalqueño A; Cuzco Gigan-
te; Pairumani Ancho; Pairumani Comp. 10; Mercado San
Gabriel Morocho Blanco; Zona de Tena Morocho Blanco; Zona
Bolivar; Mercado de Tulcan; Mercado de Ibarra Morocho
Blanco; Hda. de la Providencia; Via Quito Colección # 2;
Cuenca Morocho Blanco; Rocamex.

6. Highland Early Yellow Morocho (Pool 6)

PMV 569-Amarillo Morocho; C.R. Morocho II; C.R. Morocho
I; Comp. Piurano; C.R. Cus. Crist. Am.-I; II; y III; Morocho
Ayacuchano Sint. 1; Pool Amarillo Morocho; HEYF; HEYD;
HIYF; HIYD; Amarillo tipo Conico; Blanco Sabanero Colombia;
Chihuahua; Titicaca; Bolivia Negro; Chuta; Precoz Huaraz -
Blanco; Morado; Amarillo; Comp. Hungria; UNCAC 242; Maíz
de Indonesia; Maiz Ancho; Grano Grande; Introgression Cubano;
PMC 563; Comp. Cuzco Cristalino Am.; Amarillo de Oro;
Morocho Ayachano; Morocho Am. Duro; Boyacá 400; Boyaca
399; Barraza; HLYF; Sabanero; Muy Precoz de Altura; Comp.
Tolerante al Frio; Aysuma; Morochillo; Harinoso Precoz Chico;
Mezcla Amarilla; Lineas Illinois; INIAP 125; Am. Harinoso;
MB 51; Morocho Amarillo 2; High alt.o_2; Mercado de San
Gabriel; Morocho Blanco; Zona de Tena; Parroquia de Bolivar
(Morocho Blanco); Mercado de Tulcan (Moro.bl.); Mercado
de Ibarra (Moro. bl.); Hda. de la Providencia (Mor. bl.);
Colección # 2 via Quito; Zhima Mercado Cuenca; Cuenca
(Mor. bl.); Blanco (Mercado de Cuenca); Comp. Internacional
Tolerante al Frio; INIAP 151.

7. Highland Late White-Yellow Morocho (Pool 7)

INIAP 151; C.R. Morocho-I; II; C.R. Cus. Crist. Amar.- I;
II; III; Comp. Piurano; Morocho Ayacuchano Sint. I; Pool Am.
Morocho; Blanco Ligero; Maiz Blanco; Chupan Huanta;
Mamanaka Tarata; Morocho Blanco; Morocho; Cecel Arron;
Chochoca Variante Har. 2; Cebadas Blanco; Chunchi Mezcla;
Huaraz Mercado Blanco; Comp. Amilaceo; Blanco Amilaceo
Precoz; Zhima; Morocho Andino; HLWF; HLWD; HLYF; HLYD;
Grano Grande; Sabanero Blanco; Materiales de Kenya.

8. Gene Pool for the Northern Temperate Region

Corn Belt Composite; Westigua; Super Mix.; Sperling Early
Composite; Sperling Extra Early Comp.; Long Ear Nebraska;
Corn Belt Dent Comp.; IDRN Cornell; Assinbaing; Hawaii 5;
Wisconsin P.R.; Florida Syn.; Illinois High Oil (1); Illinois
High Oil (2); Illinois High Protein; USA 342; Ohio Hybrid 1;
OH 2; OH 3; Ohio Inbred A; OI C; S. Carolina 228; S.
Carolina 229; Adapted Gene Pool; Exotic Gene Pool; Pennsyl-
vania   Gene Pool; BSCB (R) C-6; BSSS (R) C-6; SA 65A
Escapes; SA 65B; CA 65 Escapes; Syn. E. High 34 d. cycle
SI-128-70-301-340; CB entry No damage; BS 7 (S_2) C-1;
BS 8 (S_2) C_1; Sample 1; Minn. Syn. ASA; Minn. Syn. ASB;
Minn. Syn. ASD; Minn. Syn. ASG; Minn. Syn. ASDK (S) C-3;
Minn. Syn. AS 3 (HT) C-3; PR MP 1; PR MP 4; Pioneer
X 352; Pioneer X 354; Pioneer X 356; Tlade; YB 8430 B58
(SB) C-2; YB 8431 B58 (SB) C-3; YB 8432 B58 (SB) C-4;
YB 8429 B58 C-9; WF 9; W 32; M 14; Zea mays lndentata

Table 4. (Continued)

163; ZMU 165; ZMU 166; ZMU 578; ZMU 579; ZMU 580;
ZMU 187-R; Kansas Drought Syn.; Pai Pao Mi; King Ting
Tseñ Shio Sui Hua; Pai Tuo Sua; Hua Ma Ya; Kun Lung Pai;
Ki Tan 101; Ki Tan 102; Ki Shun 83; Ki Shun 107; Lu Shan
No. 9; Lu Tan No. 31; Lu Tan No. 33; Lui Tan No. 34; Liao
Tan No. 2 Shen Tan No. 1; Ian Shan No. 10; Ian Shan No. 6;
Cheng Tan No. 1; Huan 1-1; Wu 105, Wu 102; Hsiang Yuan
Huang; Ta Ba Tang; Liao Tung Pai; Tun Liao Huang Ma Ya;
Sha Ling Tse Pai Ma Ya; Pe Rhe Su; Pai Ma Ya; Huang Huo
Tsuo; Hsiao Pai Chi, NEMP-3 BK-FS (Early); NEMP-3 BK-FS;
NEMP-2 KB-FS (Mount Lebanon); NEMP-2 BK-FS; NEMP-1
BK-FS (Bekka No. 1); NEMP-1 BK-Mex. Mix.; Locar Early-
Jutiapa; Selections Tolerant to Drought; SP 109; Agroceres 28;
Saye 231; Cargill 501; Cargill 464; Pioneer X307; Agroceres
30; Pioneer 28034; Mezcla (Agroceres 64 + Mezcla Saye 334 +
Pioneer X 313 + Cargill 413); Yugoslavia GR (1-18); 37 lines
from Kansas; Eleven materials from Korea; BS 10(FR);
BS 11(FR); BS 13 (S$_2$); BSSS$_2$(SCT); BS (SCT); BS UL-2;
BS CT 235; BS CT 234; BS UL-1; B68 H. maydis resistant;
B80; B81; B82; B83; Lancaster type; Peid type;
Funks "F"; Funks "D"; H3992; H3993; H3994; DeKalb DD
(CAD1C2; CHT1C2; CPM1C1; CHC1C1; CKZ1C1; CSS1C1;
CCG1C0; CMD1C1; CSR1C0; CSQ1C0; CON1C0; CONT1C0;
CHM1C2; CAD2C2; CHT2C2; CHM2C2; CPM2C1; CHC2C1;
CKZ2C1; CSS2C1; CCG2C0; CMD2C1; CSR2C0; CSQ2C0;
CON2C0; CONT2C0; CAD3C2; CHT3C2; CHM3C2; COM3C1;
CHC3C1; CKZ3C1; CSS3C1; CCG3C0; CMD3C1; CSR3C0;
CSQ3C0; CON3C0; CONT3C0; 200F; 200M; 400F; 400M; 600F;
600M; 800F; 800M; LO-F; LO-M; EO-F; EO-M).

9.   Gene Pool for the Intermediate Temperate Region

Andaluz; Basta; Blanco; Cuña; Daxa; Enano Levantino; Enano
Costeño; Fino; Gallego; Hembrilla; Norteño; Norteño Largo;
Queixale; Rastrojero; Tremesino; Vasco; Grano de Trigo;
Perla; Rosero; Andaluz; Mengacia; Tolsa; Molledo; Puentea-
reas; MV-SC 202; MV-TC 281; MV-TC 290; MV-MSC 291;
MV-SC 370; MV-TC 431; MV-DC 59; MV-SC 460; MV-DC
520; MV-SC 530; MV-SC 570; MV-SC 580; MV-SC 405;
MV-SC 587; MV-TC 596; MV-DC 602; MV-TC 610; MV-SC
620; MV-TC 635; MV-SC 660; MV-SC 380; MV-SC 429;
MV-SC 598; MV-SC 630; MV-TC 540; MV-TC 201; MV-MSC
262; MV-MSC 342; MV-DC 350; BE-KE 270; GK-SC 513;
1A to 34A; 36A to 78A; 80A to 85A; 87A; 90A to 94A; 96A;
97A; 99A to 131A; Yellow Dent of Mindszentpuszta; Dent of
Szeged; Avanyozon Yellow Dent;"F"Early Yellow Dent; Red
King; White Flint of Midszentpuszta; FR of Martonvasar;
Local Var. of Bodrogkoz; Local Var. of Zala; Local var.
of Fehervar; HMV 969-1; HMV 1024-3; HMV 719-2; HMV
832; HMV 833-5; HMV 929; HMV 978; HMV 979; HMV 1027;
HMV 424-3; OH 51A; Kutumbuli Selec. Large; Samsun 63;
INRA 258; INRA 230; INRA 240; INRA 260; INRA 310; INRA
400; INRA 402; INRA 188; AT; AT1 to AT6; AT 203; AT 209,
AT 564; AT 630-S; AT 633; BT; 002; 007; 500; 504; SCP;
SCQ; D373; TC 11; TC 182; W 401; Yugoslavia Kol 77 GR 1
to GR 18; Seg. from 1-5; Kohat, Swabi White; Changez;
Janey; Chanar; Bannu Yellow; Pinot-France (Italie, Roux de
Landes, Bierre, Guchen, Flint French S.C.'s, Yugoslavie,
Doue du Rouest, Pyrenes); Kovacs-Hungary (F5 Fix (-),
(J.T.E.S.) F$_4$, (Z.P.-SK-28T)F$_4$); Jakacki-Poland (SC (1-12),
(1-2-1, 1-2-2, 1-3, 3, 10, 12, 21, 32, 34, 41, 42, 72 RF,

Table 4. (Continued)

79 RF, 129-26, 164-2, 165-17, 191-1, 191-12, 191-13, 192-9, 194-1, 196-2, 200-2, 209-8, 164-2 x 138-1, 200-2 x 138-1, S72 HST x MK-8-2, S72 HST x 138-1); GIE-Pioneer-France (Flint Synt. x #, CB Synt. x #, CDS x ##); KWS-Germany (Garbo, Ibo, Hit, Granat, Iso, Iris, Irha, Micca, Massa, Forla, Garoche, Hausa, Erox, Miris, Moco, Ferro, Edo, Gavott, Giga, Inka, Gabix, Ira, Perdux, Hai, Harpun, Illo); Kojic-Yugoslavia (Yuzp L (3259/11, 3261/8-10, G-54/1.14, 518-3-12, 2039-9-12, 1703/4-12, 3028, 3216/2-18), Yuzp DC(94/1-77, 16/1-77, 269/1-77, 75/1-76, 42/1-77,Yuzp L-373 50/1-77, 44/1-77, 45/1-77), Yuzp TC 391/3-77,Yuzp DC 150/1-77 Yuzp BL-98-1,Yuzp LT-193/1,Yuzp BR-386, Pollacsek-France (Massat, Bareilles, (F-2. F1256) (F1615. F1772); Bossuet-France (GC (1-15), Primeur 170, Silac 233, Master 243, Rega 246, Royal 255, Star 304, Visa 324, Major 560); Majester-France (1190, 1198, 1218, 31H30, 364, 0005, 1307, 1318, 1323, Typhon 204, Beaufort 221, Survit 241, Cuzco 251, Astron 252, P-362, P-365, Phoebus 365, Pau-564, Concorde 560, Synt. ct.f.d.79-1, Synth. Ryrale, Pop. 31, VSH, Synth. Flint 73, Syn Dent 73, Synth. Totale 73, Melange Lardony, BKB, BKA); Kiss-France (20-14, 60-205, 60-206, 60-209, 60-215, 60-216, 60-226).

10. Gene Pool for the Southern Temperate Region

CIMMYT Maize Gene Pools (HEWF, HEWD, HEYF, HEYD, HIWD, HIYF, HIYD, HLWF, HLWD, HLYF, HLYD); ETO x Illinois; Amarillo Bajío; Largo del Día; Blanco Subtropical; Amarillo Subtropical Blanco Pakistan; Amarillo Pakistan; Pairumani Syn. 5; Amarillo Bajío x Varios Templados; Pakistan Precoces; 71 S APB - 483, 231, 581, 495, 579, 487, 174, 313, 314, 346, 347, 491, 492, 582, 585, 199-228, 494, 474, 532, 505, 235, 344, 345, 525, 584, 540, 485, 336, 337, 539, 300-303, 366, 367, 534, 526, 527, 528, 573, 576, 577, 579, 521, 533, 340-342, 529, 538, 526, 588, 524, 625, 626, 350, 351, 493, 490, 359, 372, 373, 390, 399-403, 348, 349, 356, 496, 486, 506, 511, 472, 482, 481, T5 111.

11. CIMMYT-Germany Maize Exotic Gene Pool

Chihuahua Comp.; Precoz Titicaca; Largo del Día; Morocho; Corn Belt; Blanco Pakistan; Temp. x Trop. H.E.o$_2$; Comp. Hungary; Amarillo Pakistan; Temperate Early White Flint (Pool 27); Precoz Pisankalla; Confite Puñeño; Cornell Early; Zac. 58; 2417 x 2421; Criollo Barraza; Pakistan Precoz; UNCAC 242; Pairumani Synth.; Lineas Illinois; Shingrachuon White Dent; Peking White Dent; Yellow Ken Chin; Highland Materials from Mexico; Syn.5; LBA; TALAT.

12. Brachytic-2 material

Brachytic-2 Versions of Tuxpeño-1; TIWF (Pool 19); TIWD (Pool 20); TIYF (Pool 21); TLWF (Pool 23); TLYF (Pool 25); TLYD (Pool 26); and Brachytic-2 Versions of Yellow Flint and White and Yellow Dent Materials from CIAT (Colombia).

For composition of existing pools, refer to "CIMMYT Report on Maize Improvement 1973."

Table 5. Promotion of materials from the Back-Up to the Advanced Unit.

To Population		From Pool		No. Fam.
Tuxpeño 1	(Pop. 21)	T.L.W.D.	(Pool 24)	54
Mez. Trop. Bl.-1	(Pop. 22)	"	(")	10
Bl. Cristalino-1	(Pop. 23)	T.L.W.F.	(Pool 23)	4
"	(")	"	(")	32
Ant. Ver.181-1	(Pop. 24)	T.I.Y.F.	(Pool 21)	2
"	(")	T.I.Y.D.	(Pool 22)	4
Mezcla Amarilla-2	(Pop. 26)	T.I.Y.F.	(Pool 21)	54
Am. Crist.-1	(Pop. 27)	"	(")	2
"	(")	T.L.Y.F.	(Pool 25)	50
Am. Dentado-1	(Pop. 28)	T.L.Y.D.	(Pool 26)	44
Bl. Crist. 2	(Pop. 30)	T.E.W.F.	(Pool 15)	77*
Am. Crist. 2	(Pop. 31)	T.E.Y.F.	(Pool 17)	30
Eto Blanco-1	(Pop. 32)	T.L.W.F.	(Pool 23)	4
Am. Sub-trop.-1	(Pop. 33)	Tm.I.Y.F.	(Pool 33)	20
Bl. Sub.trop.-1	(Pop. 34)	Tm.I.W.F.	(Pool 31)	65
Cogollero-1	(Pop. 36)	T.L.Y.D.	(Pool 26)	27
"	(Pop. 36)	T.I.Y.D.	(Pool 22)	52
La Posta-1	(Pop. 43)	T.L.W.D.	(Pool 24)	10
Am. Bajio-2	(Pop. 45)	Tm.I.Y.D.	(Pool 34)	50
Comp. Hungary-3	(Pop. 48)	Tm.E.Y.D.	(Pool 30)	74
"	(")	"	(")	95

Table 6. New Advanced Populations contributed by Back-Up pools.

From Back-Up Pool		No. Fam.	Population formed
Tm. E.Y.F.	(Pool 29)	240	Am.Crist.Sub-trop.3 (Pop.46)
Tm.I.W.D.	(Pool 32)	276	Bl.Dent.Sub-trop.-2 (Pop.47)
Tm.I.Y.F.	(Pool 33)	275	Am.Crist.Sub-trop.2 (Pop.33)

* Form 70% of the population.

Table 7. Comparison of cycles of pools during the 1979A season.

Pools	Cycle	Yield (kg/ha)	Days to 50% silking	Height (cm) Plant	Ear	Ear Aspect	% Moisture	Grains/ m^2	Wt/grain (mg)
	C_0	2787	84.8	163.8	98.1	3.8	23.2	1006	280
	C_1	3072	83.4	165.0	93.1	2.9	22.9	1118	278
15	C_4	2917	83.1	147.5	80.6	3.1	22.3	1117	262
	LSD	304.0	1.5	11.2	9.4	0.0	1.2	147.7	27.4
	CV%	9.7	1.6	6.6	9.6	-	5.0	12.8	9.4
	C_0	2358	87.5	156.9	82.5	4.2	26.8	970	246
	C_1	2307	85.5	138.1	71.2	3.5	26.3	914	255
16	C_4	2292	85.4	129.4	66.9	3.4	26.2	1049	221
	LSD	259.6	0.8	8.2	6.7	0.0	1.3	138.9	16.7
	CV%	10.4	0.8	5.4	8.5	-	4.5	13.3	6.5
	C_0	2277	75.4	178.1	105.0	3.6	27.6	1112	206
	C_1	2484	73.5	171.2	98.8	3.1	27.8	1191	210
17	C_4	2290	71.8	165.6	90.0	2.9	28.0	1171	196
	LSD	217.4	1.0	5.9	7.5	0.0	1.8	128.6	20.1
	CV%	8.6	1.2	3.2	7.2	-	6.1	10.4	9.2
	C_0	2029	76.9	169.4	102.5	3.8	28.4	881	232
	C_1	2352	74.1	163.1	95.0	3.4	28.2	1109	214
18	C_4	2540	74.5	167.5	97.5	3.0	29.5	1125	226
	LSD	232.0	0.6	6.5	6.2	0.0	1.7	96.8	24.5
	CV%	9.4	0.7	3.6	5.9	-	5.6	8.7	10.2

Table 7. (Continued)

Pools	Cycle	Yield (kg/ha)	Days to 50% silking	Height (cm) Plant	Height (cm) Ear	Ear Aspect	% Moisture	Grains/ m^2	Wt/grain (mg)
19	C_1	1954	88.3	153.0	83.0	4.2	22.4	835	239
	C_4	2009	88.1	146.5	81.0	4.0	22.2	892	226
	C_8	2661	85.8	135.0	70.0	2.4	23.6	1139	235
	LSD	244.4	1.0	4.9	3.9	0.0	1.8	135.2	26.3
	CV%	11.8	1.2	3.6	5.3	-	8.4	15.1	12.0
20	C_1	2006	89.1	174.0	96.5	3.6	24.5	842	241
	C_4	2199	87.5	162.5	85.5	3.3	24.6	867	255
	C_8	2537	86.6	151.0	82.0	2.8	26.2	952	268
	LSD	216.4	0.7	8.0	4.8	0.0	1.8	107.0	26.4
	CV%	10.2	0.9	5.2	5.8	-	7.7	12.8	11.0
21	C_1	2623	88.0	187.0	111.0	3.6	24.7	947	279
	C_4	2785	86.6	175.5	99.0	3.1	24.1	1070	261
	C_8	3373	85.3	168.5	99.5	2.6	25.5	1178	288
	LSD	301.5	0.7	6.2	4.8	0.0	1.7	135.2	20.2
	CV%	11.0	0.8	3.7	4.9	-	7.2	13.5	7.8
22	C_2	3126	95.9	166.5	93.5	3.4	23.6	1039	302
	C_5	4015	94.6	167.5	97.0	2.8	24.9	1172	344
	C_9	3973	94.5	159.0	91.5	2.7	24.4	1301	306
	LSD	432.2	1.6	6.5	5.4	0.0	2.0	129.7	18.4
	CV%	12.4	1.8	4.2	6.1	-	8.9	11.8	6.2
23	C_1	2521	90.3	166.5	94.0	3.5	24.6	1040	245
	C_4	2974	89.0	165.1	93.5	3.0	24.8	1269	237
	C_8	3488	87.8	157.0	83.0	2.2	25.9	1306	268
	LSD	225.0	0.8	5.6	4.1	0.0	1.8	133.9	22.9
	CV%	8.0	1.0	3.6	4.9	-	7.8	11.8	9.7
24	C_1	3208	91.0	188.0	108.0	3.3	27.7	1383	232
	C_4	3271	90.4	179.0	102.5	3.1	27.0	1495	224
	C_8	3587	88.7	169.0	95.0	2.6	26.3	1495	241
	LSD	319.1	0.8	7.2	4.0	0.0	2.3	214.1	23.2
	CV%	10.1	0.9	4.3	4.2	-	9.1	15.6	10.6
25	C_1		64.2	184.5	102.0	Other data not recorded because of excessive lodging (storm)			
	C_4		63.7	184.5	97.5				
	C_8		62.1	171.0	90.0				
	LSD		0.6	6.0	3.9				
	CV%		1.0	3.6	4.3				
26	C_1		65.4	177.0	95.5	Other data not recorded because of excessive lodging (storm)			
	C_4		64.2	176.5	93.0				
	C_8		62.1	164.0	81.5				
	LSD		0.6	5.6	4.5				
	CV%		1.0	3.5	5.4				

Table 7. (Continued)

Pools	Cycle	Yield (kg/ha)	Days to 50% silking	Height (cm) Plant	Height (cm) Ear	Ear Aspect	% Moisture	Grains/ m²	Wt/grain (mg)
27	C_1	4144	82.5	181.9	100.0	3.2	28.3	1686	248
	C_5	3994	81.2	156.9	86.2	2.8	26.8	1654	242
	C_9	4086	77.9	148.1	80.0	2.5	24.2	1682	247
	LSD	392.0	1.4	6.9	7.3	0.0	3.4	261.6	30.8
	CV%	9.0	1.7	4.0	7.6	-	12.2	14.6	11.7
28	C_0	5177	79.1	176.2	95.0	2.7	28.2	1906	271
	C_3	5042	77.8	161.9	87.5	2.5	26.9	1926	263
	LSD	771.1	1.6	6.5	5.0	0.0	2.5	328.6	17.7
	CV%	12.8	1.7	3.2	4.6	-	7.6	14.5	5.6
29	C_0	2222	68.5	152.5	75.6	3.0	24.6	870	258
	C_2	2363	66.4	151.2	71.9	2.9	22.0	990	239
	C_4	2260	65.4	143.1	70.0	3.0	21.6	973	233
	LSD	387.8	1.7	4.7	4.2	0.0	2.8	184.8	26.7
	CV%	15.8	2.4	2.9	5.4	-	5.4	18.2	10.2
30	C_0	3921	72.0	167.5	93.1	2.9	16.9	1485	264
	C_2	4827	76.1	177.5	100.6	2.2	21.0	1713	283
	C_4	4956	73.8	168.1	89.4	2.1	18.5	1807	275
	LSD	523.7	1.5	5.5	5.9	0.0	1.6	171.5	17.7
	CV%	10.7	1.9	3.0	5.8	-	7.7	9.6	6.0
31	C_0	5504	81.2	187.5	110.0	3.2	29.9	1946	284
	C_2	5745	80.8	178.8	104.4	2.1	30.3	1955	294
	C_4	5531	79.5	169.4	97.5	2.4	27.8	1944	285
	LSD	596.3	1.1	8.0	4.9	0.0	1.8	216.6	15.2
	CV%	9.9	1.3	4.2	4.4	-	5.7	10.4	4.9
32	C_1	4536	86.0	197.0	119.0	3.9	26.2	1401	327
	C_5	5647	83.7	178.0	104.5	2.9	26.0	1846	306
	C_9	5833	81.3	168.5	99.0	2.3	24.3	1806	324
	LSD	568.2	1.5	6.5	4.2	0.0	2.5	240.2	18.7
	CV%	11.3	1.9	3.8	4.2	-	10.4	15.2	6.2
33	C_1	1652	78.1	168.5	91.0	-	10.6	640	254
	C_5	2425	76.5	161.5	81.0	-	8.8	854	285
	C_9	2254	74.8	142.0	72.5	-	8.5	963	237
	LSD	505.8	2.0	8.2	6.1	-	3.4	215.0	29.9
	CV%	25.5	2.8	5.5	8.0	-	38.5	27.9	12.3
34	C_1	3231	82.6	175.5	98.0	3.9	19.7	1086	298
	C_5	4201	81.3	164.5	90.5	3.1	20.3	1483	285
	C_9	4846	79.0	147.5	81.5	1.9	18.6	1586	336
	LSD	387.7	1.0	8.0	4.0	0.0	2.3	291.9	82.0
	CV%	10.1	1.3	5.3	4.8	-	12.6	22.4	28.5

Table 8. Comparison of cycles of pools during the 1978B season.

Pools	Cycle	Yield (kg/ha)	Days to 50% silking	Height (cm) Plant	Ear	Ear Aspect	% Moisture	Grains/ m²	Wt/grain (mg)
19	C_1	4114	58.8	196.5	112.0	3.1	28.6	1501	295
	C_4	4958	57.6	194.5	107.0	2.9	27.8	1765	282
	C_8	5114	55.5	178.0	100.0	2.3	27.3	1662	300
	LSD	121.0	1.1	7.5	4.9	-	2.2	193.8	27.7
	CV%	7.9	2.0	4.2	4.9	-	8.3	12.6	8.2
20	C_1	4507	59.9	216.5	129.0	3.6	23.4	1261	358
	C_4	4874	57.7	213.0	122.5	3.3	22.5	1315	374
	C_8	5092	56.6	194.5	110.5	2.6	23.4	1400	366
	LSD	486.7	0.8	9.6	5.8	-	1.8	154.3	35.5
	CV%	10.7	1.5	4.9	5.1	-	8.3	12.4	10.3
21	C_1	5157	57.1	214.5	126.0	3.0	28.8	1641	316
	C_4	5468	55.8	203.5	115.5	2.8	28.8	1573	348
	C_8	5484	54.3	192.4	110.5	2.6	28.4	1700	324
	LSD	367.4	0.7	8.2	6.1	-	2.3	133.7	30.8
	CV%	7.3	1.2	4.3	5.5	-	8.5	8.7	9.9
22	C_2	3183	63.6	162.0	87.5	3.1	25.0	991	323
	C_5	3178	63.5	157.5	86.5	2.9	25.2	1005	319
	C_9	3457	61.5	153.5	80.5	2.6	25.0	1059	329
	LSD	469.5	1.4	9.1	6.0	-	2.0	168.6	31.4
	CV%	15.3	2.4	6.2	7.5	-	8.0	17.6	10.3
23	C_1	5557	61.3	124.0	8.6	2.9	28.3	1655	337
	C_4	5580	60.0	120.5	12.3	2.5	27.4	1682	335
	C_8	6039	58.8	108.5	5.7	1.9	27.7	1852	328
	LSD	541.5	0.7	5.4	8.3	-	1.8	206.2	27.2
	CV%	10.1	1.2	4.9	98.9	-	6.9	12.7	8.7
24	C_1	5208	65.3	176.0	93.5	2.4	27.1	1634	322
	C_4	5763	64.2	168.0	86.0	2.4	26.1	1767	327
	C_8	5451	62.5	164.0	88.5	2.4	26.7	1827	310
	LSD	367.2	1.1	7.1	6.9	-	1.6	261.4	36.7
	CV%	7.1	1.9	4.4	8.2	-	6.4	16.0	12.2
25	C_1	4830	63.0	216.5	124.0	3.0	25.7	1612	301
	C_4	4882	62.3	201.0	111.5	2.0	24.1	1618	306
	C_8	4872	61.0	193.5	106.0	2.0	24.0	1660	301
	LSD	300.5	0.6	5.9	6.3	-	1.6	185.9	24.6
	CV%	6.6	1.0	3.1	5.8	-	6.9	12.1	8.7
26	C_1	4915	58.6	215.0	127.0	2.6	25.1	1671	295
	C_4	5004	58.2	211.5	123.0	2.3	26.1	1663	304
	C_8	5123	56.3	193.5	110.0	1.4	24.3	1711	303
	LSD	294.9	0.8	7.3	4.0	-	2.4	194.0	32.6
	CV%	6.3	1.5	3.8	3.5	-	10.2	12.3	11.5

Table 8. (Continued)

Pools	Cycle	Yield (kg/ha)	Days to 50% silking	Height (cm) Plant	Ear	Ear Aspect	% Moisture	Grains/ m^2	Wt/grain (mg)
31	C_0	6575	59.6	205.6	131.9	3.0	24.7	1807	363
	C_2	6228	58.5	203.7	125.0	2.6	24.0	1792	349
	C_4	6514	56.6	193.1	118.1	2.4	24.6	1866	349
	LSD	741.0	1.1	8.6	7.2	-	2.1	166.7	26.4
	CV%	10.7	1.8	4.0	5.3	-	8.1	8.5	7.0
32	C_1	6995	63.6	207.0	130.0	2.6	28.8	2263	310
	C_5	6830	61.3	186.0	114.5	2.6	27.0	2051	335
	C_9	6461	60.0	172.0	102.5	1.9	25.6	1990	324
	LSD	615.0	1.0	9.1	6.6	-	1.6	166.0	27.1
	CV%	9.7	1.8	5.1	6.1	-	6.5	8.4	8.9
33	C_1	4385	60.5	201.0	129.5	3.9	30.4	1447	305
	C_5	4812	59.0	190.5	116.0	3.3	31.2	1575	307
	C_9	5221	57.8	175.0	103.0	3.2	28.7	1644	320
	LSD	611.2	1.0	10.9	7.3	-	2.1	242.6	17.9
	CV%	13.5	1.8	6.1	6.7	-	7.4	16.6	6.1
34	C_1	5216	57.4	203.5	126.5	3.7	31.3	1484	351
	C_5	6797	56.8	195.0	119.0	2.8	32.1	1729	354
	C_9	6555	54.5	179.0	109.0	2.9	31.5	1915	345
	LSD	526.8	0.8	8.1	8.1	-	1.7	195.3	28.3
	CV%	9.4	1.5	4.5	7.3	-	5.7	12.2	8.6

Table 9. Comparison of cycles in pools. Data combines over the two seasons.

Pools	Cycles	Yield (kg)	Days to 50% silking	Height (cm) Plant	Ear
19	C_1	3184	74	175	98
	C_4	3483	73	171	94
	C_8	3888	71	156	85
	5% LSD	211	0.7	10.1	3.0
	% CV	9.3	1.5	9.4	5.1
20	C_1	3257	74	195	113
	C_4	3537	73	188	104
	C_8	3815	72	173	96
	5% LSD	257	0.5	6.0	3.6
	% CV	11.3	1.1	5.1	5.4
21	C_1	3890	73	201	118
	C_4	4126	71	190	107
	C_8	4429	70	180	105
	5% LSD	230	0.1	5.0	3.7
	% CV	8.6	1.0	4.1	5.2
22	C_2	3155	80	164	91
	C_5	3597	79	162	92
	C_9	3715	78	156	86
	5% LSD	308	1.0	5.4	3.9
	% CV	13.8	2.0	5.2	6.8

25

Table 9. (Continued)

Pools	Cycles	Yield (kg)	Days to 50% silking	Height (cm) Plant	Height (cm) Ear
23	C_1	4039	76	190	109
	C_4	4277	74	185	107
	C_8	4764	73	174	96
	5% LSD	283	0.5	4.1	3.3
	% CV	10.1	1.0	3.5	4.9
24	C_1	4208	78	182	101
	C_4	4517	77	174	94
	C_8	4519	76	166	92
	5% LSD	235	0.7	4.9	3.8
	% CV	8.3	1.4	4.4	6.3
25	C_1		64	201	113
	C_4		63	193	104
	C_8		62	182	98
	5% LSD		0.4	4.0	3.6
	% CV		1.0	3.3	5.3
26	C_1		62	196	111
	C_4		61	194	108
	C_8		59	179	76
	5% LSD		0.2	1.5	0.5
	% CV		0.5	1.2	0.7
31*	C_0	6039	70	197	121
	C_2	5987	70	191	115
	C_4	6023	68	181	108
	5% LSD	454	0.8	5.7	4.2
	% CV	10.4	1.5	4.1	5.0
32	C_1	5766	75	202	124
	C_5	6239	72	182	110
	C_9	6147	71	170	101
	5% LSD	364	0.8	1.2	1.6
	% CV	8.3	1.5	0.9	1.9
33	C_1	3018	69	185	110
	C_5	3618	68	176	93
	C_9	3733	66	158	88
	5% LSD	383	1.1	6.6	4.6
	% CV	17.3	2.6	5.9	7.3
34	C_1	4224	70	190	112
	C_5	5149	69	180	105
	C_9	5700	67	163	95
	5% LSD	316	0.6	5.5	4.4
	% CV	9.8	1.4	4.8	6.5

* Only 4 cycles of the initial recombination completed at the time of evaluation.

Table 10. Progress in pools where combined analysis available.*

Pools	Yield/ha. kg	Yield/ha. %	Days to 50% silking Days	Days to 50% silking %	Plant height cm	Plant height %	Ear height cm	Ear height %
19	+ 704	+22.1	-3	-4.0	-19	-10.9	-13	-13.3
20	+ 558	+17.1	-2	-2.7	-22	-11.3	-17	-15.0
21	+ 539	+13.9	-3	-4.1	-21	-10.4	-13	-11.0
22	+ 560	+17.7	-2	-2.5	- 8	- 4.9	- 5	- 5.5
23	+ 725	+17.9	-3	-3.9	-16	- 8.4	-13	-11.9
24	+ 311	+ 7.4	-2	-2.6	-16	- 8.8	- 9	- 8.9
25	-	-	-2	-3.1	-19	- 9.5	-15	-13.3
26	-	-	-3	-4.8	-17	- 8.7	-35	-31.5
31**	- 16	- 0.3	-2	-2.9	-16	- 8.1	-13	-10.7
32	+ 381	+ 6.6	-4	-5.3	-32	-15.8	-23	-18.5
33	+ 720	+23.9	-3	-4.3	-27	-14.6	-22	-20.0
34	+1476	+34.9	-3	-4.3	-27	-14.2	-17	-15.2
MEAN	595.8	+16.1	-2.7	-3.7	-20	-10.5	-16.2	-14.6

* All the values in the table are significant at 0.05 level of probability, except for yield in pool 31.
** Only 4 cycles of the initial recombination completed at the time of evaluation.

Table 11. Distribution of the preliminary evaluation trials (PETs).

Country	PET 1	PET 2	PET 3	TOTAL
South America:				
1. Bolivia	-	-	1	1
2. Brazil	1	1	1	3
3. Colombia	1	-	-	1
4. Chile	-	-	1	1
5. Ecuador	1	-	-	1
6. Argentina	1	-	1	2
Central America:				
7. Guatemala	1	1	-	2
Africa:				
8. Egypt	1	-	1	2
9. Nigeria	1	1	-	2
10. Ghana	1	1	-	2
11. Tanzania	1	1	1	3
12. Zaire	1	1	1	3
13. Haute Volta	1	-	1	2
Asia:				
14. India	4	4	4	12
15. Thailand	1	2	1	4
16. Turkey	1	-	1	2
17. Pakistan	1	-	1	2
18. Philippines	1	-	-	1
19. Mexico				
a) Río Bravo	1	1	1	3
b) Tlaltizapan	1	1	2	4
c) Poza Rica	2	2	1	5
TOTAL	23	16	19	58

Table 12. Performance of PET-1 materials in Mexico.

Pedigree	Poza Rica - 1979 Winter						Poza Rica - 1979 Summer						Tlaltizapan - 1979 Winter					
	Yield kg/ha	Days 50% silk	Height(cm) Plant	Ear	Plants harvested	% Moisture	Yield kg/ha	Days 50% silk	Height(cm) Plant	Ear	Plants harvested	% Moisture	Yield kg/ha	Days 50% silk	Height(cm) Plant	Ear	Plants harvested (cm)	% Moisture
Ant.Rep.Dom.(Pop.35)C3	3044	88	173	95	43	24.6	4963	55	160	74	42	22.0	6921	84	208	121	43	30.5
T.E.W.F.(Pool 15)C6	2988	83	166	90	44	21.2	4843	54	161	86	42	20.1	6532	79	203	118	43	25.1
T.E.W.B.(Pool 16)C6	2888	84	150	90	42	22.1	5200	53	170	95	43	20.1	7514	79	195	111	42	21.9
T.E.Y.F.(Pool 17)C6	2846	83	164	94	43	20.2	4890	54	164	86	41	20.0	6526	79	208	120	44	21.0
T.E.Y.D.(Pool 18)C6	2826	87	163	90	40	22.7	4825	53	166	86	42	21.2	6845	80	205	116	44	21.7
Trop.Amar. Cr. 2	2803	82	158	76	43	20.0	4020	53	149	74	42	18.6	7622	77	198	110	44	29.5
Ant.Rep.Dom.=Pairumani	2344	85	150	86	42	22.4	3844	54	171	84	40	20.2	5888	82	196	108	43	26.4
Indonesian Comp.	1560	77	148	71	42	14.5	-	-	-	-	-	-	3711	69	181	93	43	16.1
Mat.llamxGuay.Bl.(Lote 80B)	1099	75	130	64	40	14.2	3067	51	140	85	40	16.0	4048	63	159	79	43	15.9
Comp.Zap.Chico	789	76	120	63	32	13.5	-	-	-	-	-	-	3363	69	173	95	38	17.5
Selección Precoz (Lote 81)	-	-	-	-	-	-	4700	53	164	83	43	13.2	-	-	-	-	-	-
Mat.llam.Guay.Pak.(Lote 80)	-	-	-	-	-	-	2617	52	148	75	38	14.6	-	-	-	-	-	-
LSD 5%	412						336						358					
C.V.	22.4						10.3						8.2					

Table 13. Duration of grain filling, yield/day and grain growth (mg) day of the PET-1 materials.

Pedigree	Poza Rica - 1979 Winter					Poza Rica - 1979 Summer					Tlaltizapan - 1979 Winter				
	Days from Fl.to P.M.	Days from Pl.to P.M.	Yield (kg)/day Fl.to P.M.	Yield (kg)/day Pl.to P.M.	Grain growth mg/day	Days from Fl.to P.M.	Days from Pl.to P.M.	Yield (kg)/day Fl.to P.M.	Yield (kg)/day Pl.to P.M.	Grain growth mg/day	Days from Fl.to P.M.	Days from Pl.to P.M.	Yield (kg)/day Fl.to P.M.	Yield (kg)/day Pl.to P.M.	Grain growth mg/day
T.E.W.F. (Pool 15) C6	133	50	22.5	59.8	4.02	104	50	46.6	96.1	4.80	138	50	47.1	110.3	4.59
T.E.W.D. (Pool 16) C6	133	49	21.7	58.9	4.39	104	51	50.0	102.0	4.60	138	56	54.5	127.4	5.05
T.E.Y.F. (Pool 17) C6	130	48	21.7	59.3	3.68	102	49	47.9	101.8	5.02	141	62	49.4	105.3	4.95
T.E.Y.D. (Pool 18) C6	133	49	21.2	61.4	6.30	104	51	46.4	94.6	4.16	136	50	50.1	136.9	5.30
Ant. Rep. Dom.(Pop. 35)C3	133	45	22.5	67.7	4.13	104	49	47.7	101.1	4.67	143	59	43.4	117.3	4.30
Trop. Amar. Cr. 2	129	47	21.7	58.6	5.72	104	51	47.3	96.3	4.96	136	59	46.3	130.0	4.16
Ant. Rep. Dom.=Pairumani	134	45	17.5	47.9	3.33	104	50	37.0	76.0	4.56	141	50	41.6	99.5	4.92
Indonesian Comp.	123	46	12.7	33.9	5.54	-	-	-	-	-	124	56	32.8	73.7	3.57
Mat. llamxGuay.Bl.(Lote 80B)	125	50	8.8	22.0	3.40	102	51	30.1	60.1	4.31	125	56	29.7	86.2	3.41
Comp. Zap. Chico	123	47	6.4	16.8	2.81	-	-	-	-	-	128	50	26.3	57.0	3.74
Selección Precoz (Lote 81)	-	-	-	-	-	102	49	47.0	97.2	3.18	-	-	-	-	-
Mat. llam.Guay.Pak.(Lote 80)	-	-	-	-	-	90	47	26.4	55.7	3.61	-	-	-	-	-

* wt/kernel (mg) at black layer
No.of days from flowering to black layer

28

Table 14. Performance of PET-2 materials in Mexico.

Pedigree	Poza Rica - 1979 Summer						Tlaltizapan - 1979 Winter					
	Yield kg/ha	Days 50% silk	Height(cm) Plant	Ear	Plants harvested	% Moisture	Yield kg/ha	Days 50% silk	Height(cm) Plant	Ear	Plants harvested	% Moisture
T.I.W.F.(Pool 19) C_9	5630	56	185	95	42.0	22.9	7030	85	215	125	42.7	23.2
Bl.Crist.1(Pop.23) C_4	6442	57	201	104	41.5	25.1	6897	88	226	136	43.5	24.7
Mix.1-Col.Gpo.1-ETO C_4	5828	58	203	99	40.7	23.3	7333	89	220	126	42.7	25.4
T.I.W.F. C_3 DM. Res.	5687	58	208	110	42.0	23.9	6388	86	226	141	43.5	21.1
T.I.W.F. C_3 St. Res.	5758	59	208	113	41.2	24.5	7412	91	234	141	43.5	25.7
ETO Blanco Pop. 32) C_3	5217	59	185	94	39.0	23.7	6855	89	208	119	43.2	28.0
T.L.W.F. (Pool 23)C_9	5773	60	186	94	39.7	25.2	7815	88	218	131	42.2	23.1
T.I.W.D. (Pool 20)C_9	5826	56	195	108	41.0	24.3	7276	86	215	133	41.7	23.0
T.L.W.D. (Pool 24)C_9	6547	58	198	105	41.2	26.2	3076	89	225	138	43.5	26.9
Tuxp. P.B. C_{12} D.R. Sl.	6594	59	180	90	40.2	26.7	7515	90	214	121	43.2	27.1
Tuxp. 1 (Pop. 21) C_3	6553	59	193	99	41.5	27.7	7812	90	209	118	43.7	26.8
Tuxp. P.B. C_{15}	5090	59	146	71	37.0	26.4	7415	90	219	129	43.2	28.0
T.L.W.D. C_3 DM.Res.	5036	59	214	117	39.7	25.4	7285	88	236	140	43.0	22.1
T.L.W.D. C_3 St. Res.	5469	60	209	113	38.2	23.4	6946	92	238	148	43.5	25.7
Mez.Trop. Bl.(Pop.22) C_4	6557	60	198	106	38.7	24.9	8258	90	234	141	44.0	29.3
Tuxp.Caribe (Pop. 29) C_4	6616	60	195	105	41.7	25.3	8282	90	233	140	43.5	23.2
La Posta (Pop. 43) C_4	6248	61	225	123	40.2	29.1	7897	93	255	159	43.5	26.3
Mez.Am. (Pop. 26) C_3	4995	56	191	99	42.7	24.4	7191	87	225	125	44.0	23.6
T.I.Y.F.(Pool 21) C_9	6265	56	194	103	41.2	23.7	7336	86	224	135	42.5	21.4
T.L.Y.F. (Pool 25) C_9	6168	58	205	110	40.0	23.8	6818	89	233	141	39.5	25.3
Am. Crist. 1 (Pop. 27) C_4	5746	60	203	105	40.7	26.3	6509	92	236	145	43.0	28.2
T.I.Y.D. (Pool 22) C_{10}	5976	58	194	103	41.7	23.7	6788	88	228	135	43.7	24.2
T.L.Y.D. (Pool 26) C_9	6300	58	194	100	40.5	26.1	7721	89	228	140	42.5	21.4
T.Y.F.D. C_3 DM Res.	5797	59	208	113	40.0	22.5	6224	88	235	149	42.2	21.4
Ant. Ver.181 (Pop. 24)C_4	5895	59	199	108	41.7	27.5	7097	91	233	146	43.0	25.4
T.Y.F.D. C_3 St. Res.	4896	60	196	111	38.7	22.4	6421	89	228	138	43.2	23.6
Amar. Dent (Pop. 28) C_3	5826	60	210	115	43.2	26.1	8079	91	243	154	43.7	22.9
Cogollero (Pop. 36) C_3	5905	60	226	125	41.0	25.9	7333	90	245	158	43.0	21.8
LSD 5%	493						421					
C.V.%	12.0						8.2					

Table 15. Duration of grain filling, yield/day and grain growth (mg)/day of the PET-2 materials.

Pedigree	Tlaltizapan - 1979 Winter				Grain growth mg/day	Poza Rica - 1979 Summer				Grain growth mg/day
	Days from Pl. to P.M.	Fl. to P.M.	Yield (kg)/day Pl. to P.M.	Fl. to P.M.		Days from Pl. to P.M.	Fl. to P.M.	Yield (kg)/day Pl. to P.M.	Fl. to P.M.	
T.I.W.F. (Pool 19) C_9	151	66	46.6	106.5	4.35	105	49	53.6	114.6	4.86
Bl.Crist.1 (Pop. 23)	154	66	44.8	104.5	4.20	109	52	59.1	123.9	4.31
Mix.1-Col.Gpo.1-ETO(Pop. 25)	152	63	47.9	115.6	4.17	109	51	53.5	114.3	4.71
T.I.W.F. C_3 - DM Res.	148	62	43.2	103.0	4.39	110	52	51.7	109.4	4.08
T.I.W.F. C_3 St. Res.	155	64	47.8	115.8	4.47	110	51	52.5	102.9	4.22
ETO Blanco (Pop. 32)	152	63	45.1	108.8	4.70	110	51	47.4	102.3	5.24
T.L.W.F. (Pool 23)C_9	153	65	51.1	120.2	4.05	111	51	52.0	113.2	4.72
T.I.W.D. (Pool 20)C_9	152	66	47.9	110.2	4.70	111	55	52.5	105.9	4.29
T.L.W.D. (Pool 24)C_9	155	66	52.1	122.4	4.67	109	51	60.1	128.4	4.78
Tuxp. P.B. C_{12} Drought Sel.	155	65	48.5	115.6	4.35	110	51	59.9	129.3	4.73
Tuxp. 1 (Pop. 21)C_3	156	66	50.1	118.4	4.21	111	52	59.0	126.0	4.65
Tuxp. P.B. C_{15}	156	66	47.5	112.3	3.85	110	51	46.3	99.8	4.14
T.L.W.D. C_3 DM Res.	152	64	47.0	113.8	4.70	110	51	46.2	99.7	4.49
T.L.W.D. C_3 St. Res.	154	62	45.1	112.0	4.40	110	50	49.7	109.4	4.44
Mez.Trop.Bl.(Pop. 22)	155	65	54.0	131.1	4.73	111	51	59.1	128.6	5.16
Tuxp. Caribe (Pop. 29)	157	67	52.8	123.6	4.10	111	51	59.6	129.8	4.57
La Posta (Pop. 43) C_4	157	64	50.3	123.4	4.36	110	49	56.8	127.5	4.76
Mez.Am. (Pop. 26)C_3	155	66	47.0	109.0	4.29	111	65	45.0	90.8	4.51
T.I.Y.F. (Pool 21) C_9	149	65	49.2	116.4	4.22	109	53	57.5	118.2	4.40
T.L.Y.F. (Pool 25) C_9	152	63	44.0	108.2	4.57	111	53	55.6	116.4	4.81
Amar. Crist.1 (Pop. 27)	152	60	43.8	108.5	4.47	111	51	51.8	112.7	5.06
T.I.Y.D. (Pool 22) C_{10}	151	65	45.0	107.7	4.71	109	51	54.8	117.2	4.60
T.L.Y.D. (Pool 26)C_9	155	66	49.8	117.0	4.06	111	53	56.8	116.9	5.19
T.Y.F.D. C_3 DM Res.	154	66	40.4	94.3	3.97	110	51	52.7	113.7	4.67
Ant. Ver. 181 (Pop. 24)	155	62	46.4	114.5	4.24	111	52	53.1	113.4	4.19
T.Y.F.D. C_3 St. Res.	156	61	42.6	105.3	4.62	106	46	46.2	106.4	5.35
Amar.Dent (Pop. 28)	153	62	52.6	130.3	4.42	107	47	54.4	124.0	4.98
Cogollero (Pop. 36)	152	63	46.2	118.3	4.16	110	50	53.7	113.1	4.72

Grain growth rate mg/day = $\dfrac{\text{wt/kernel (mg) at Black layer}}{\text{No. of days from flowering to Black layer}}$

Table 16. Performance of PET-3 materials in Mexico.

Pedigree	Tlaltizapan - 1979 Winter						Tlaltizapan - 1979 Summer					
	Yield kg/ha	Days 50% silk	Height(cm) Plant	Ear	Plants harvested	% Moisture	Yield kg/ha	Days 50% silk	Height(cm) Plant	Ear	Plants harvested	% Moisture
Tm.E.W.F. (Pool 27)C_9	5952	74	188	100	42	25.7	3402	51	203	113	44	19.5
Tm.E.W.D. (Pool 28)C_4	6851	74	196	106	44	22.0	3337	52	196	108	44	20.8
Tm.E.Y.F. (Pool 29)C_5	5284	70	173	89	44	22.6	3146	51	195	103	44	19.3
Tm.E.Y.D. (Pool 30)C_5	5887	71	186	98	42	20.7	2755	51	186	99	44	23.1
Indonesia Comp.-Corn Belt	6188	76	205	113	43	27.2	4201	55	219	119	44	26.3
Comp. Hungary (Pop. 48)	6867	77	198	106	42	26.1	3415	52	208	111	43	19.2
Tm. I.W.F. (Pool 31) C_5	7700	82	201	119	44	21.7	5621	58	206	125	43	31.4
Bl. Sub-tropical (Pop. 34)	7916	86	229	140	43	27.3	6576	61	234	146	44	42.4
Tm. I.W.D. (Pool 32)C_9	8092	83	209	129	43	19.9	6455	58	208	119	44	32.3
Tm. I.Y.F. (Pool 33)C_9	7294	79	205	114	44	19.0	4837	55	209	123	43	29.1
Tm. I.Y.D. (Pool 34)C_9	7028	80	200	115	43	32.4	5371	56	203	116	43	32.5
Am. Bajío (Pop. 45)	8037	80	213	124	43	28.8	4900	56	208	121	43	26.4
Ant.Rep. Dom.-Corn Belt	7239	81	216	128	44	21.6	5122	57	216	126	44	28.7
Am. Bajío-Templado	7402	84	219	135	44	20.0	5366	59	228	139	44	33.3
Sel.Pl.Peq.Maz.Gde.	6829	85	204	124	43	25.0	4899	61	216	125	43	33.6
LSD 5%	429						314					
C.V.%	8.8						10.3					

Table 17. Duration of grain filling, yield/day and grain growth (mg)/day of the PET-3 materials.

Pedigree	Tlaltizapan - 1979 Winter				Grain growth mg/day	Tlaltizapan - 1979 Summer				Grain growth mg/day
	Days from Pl.to P.M.	Fl.to P.M.	Yield (kg)/day Pl.to P.M.	Fl.to P.M.		Days from Pl.to P.M.	Fl.to P.M.	Yield (kg)/day Pl.to P.M.	Fl.to P.M.	
Tm.E.W.F. (Pool 27) C_9	136	62	43.8	96.0	4.79	108	57	31.5	59.7	4.77
Tm.E.W.D. (Pool 28) C_4	136	62	50.4	110.5	4.52	109	57	30.6	58.5	4.25
Tm.E.Y.F. (Pool 29) C_5	130	60	40.6	88.1	4.30	108	57	29.1	55.2	3.82
Tm.E.Y.D. (Pool 30) C_5	130	59	45.3	99.8	4.98	106	55	26.0	50.1	3.20
Indonesia Comp.-Corn Belt	135	59	45.8	104.0	4.12	108	53	38.9	79.3	3.81
Comp. Hungary (Pop.48)	136	59	50.5	116.4	4.05	107	55	31.1	62.1	4.18
Tm.E.W.F. (Pool 31) C_5	144	62	53.4	124.1	4.66	112	54	50.2	104.1	5.17
Bl.Sub.tropical (Pop. 34)	143	62	55.5	127.7	4.48	114	53	57.7	124.1	5.32
Tm.I.W.D. (Pool 32) C_9	145	62	55.8	130.5	4.71	112	54	57.6	119.5	5.02
Tm. I.Y.F. (Pool 33) C_9	141	62	51.8	117.7	4.32	114	50	42.4	82.0	3.81
Tm.I.Y.D. (Pool 34) C_9	136	56	51.7	125.5	5.59	111	55	48.4	97.7	4.76
Am. Bajío (Pop. 45)	136	56	59.1	143.5	6.00	110	54	44.5	90.7	5.03
Ant. Rep. Dom. - C.B.	140	59	51.7	122.7	4.83	107	50	47.9	102.4	5.24
Am. Bajío Templado	143	59	51.8	125.5	4.74	116	57	46.2	94.1	4.52
Sel. Pl.Peq. Maz. Grande	144	59	47.4	115.8	5.29	115	54	42.6	90.7	5.20

Grain growth rate mg/day = $\dfrac{\text{wt/kernel (mg) at Black layer}}{\text{No.of days from flowering to Black layer}}$

ADVANCED UNIT

CIMMYT's improved maize germ plasm reaches collaborators in national programs through the Advanced Unit, a multi-disciplinary team of scientists that focuses on population improvement through international testing. In 1978/79 this team worked with 26 maize populations, each designed to serve a tropical, sub-tropical, or temperate region. Before being sent out for international progeny testing, each advanced population is grown for three generations in Mexico. Each population undergoes continuous selection using mostly within-family variation and giving special emphasis to traits such as shorter plant height, fewer days to maturity, better standability, and better resistance to diseases and insects. Each advanced population is tested internationally in progeny trials once every two years at six sites, worldwide. These international progeny trials serve two purposes. First, about ten of the best progenies are identified by each international collaborator, and these will be used to form an experimental variety (selection pressure

approximately 4 per cent). Second, 30 to 40 per cent of the best across-site progenies are selected to regenerate the next cycle of the population.

Whereas the gene pools in the Back-Up Unit are selected on the basis of visual observations across sites in Mexico, the Advanced Unit populations are improved on the basis of specific progeny performance in replicated yield trials, using across-locations data from up to six sites around the world. Thus, the major selection pressure applied to each of the Advanced Unit populations is in agro-climatic conditions where the populations will be used.

MODIFIED POPULATION IMPROVEMENT SCHEME

The Advanced Unit population improvement program was modified in 1978 with a combination of both among- and within-family improvement procedures. This scheme (illustrated in figure 1) is designed to make optimum use of data retrieved from both north and south of the Equator.

FIGURE 1. Modified CIMMYT Maize Population Improvement Scheme.

STEP	SEASON	NO. OF FAMILIES	BREEDING SYSTEM
		Base Pop. + Pool	
1	A	$\pm$ 10 F.S.*	PROGENY REGENERATION 250 FS fams. are generated for IPTTs
2	B	250 F.S.	INTERNATIONAL PROGENY TESTING TRIALS (IPTTs) Simple lattice 16 x 16 at 6 different countries.
3	A	250 F.S. + $\pm$ 30 H.S.**	FAMILY IMPROVEMENT, ALTERNATIVES 1) Within family sibs in each group. 2) Within family sibs reciprocal. 3) S_1 Based on across sites performance about 32% of families are selected (3 ears from each original family).
4	B	$\pm$ 80 x 3 + $\pm$ 20 x 3	HALF-SIB RECOMBINATION AMONG SELECTED FAMILIES Bulk pollination among selected plants within each group.
1	A	$\pm$ 240 H.S. + $\pm$ 60 H.S.**	PROGENY REGENERATION Plant to plant (direct-reciprocal) crosses among families within group to generate a new set of 250 F.S. ($\pm$ 220 B.P. + $\pm$ 30 Pool). Repeat procedure.

BP = BASE POPULATION   A = OFF SEASON (Winter-Spring)
FS = FULL SIB   B = MAIN SEASON (Summer-Fall)
HS = HALF SIB

* Before 1978A progeny recombination and regeneration was done using the best F.S. families based on across site mean performance in the previous cycle.

** Evaluation of elite pool families can be started at steps 3 or 1.

This system also makes better use of the time between international progeny testing cycles for additional improvement for desired traits in Mexico. This modification allows breeders to capitalize on within-family variation to improve the population further for specific characters (step 3 in figure 1). In addition, better recombination of the improved families is accomplished in the additional generation (step 4) in the modified scheme.

Table 1 lists the maize populations currently being improved. Tables 2 and 3 list the traits being emphasized in the improvement of each population during the family improvement phase.

Development of Experimental Varieties (EV)

Figure 2 depicts the flow and time sequence of the germ plasm improvement process from progeny regeneration, International Progeny Testing Trials (IPTTs), through the development and testing of Experimental Varieties (EV) and Elite Experimental Varieties (ELV) to supply seed to national programs for multiplication and trials in farmers' fields.

A very high selection intensity is used in developing site-specific and across-site experimental varieties. Usually the "ten best" of the 250 families are selected and their remnant seed is used for a balanced recombination to constitute the corresponding EV. Seed of all EVs is increased in the following season for further testing as ELVTs and for use by cooperators.

As in previous years, the EVs are designated by the name of the testing site (or across-sites), year, and population number, in that order (e.g., Poza Rica 7822). Since 1978, specific country requests to create an EV have been identified by placing a number in parenthesis following the testing site name (e.g., San Andres (1) 7823). When more

than one specific country request is received, it is identified sequentially (e.g., San Andres (2) 7823). EV designations that do not have numbers in parenthesis are based on statistically analyzed data collected through the international testing program.

Superior varieties are identified through multilocation Experimental Variety Trials (EVTs) and Elite Experimental Variety Trials (ELVTs). Seed of each EV (or ELV) is increased immediately and sufficient quantities are maintained so that foundation seed can be made available quickly for use by national programs or other cooperators. The cooperators can use the experimental varieties and improved populations for: (1) direct release after further national testing, (2) further improvement and selection under their conditions, and (3) use in their national breeding program for improvement of their populations or development of lines for hybrid programs.

ADVANCED UNIT OPERATIONS IN MEXICO

Tables 2 and 3 show the improvement sequence in the Advanced Unit populations for the 1978A, 1978B, 1979A, and 1979B growing seasons.

Family improvement objectives included selection for reduced plant height, standability, earliness, better resistance to fall armyworm (FAW) and sugar cane borer (SCB), better ear rot resistance, and better stalk quality.

Introgression of New Germ Plasm into Advanced Unit Populations

Figure 1 shows the procedure used for adding new germ plasm to Advanced Unit populations. Outstanding families from corresponding pools can enter the improvement scheme at either steps 1 or 3. Germ plasm additions remain separate from the base population through

FIGURE 2. CIMMYT's International Maize Population Improvement and Utilization.

SEASON	GERMPLASM IMPROVEMENT						IMPROVED GERMPLASM UTILIZATION
A	PROGENY REGENERATION NURSERY TO PRODUCE 250 F.S. FAMS./POP.						
B	LOC. 1	LOC. 2	LOC. 3	LOC. 4	LOC. 5	LOC. 6	PROGENY TRIALS (IPTTs) (250 F.S. + 6 CHECKS) SIMPLE LATTICE 16 x 16.
A	FAMILY IMPROVEMENT BASE POP. + ORIGINATED FROM POOLS						EXP. VAR. DEVELOPMENT WITH 10 BEST FAMS. FROM EACH LOC. AND 10 BEST ACROSS LOCATIONS.
B	FAMILY IMPROV. & RECOMBINATION						EXP. VAR. TRIALS ARE CONDUCTED AT 30 TO 50 LOCATIONS. EXP. VARS. SEED IS INCREASED
A	PROGENY REGENERATION NURSERY TO PRODUCE 250 FULL SIB FAMS.						ELITE EXP. VAR. TRIALS ARE CONDUCTED AT 60 TO 80 LOCATIONS.
B	LOC. 1	LOC. 2	LOC. 3	LOC. 4	LOC. 5	LOC. 6	PROGENY TRIALS. (IPTTs)

ELITE POOL FAMILIES CAN BE STARTED AT FIRST OR THIRD STEPS.

In the course of the breeding activities, new techniques and apparatus are developed to improve and speed the work. One such device is the bazooka used for larvae infestation. With the bazooka, 1,500 plants can be uniformly infested in one hour—a 300 percent increase over former methods. CIMMYT is distributing bazookas to national collaborators.

the IPTT phase. Only progenies that demonstrate superior agronomic performance across locations (and thus would contribute positively to the base population) are merged genetically during the next improvement cycle.

Table 4 lists the contributions of various pools to Advanced Unit base populations in 1978 and 1979. The amount of new germ plasm merged to the base populations varied from 0 to 46 per cent.

New Populations and Discontinuation of Some Advanced Unit Populations

Table 5 lists new populations in the Advanced Unit and their origins (based on complete germ plasm substitution coming from Back-Up, Special Projects, and Quality Protein Units). Changes included complete genetic replacement of two populations (Populations 33 and 39, and promotion of three new populations (Populations 30, 31, 45). The Populations 37 and 53 were discontinued. Details of basic germ plasm constituting new populations are described in the Back-Up, Special Projects, and Quality Protein sections of this report.

Special Advanced Unit Trials

Results of Experimental Variety F_1/F_2 Trial

In 1979A and 1979B, trials were conducted at Poza Rica and Tlaltizapan to assess the differences in yield performance of F_1 and F_2 generations of ELVs. Fifteen ELVs were chosen and the yields of the F_1 and F_2 gen-

erations of each ELV were compared. Each variety was formed from 8 to 13 full-sib families. For each variety, the F_1 generation consisted of a balanced genetic recombination of all families (obtained by a balanced plant-to-plant crossing among all families). The F_2 generation was advanced through bulk pollinations of F_1 generations of each variety.

Yield depression from F_1 to F_2 of ELVs tested varied from 0.3 to 17.3 per cent (table 6). The average depression over environments and varieties was 7.2 per cent and was significant. Yield depression (over environments) between F_1 and F_2 generations was highly significant (6.9 to 12.7 per cent) for eight varieties, significant for two varieties (5.6 to 5.8 per cent), and was not significant for the remaining five varieties (3.5 to 5.1 per cent).

Yield depression at different sites was quite variable for most varieties, although the depression for five varieties was more stable across sites. It would seem that some varieties are more stable than others.

Progress in Advanced Unit Populations after Two to Three Cycles of Improvement

Thirteen populations that had completed two to three cycles of improvement were chosen to evaluate the progress of selection in these populations.

The first trial was grown in 1978B at three locations in Mexico, and the performance was determined in terms of yield, plant height, and days to flowering for cycle 1 to cycle 2 or 3 (table 7). Problems with seed and growing conditions allowed only preliminary conclusions to be

drawn from this data. However, trends of progress clearly demonstrated increased yields, shortened plant height, and reduction in time to flowering.

To document progress more accurately, the trial was repeated in 1979B. The same 13 tropical populations were tested again to evaluate the improvement between cycle 0 and the latest cycle (C_2 or C_3) of selection. Table 8 shows the across-site performance for days to silking, plant height, and yield. The across-site performance showed a significant yield increase over two to three cycles of improvement for six of these populations. In four populations, days to maturity were reduced significantly. Six populations showed a significant reduction in plant height over the cycles of improvement. All 13 populations showed some increase in yield along with a decrease in days to silking and plant height.

The highest gains in yield, along with a considerable decrease in days to silking and plant height, were observed in the populations Cogollero and La Posta. Two cycles of selection in the population Cogollero resulted in a yield increase of 20 per cent over C_0, a decrease of 2 days to silking, and a reduction of 12 cm in plant height. La Posta gained 16 per cent in yield after three cycles of improvement and was three days earlier to silking and 12 cm shorter in plant height. It should be noted that in 1975, after one cycle of improvement, the best fraction of population IDRN was merged into Cogollero. This merging might explain part of the 20 per cent yield gain over two cycles of improvement. No germ plasm was added to the population La Posta.

The populations Antigua-Veracruz 181 and Amarillo Cristalino 1 also showed a highly significant increase in yield (10.6 and 13.6 per cent) over three cycles of improvement, while their maturity and plant height were only slightly reduced. The populations Blanco Cristalino 1 and Antigua-República Dominicana showed a significant yield increase, but only a moderate reduction in maturity and plant height characters.

The populations (Mix.-Col.Gpo.)ETO and Mezcla Amarilla were one day earlier to silking, showed slightly reduced plant height, and showed only slight improvement in yield.

Only moderate improvement was measured for Populations 21, 22, 28, 29, and 32. This may be related to the lack of adequate data from IPTT sites which prevented selection of really superior progenies for population improvement. In the initial stages of improvement, the selection of the best families for the next cycle of improvement was sometimes based on only two sites. This factor, plus the poor quality of some of the IPTT data, may explain the more modest progress made in improving these populations.

Despite these limitations, the results of these trials clearly demonstrate the effectiveness of the full-sib population improvement system used by CIMMYT since 1974. Data from experimental trials at Ciudad Obregon (a heat

and moisture stress environment) show that the latest cycle of improvement had considerably better yield performance than did cycle 0 (table 9). This could be an indication of improved adaptability of the advanced populations to some stress situations.

It is important to emphasize that these populations were not subjected to intense selection pressure for yield alone. Rather, a combined pressure for yield, reduction in plant height, and earlier maturity was applied. Therefore, the assessment of the relative values of yield improvement for most of the populations also should include considerations of the gains made in their maturity and plant height characters.

Formation and Increase of Experimental Varieties

Table 10 provides information on EVs that were developed and increased during 1978-79. A total of 142 EVs were developed from 30 populations. There was a total of 173 seed increases from F_1 to F_2 generations. This seed was used to meet the demands for conducting the international EVTs and ELVTs and to fill cooperating country seed requests for use in their breeding and production programs.

DISTRIBUTION AND RESULTS OF INTERNATIONAL TESTING

In 1978, international progeny testing included 13 Advanced Unit populations of Group 1 and in 1979, 13 of the 14 populations of Group 2 (table 1). Populations 37, 42, and 53 were eliminated from the Advanced Unit program at the end of 1978.

Advanced Unit trials conducted at CIMMYT experimental stations in 1978-79 included 31 IPTTs (18 at Poza Rica, 7 at Tlaltizapan, 4 at Ciudad Obregon, 1 at El Batan and 1 at Toluca); 12 EVTs (8 at Poza Rica, 2 at Tlaltizapan, 1 at El Batan and 1 at Toluca); and six ELVTs (4 at Poza Rica and 2 at Tlaltizapan). Details and results are given in 1978 and 1979 *Maize International Testing Reports*.

Distribution and data recovery percentages for the IPTTs, EVTs, and ELVTs are given in table 11. In 1978, a total of 76 IPTTs, 295 EVTs, and 206 ELVTs were requested by 80 countries. In 1979, 76 IPTTs, 244 EVTs, and 233 ELVTs were sent to collaborators in 85 countries. Data were recovered from 48 per cent of the total trials distributed in 1978. In 1979, data retrieval by July 1980 (72 per cent) was very good for IPTTs, while the data returns were less for EVTs and ELVTs (EVTs: 26 to 49 per cent; ELVTs: 24 to 36 per cent). Additional data are expected, but cannot be included in this report.

Results from the 1978 and 1979 IPTTs are presented in tables 12 to 15. The best performing varieties identified in EVTs 12, 13, 14A, 14B, 15, 16, 17 and ELVTs 18, 19, 20 are listed in tables 16 to 25. Complete data for each IPTT, EVT, and ELVT (for which results were returned) have been presented in the 1978 and 1979 *Maize International Testing Reports*.

CIMMYT's Advanced Unit is responsible for the refinement and handling of those maize materials which are ready for international testing. In general, improved Advanced Unit materials are shorter in height, more uniform, mature earlier, and are agronomically superior when compared to the original cycles of selection.

Results of International Progeny Testing Trials (IPTTs)

Results are reported from 54 of the 76 IPTTs for 1978. The remaining 27 IPTTs were either not planted or were lost due to environmental problems such as floods and droughts.

Table 12 shows: (1) mean yield of selected families (10 in most cases) for variety development and the mean yield of all 250 progenies, as per cent of the mean of the checks, (2) days to silk, as number of days earlier or later than check means, and (3) plant height, as number of centimeters taller or shorter than check means. In most cases, the mean yield of progenies selected for EV formation was considerably superior (up to 251 per cent) to that of the mean of the checks. For about two-thirds of all 71 site-specific and across-site experimental varieties, the mean performance of the selected progenitors was superior to the best check variety in yield. These were usually earlier and shorter. EV progenitors superior to the best checks were identified in the IPTTs grown in Mexico, Nicaragua, El Salvador, Haiti, Colombia, Ecuador, Peru, Bolivia, Brazil, Tanzania, Zaire, and Ghana. Most of the remaining EV progenitors identified were equal to the best check in yield, and were earlier and/or shorter.

Selection pressure applied to Group 1 populations in improvement phases (table 13) ranged from 30 to 64 per cent (average 44 per cent). For three populations (pop. 39, 43, and 45), data were recovered from only two testing sites before recombination time, thus a high selection pressure was not applied. The selection differential for yield

of the families selected for the fourth cycle of population improvement ranged from 4 to 13 per cent (mean 9 per cent) over the population mean. With the exceptions of populations 35 and 44, the mean yield of the selected families was superior to the check means. Differences between the selected progeny mean and population mean were negligible for maturity; variable, but slight, for plant and ear height; and slightly improved for ear rots and lodging.

Poor data recovery in 1978 was one of the barriers to better progress. Data were returned on average from only three of six possible sites before recombination time. Data recovery was 50 per cent or less for six populations. This resulted in the application of relatively low selection intensity, and will be reflected by slower genetic gains over cycles of improvement for these populations.

Data recovery for the 1979 IPTTs (Group 2) was much better: 53 (70 per cent) out of 76 sites had returned data before the recombination of the selected families. Superior progenies were selected to form 72 EVs for testing in 1980.

Table 14 shows the selection pressure applied to Group 2 populations, as well as the performance of selected families for the next cycle as compared to the population mean performance.

The selection differential for yield of all the populations ranged from 5 to 13 per cent (mean 9 per cent) over the population mean. Stronger selection was applied for ear rot and husk cover. Selected families showed much better performance for these characters than the mean of the

35

population. For the other characters mentioned in Table 14, the performance of the selected families was equal to that of the mean of the population.

IPTT results available by July, 1980, are summarized in table 15. Included in this table are the mean performances of progenies selected for 1979 EV development and their comparisons to the population, the mean of the checks, and best check. These data indicate a trend similar to the 1978 results. For most populations and testing sites, it was possible to select ten progenies having a mean yield equal or superior to that of the checks mean or best check, which could be used to develop EVs with potential for better yield and agronomic characteristics. Countries that grew IPTTs and identified EV progenitors superior or equal in mean yield to the best check variety (along with earlier maturity and/or shorter plant height) included Mexico, Guatemala, Costa Rica, Honduras, Panama, Venezuela, Ecuador, Peru, Bolivia, Brazil, Chile, Pakistan, and Egypt. For the intermediate maturity populations (Populations 26, 30, and 31) the best check varieties were, in most cases, sufficiently late and tall to nullify comparison with EV progenitors in terms of yield performance.

Test results for 1978 and 1979 showed that the best checks often were hybrids. In many cases, a number of EV progenitors competed favorably with these check hybrids in terms of yield performance, and often were much shorter and earlier in maturity.

Results of Experimental Variety Trials

EVT 12—In 1978 and 1979, a total of 67 tropical late white dent and flint EVs were tested in EVT 12. Eleven of these EVs originated from population Tuxpeño 1, 11 from Mezcla Tropical Blanca, 7 from Tuxpeño Caribe, 8 from Braquiticos, 9 from La Posta, 5 from Blanco Cristalino 1, 3 from (Mix.- Col.Gpo.)ETO, 2 from ETO Blanco, and 11 from AED x Tuxpeño.

Table 16 shows the performance of the best EVs in 21 different countries. In Bolivia, Costa Rica, Honduras, Guatemala, Mexico, Colombia, Ghana, Zaire, Saudi Arabia, Tanzania, Nigeria, Malawi, Swaziland, Yemen A.R. and Philippines, several EVs from various populations yielded significantly more (up to 88 per cent) than the best local check, and in most cases were earlier in maturity and shorter in plant height. In other countries, EVs were equal in yield to the best check (often a hybrid) but were much earlier and/or shorter than the check. The best performing EVs were derived from Mezcla Tropical Blanca, Tuxpeño-Caribe, and La Posta. Some EVs from Blanco Cristalino 1, AED x Tuxpeño, Tuxpeño, Braquiticos, and (Mix.-Col.Gpo.) ETO performed well in some countries. In EVT 12, the outstanding EVs in 1978 across countries were Los Baños (3) 7622, Ferke (1) 7622, Poza Rica (E) 7729, Omonita 7643, Poza Rica 7643, and Across 7643. La Máquina 7721 and Palmira (2) 7631 also performed well.

The 1979 elite varieties (ELVs) identified from the

1978 EVT 12 were La Maquina 7843, Poza Rica 7843, Poza Rica 7822, Across 7622, Across 7729, Dholi 7622, Guanacaste 7729, Kisanga 7729, Across 7721, and San Andres (1) 7823.

EVT 13—A total of 37 tropical, late, yellow dent and flint EVs were tested in EVT 13 in 1978 and 1979. Twelve EVs were derived from the population Amarillo Cristalino 1, 10 from Amarillo Dentado, 6 from Cogollero, 2 from Antigua-Veracruz 181, 3 from Mezcla Amarilla, and 4 from Antigua-Republica Dominicana.

Table 17 shows the performance of the best EVs from EVT 13 as compared to the best check for yield, days to silking, and plant height. These EVs seem to have excellent potential for use by national programs. In nearly all countries, several EVs were equal to or out-yielded the best check, and were earlier in maturity and significantly shorter in plant height.

Experimental varieties from all populations in this trial performed well. Several EVs derived from parent population 28, Amarillo Dentado, showed very good performance. Across 7728 and Poza Rica 7728 were the highest yielders and showed stable performance over many locations. Several EVs, derived from various parent populations, performed outstandingly (110 to 191 per cent of best check yield) in Guatemala, Jamaica, Haiti, Honduras, Mexico, Panama, Dominican Republic, Bolivia, Colombia, Peru, Ghana, Ivory Coast, Mali, Sierra Leone, Nigeria, Upper Volta, Sudan, Yemen A.R., Saudi Arabia, Bangladesh, Pakistan, Nepal, Burma, Sri Lanka, and the Philippines.

EVT 14A— This trial, which included tropical, intermediate, yellow dent, and flint EVs, was distributed in 1978 only. It included 13 varieties: 5 from population Antigua-Veracruz 181, 6 from Mezcla Amarilla, and 2 from Antigua-República Dominicana. Table 18 lists the best performing EVs from this trial grown in 24 countries. Experimental varieties outyielded the best check in 13 countries, and, in many countries, the varieties were either better than the checks in maturity (earlier) or plant height (shorter), or both. Superior varieties were Across 7624, Pichilingue 7726, and Ferke (2) 7635. These varieties performed well in Peru, Costa Rica, Dominican Republic, Bolivia, Nigeria, Sudan, Sri Lanka, Pakistan, Burma, the Philippines, and Bangladesh.

EVT 14B—Thirty-three tropical, intermediate-to-late, white flint, and semi-flint EVs were tested in EVT 14B in 1978 only. Six EVs originated from Blanco Cristalino 1, 11 from (Mix.-Colima Gpo.) ETO, 5 from the "old" population 30, Blanco Cristalino, and 11 from ETO Blanco. Table 19 shows the performance of the best EVs in 20 countries. In 13 countries, some varieties were superior to the best local checks in terms of higher yield, earlier maturity, and shorter plant height. Countries where several EVs performed well (yield 109-192 per cent compared to best check) included Bolivia, Guatemala, Mexico, Senegal,

Nigeria, Zaire, Nepal, and the Philippines.

Experimental varieties that were superior across countries were Nyankpala 7623, Cali 7623, Maracay 7525, Ilonga 7530, San Andres (2) 7530, San Andres (2) 7632, and Los Baños (3) 7632.

EVT 15—A total of 27 tropical and subtropical quality protein maize (QPM) EVs (intermediate and late, white and yellow, flint and dent) were tested in EVT 15 in 1978 and 1979. Four EVs originated from PD(MS)6 H.E.o_2, 1 from Tuxpeño o_2, 8 from Yellow H.E.o_2, 9 from White H.E.o_2, and 5 from Templado Amarillo H.E.o_2. Table 20 shows the performance of the best EVs in 23 countries.

In 14 countries, yields of some QPM EVs were equal to or superior to the best check varieties (in most cases these were either normal hybrids, varieties, or both), and were usually earlier and shorter. Some of the QPM EVs evaluated in Bolivia, West Africa, Pakistan and South East Asia (except Thailand) showed considerable promise. Although ear rots are sometimes a severe problem with QPM materials, many of the QPM varieties tested were equal to or showed less ear-rot incidence than did the check varieties.

The best QPM EVs identified in this trial in 1978 were Obregon 7740, Tlaltizapan 7740, Satipo (2) 7639, and Tlaltizapan (E) 7741. In the 1979 trials, three varieties (Ilonga 7740, Across 7740, and Laguna 7740) showed good and stable performance.

EVT 16—Thirty-three temperate-subtropical late (white and yellow, flint and dent) EVs were tested in EVT 16 in 1978 and 1979. Eight varieties were derived from the "old" population Amarillo-Subtropical, 9 from Blanco Subtropical, 8 from ETO x Illinois, 1 from AED x Tuxpeño, 2 from Amarillo Bajio, and 5 from Hungarian Composite. Table 21 shows the performance of the best EVs in 24 countries.

With the exception of results from two countries in southern Africa, the yield performance of several EVs was equal to or superior to that of the best local checks. In terms of comparative maturity and plant height, the performance of the varieties was somewhat mixed—sometimes much later and taller, or earlier and shorter than the local checks. This is probably due to the wide diversity of the check varieties and to the environmental conditions (subtropical and temperate) under which these EVs were grown.

Across locations, the outstanding EVs from the 1978 trials were Tlaltizapan 7633, Tlaltizapan 7734, Sids (1) 7734, Pantnagar 7734, Cali (2) 7642, Across 7642, and Obregon 7748. On the basis of data from 14 sites in 1979, the best performing EVs were Tlaltizapan 7842, Across 7734, Tlaltizapan 7833, Tlaltizapan 7844, and Tlaltizapan 7845. Several of the EVs from this trial showed outstanding performance in Mexico, Bolivia, Chile, Egypt, Lesotho, Nigeria, Bangladesh, Pakistan, Iraq, Burma, Afghanistan, Yemen A.R., Jordan, Morocco, and Saudi Arabia.

EVT 17—Eight experimental highland maize varieties were tested in EVT 17 in 1978. One EV originated from early white dent materials, 1 from early white floury, 4 from early yellow flint, 1 from early yellow dent, and 1 from intermediate yellow dent populations. The performance of the best EVs in five countries is shown in table 22. Some of the EVs were much superior in yield to the best checks in four of the five countries. Batan 7660, Toluca 7653, and Batan 7652 were superior across locations. Batan 7660 was the outstanding variety in Ethiopia, Lesotho, and Mexico.

Results of Elite Experimental Variety Trials (ELVTs)

After EVs have performed consistently well (for yield and other characters) across the locations in which they are tested in EVTs, they are classified as "Elite" varieties and undergo wider testing in elite variety trials (ELVTs). This testing is described below.

ELVT 18—This trial consisted of all EVs identified as elite varieties from the EVTs 12, 13, 14A, and 14B grown in 1977 and 1978. It included 34 tropical ELVs of intermediate-to-late maturity, and white and yellow flints and dents. This trial was distributed to more than 100 locations in 85 countries in 1978 and 1979. Table 23 lists the performance of the best ELVs compared to the best check varieties in 38 countries.

In most of the countries that grew this trial, ELVs were identified that were equal or superior in yield to the best local checks. In most cases, they were equal or earlier in maturity, and in many instances, they were much shorter (up to 78 cm) than the best local check. Several of the EVs that demonstrated superiority and potential at the EVT level of testing were confirmed as being outstanding and stable performers in the ELVTs. With two years of stable performance confirmed at several locations in a given country, national programs can recommend use of such varieties in their production or improvement programs with some confidence.

Elite varieties have demonstrated their potential for increased production in Bolivia, Peru, Venezuela, Panama, Honduras, Nicaragua, Haiti, the Bahamas, Mexico, Upper Volta, Senegal, Ivory Coast, Ghana, Botswana, Tanzania, and the Philippines.

The most outstanding ELVs across locations in 1978 were: Across 7522, Delhi (1) 7622, Across 7528, Ferke (1) 7529, and Across 7529. Based on 1979 data received from 24 countries, the outstanding ELVs were Poza Rica 7643 and Ferke (1) 7622, Poza Rica (E) 7729, and Tocumen 7728.

ELVT 19—This trial included the 12 QPM experimental varieties identified as elite in EVT 15 trials conducted in 1977-78. The QPM ELVs were of tropical and subtropical adaptation, with late and intermediate characteristics, of yellow and white grain color, and flint and dent types. Three were derived from population Tuxpeño o_2, 1 from PD(MS)6

37

H.E.o_2, 4 from Yellow H.E.o_2, 3 from White H.E.o_2, and 1 from Templado Amarillo H.E.o_2.

Table 24 lists the performance of the best ELVs in 26 countries for 1978-79. The QPM ELVs were equal or superior to the best local checks (in most cases normal varieties) in fewer countries than observed with CIMMYT's normal ELVs. The yield performance of some of these QPM ELVs was equal to or better than that of the best checks in the following countries in 1978 and/or 1979: Peru, Panama (1979), Mexico (1979), Senegal (1979), Tanzania, Pakistan, Burma, and the Philippines.

However, the results from EVT 15 (Table 20) and OMPT 11A and OMPT 11B (see QPM section) indicate that some of the newer QPM experimental varieties are showing better yield potential and may soon demonstrate equal or superior agronomic performance as compared to normal maize varieties and hybrids.

ELVT 20—In 1978 and 1979, a total of 17 temperate-subtropical varieties were tested in ELVT 20. These ELVs were selected for testing based on their performance in EVT 16 in 1977 and 1978. Three were derived from the "old" population Amarillo Subtropical, 3 from Blanco Subtropical, 7 from ETO x Illinois, 3 from AED x Tuxpeño, and 1 from Hungarian Composite. Table 25 shows the performance of some of the best ELVs in 22 countries.

ELVs were equal to, or superior in yield to, the best local checks in Argentina, Mexico, Bolivia, Surinam, Egypt, Ethiopia, Somalia, Jordan, Saudi Arabia, Republic of South Africa, Botswana, Zaire, Mali, Malawi, and Pakistan. In several countries, they were as much as seven days earlier in silking and 46 cm shorter when compared to the best local checks.

Across all locations, the best performing ELVs were Ukiriguru 7542, Khumaltar (1) 7633, and Ukiriguru 7534 in 1978; and Tlaltizapan 7644, Gemeiza (2) 7644, Tlaltizapan 7633, and Across 7642 in 1979.

Further Comments on International Testing in 1978-79

In total, more than 80 countries participated in the international testing program in 1978 and 1979. Table 26 summarizes the contribution of these maize populations through the performance of the population *per se* (IPTTs) and through varieties derived from the populations (EVs and ELVTs).

In 1978-79, the populations distributed worldwide included 21 lowland tropical maize populations, 7 subtropical/temperate, and 5 tropical highland populations (1978 only).

Table 26 shows that the best performing materials were the lowland tropical populations Amarillo Dentado 1, Cogollero 1, Amarillo Cristalino 1 (yellow), Mezcla Tropical Blanca 1, and Tuxpeño Caribe 1 (white). They made excellent contributions to national program efforts in more than 25 different countries around the world. Among the subtropical/temperate materials, the populations ETO x Illinois, Amarillo Subtropical, and Blanco Subtropical performed well in more than 20 different countries.

The newly created populations Blanco Cristalino 2, Amarillo Cristalino 2, and Amarillo Bajio have not been tested sufficiently to verify the potential which these earlier-maturing materials have.

Table 27 lists the countries in which experimental maize populations outperformed the best local checks. In 54 of the countries that grew trials in 1978-79, EVs performed as well as or better than the best check.

Detailed information about the performance of CIMMYT's maize populations in EVTs and ELVTs is given in tables 16 to 25. Very often the new EVs and ELVs are compared against the best locally developed hybrid varieties. The data in table 28 show the substantial superiority of the EVs over the hybrids in low-to-medium yielding environments, while the hybrids are superior under high-yielding conditions (see also tables 16 to 25). Apparently, the EVs with their broader genetic base have a much better buffering capacity under stress conditions than do the genetically narrower hybrids. This evidence suggests that open-pollinated varieties are more suitable for subsistance farming conditions, where the short-term objective is to improve very low yield levels that average between 1 and 3 t/ha.

Analysis of the across-location performance of the EVs tested worldwide provides a clear view of the wide adaptation capability of several of the new EVs. Among these outstanding new varieties are Across 7728, Poza Rica 7643, and Ferke (1) 7622.

One of the future Advanced Unit activities will be the development of earlier-maturity populations and varieties for lowland tropical and subtropical-temperate environments.

Table 1. List of CIMMYT maize populations in 1978-1979.

	(Group I) Internationally tested in even years.		(Group II) Internationally tested in odd years.
Pop. no.	**Population name**	**Pop. no.**	**Population name**
22	Mezcla tropical blanca	21	Tuxpeño-1
23	Blanco cristalino-1	25	(Mix. 1 - Col. Gpo. 1) ETO
24	Antigua-Veracruz 181	26	Mezcla amarilla
27	Amarillo cristalino-1	28	Amarillo dentado
32	ETO blanco	29	Tuxpeño caribe
33	Amarillo subtropical	30	Blanco cristalino-2
35	Antigua-Rep. Dom.	31	Amarillo cristalino-2
39	Yellow H.E. o_2	34	Blanco subtropical
42	ETO-Illinois	36	Cogollero
43	La Posta	37*	Tuxpeño o_2
44	AED-Tuxpeño	38	PD (MS) 6 H.E. o_2
45	Amarillo del bajio	40	White H.E. o_2 -1
47	Templado blanco dentado	41	Templado amarillo o_2
53*	Highland early white floury	48	Compuesto de Hungria

* Populations 37 and 53 were discontinued in 1978.

Table 2. Seasonal sequence in the improvement of maize populations, 1978.

Pop. no.	Selection emphasis	Group I — Breeding Procedures			
		1978A	1978B	1979A	1979B
		- POZA RICA -			
22	Reduced plant height	Reciprocal sibs	IPTT*	Within family sibs	Recombination of sibs
23	" " "	"	"	" " "	" " "
24	Fall armyworm resistance	"	"	Selfing	" " S_1s
27	Sugar cane borer resistance	"	"	"	" " "
32	Earliness	"	"	Within family sibs	" " sibs
35	Standability	"	"	Selfing	" " S_1s
39	Reduced plant height	"	"	Within family reciprocal sibs	" " sibs
43	" " "	"	"	Within family sibs	" " "
		- TLALTIZAPAN -			
33**	Uniformity: plant type, maturity	"	"	Among family sibs	Among family sibs
42	Reduced plant height	"	"	---------------	---------------
44	Uniformity: plant type, maturity	"	"	---------------	---------------
45	Reduced plant height	"	"	Within family sibs	Recombination of sibs
47	Uniformity: plant type, maturity	"	"	Among " "	Among family sibs
53	---------------------	- EL BATAN & TOLUCA - IPTT*		Discontinued	---------------

Note.   In each season, selection pressure is applied for the primary characteristic. Other desirable traits are taken into consideration to the extent possible. Recombination is accomplished by bulk pollination of selected plants. Reciprocal sibs among families are made to regenerate the 250 full sib families for the following cycle of yield testing.

*   Mexico plus 5 other countries.

** Population 33 was completely replaced by families from pool 33 in 1979A.

Table 3. ' Seasonal sequence in the improvement of maize population 1979.

Pop. no.	Selection emphasis	Group 2 Breeding Procedures			
		1978A	1978B	1979A	1979B

- POZA RICA -

Pop. no.	Selection emphasis	1978A	1978B	1979A	1979B
21	Fall armyworm resistance	Selfing	Recombination of S_1's	Reciprocal sibs	IPTT's**
25	Sugar cane borer resistance	"	" " "	" "	"
26	Earliness	Within family sibs	" " sibs	" "	"
28	Reduced plant height	" " "	" " "	" "	"
29	" " "	" " "	" " "	" "	"
30	Uniformity: plant type, maturity	Among family sibs	Among family sibs	" "	"
31	" " " "	" " "	" " "	" "	"
36	Reduced plant height	Within family sibs	Recombination of sibs	Discontinued	-----
37*	Ear rot resistance	Selfing	Recombination of S_1's	Reciprocal sibs	IPTT's**
38	Earliness	Within family sibs	" " sibs	" "	"
40	Reduced plant height	" " "	" " "	" "	"

- TLALTIZAPAN -

Pop. no.	Selection emphasis	1978A	1978B	1979A	1979B
34	Reduced plant height	Within family sibs	Recombination of sibs	" "	"
41	Ear rot resistance	Selfing	" " S_1's	" "	"
48	" " "	"	" " sibs	" "	"

Note.- In each season, selection pressure is applied for the primary characteristic. Other desirable traits are taken into consideration to the extent possible. Recombination is accomplished by bulk pollination of selected plants. Reciprocal sibs among families are made to regenerate the 250 full sib families for the following cycle of yield testing.
* Discontinued in 1978.
** Mexico plus 5 other countries.

Table 4. New full-sib families added to AU populations for IPTTs in 1978-79 and number of full-sib families merged genetically with base population.

Pop. No.	Population Name	Constitution for IPTT		Selected no. of F.S. merged for next cycle from:	
		No. F.S. of A.U. Pop.	No. F.S. from new Germplasm	A.U. Pop.	New Germplasm
21	Tuxpeño-1	190		79	
			30 Pool 24		16 (17%)
			30 TSR-Conv.*		1 (1%)
22	Mezcla Trop. Blanca	233		107	
			17 Pool 24		13 (11%)
23	Blanco Cristalino-1	230		104	
			20 Pool 23		11 (10%)
24	Ant. x Ver. 181	220		84	
			30 B.U. FAM		16 (16%)
26	Mezcla Amarilla	190		47	
			35 Pool 21		22 (26%)
			25 TSR-Conv.*		17 (20%)
27	Amarillo Cristalino-1	230		62	
			20 B.U. FAM		14 (18%)
28	Amarillo Dentado	184		70	
			36 Pool 26		9 (10%)
			30 TSR-Conv.*		13 (14%)
29	Tuxpeño Caribe	200		74	
			50 TSR-Conv.*		10 (12%)
34	Blanco Subtropical	220		96	
			30 Pool 31		10 (8%)
35	Ant.-Rep. Dom.	240		110	
			10 Across 7535		0 (0%)
41	Templado Amarillo H.E.o$_2$	222		86	
			28 Lote 191		12 (12%)
43	La Posta	238		108	
			12 Pool 25		7 (6%)

* TSR = Tar spot resistant conversion (Phyllachora maydis).

Table 5. Genetic constitution of new AU populations.

Pop. No.	Group	Population Name	GENETIC CONSTITUTION						
			Source	Improvement within Mexico				No. of F.S. constituting C-0	First IPTT
				No. H.S. cycles	No. H.S. FAM	No. F.S. recomb.	Progeny test		
30	2	Blanco Cristalino-2	Lote 81 (Sel. precoz)	5	242	1	---	100	1979
			Pool-15		77	-	---	150	
31	2	Amarillo Cristalino-2	Lote 81 (Sel. precoz)	5	358	1	---	235	1979
			Pool-17	4	30	-	---	15	
33	1	Amarillo Sub-tropical	Pool 33	9	275	2	---	250	1980
39	1	Yellow H.E.o$_2$	CIMMYT H.E.o$_2$	4	402	2	3 Loc.	250	1978
45	1	Amarillo Bajío	Lote 83 (Am. Bajío)	8	439	-	---	250	1978
47	1	Templado Blanco Dentado	Pool 32	9	276	2	---	250	1980

Table 6. Per cent yield reduction of 15 Elite Experimental Varieties from F_1 to F_2 at 4 different environments.

	Variety		No. Fam.	Yield (Kg/ha) variation of FAM	Relative Yield depression from F_1 to F_2 at				
					PR 79 A	PR 79 B	TL 79 A	TL 79 B	$\overline{X}$
1	La Maquina	7422	13	2090	- 8.1*	+ 5.7	- 3.2	-14.7**	- 4.8
2	Across	7422	9	1290	- 9.6*	- 9.2*	- 7.5	-13.2*	- 9.6**
3	Across	7522	10	1100	- 6.1	- 2.3	- 7.0	- 6.1	- 5.6*
4	Palmira	7522	10	2540	- 9.3**	- 9.9*	- 6.2	- 9.5	- 8.3**
5	Poza Rica	7423	13	470	- 8.8*	- 7.9	- 7.5	- 9.8	- 8.4**
6	Across	7424	9	640	- 5.7	- 6.4	+ 1.8	-12.6*	- 4.9
7	Across	7425	9	1500	- 4.0	-10.8*	- 5.9	-17.3**	-10.0**
8	Tocumen	7428	10	1440	- 0.3	+ 4.6	- 8.4*	- 8.6	- 4.3
9	Yousafwala	7428	8	----	- 6.9	- 1.8	- 6.5	- 4.9	- 5.1
10	Guanacaste	7528	10	1640	-14.1**	- 1.5	-16.5**	- 4.0	-10.1**
11	Suwan	7528	10	1690	-14.6**	-12.5**	- 1.5	- 7.1	- 7.8**
12	Cotaxtla	7429	10	580	- 4.4	- 4.9	+ 6.1	-14.4**	- 3.5
13	Across	7429	8	1520	- 8.5*	- 5.5	- 1.3	-15.2**	- 6.9
14	Across	7529	10	780	-12.1**	- 5.9	- 0.4	- 9.4	- 5.8*
15	Across	7536	10	1110	-17.0**	-12.7**	- 8.3	-16.4**	-12.7**
	$\overline{X}$				- 8.7**	- 5.5**	- 4.9**	-11.0**	- 7.2**

* and ** significant at P = 0.05 and 0.01, respectively.

Table 7. Yield, plant height and days to 50 per cent silking of different cycles of improvement as the mean of 13 tropical populations across 3 environments in 1978 and 1979.

Y e a r		Yield (kg/ha)	Difference of C 2 or 3		Plant height (cm)	Difference of C 2 or 3	Days to 50% silking	Difference of C 2 or 3
			kg	%				
1978	C 1	5580	+ 420	+ 7.5	219	-3	62.7	-1.7
1979	C 0	4867	+ 383	+ 7.9	216	-6	63.5	- .7

Table 8. Days to 50 per cent silking, plant height and yield of C0 and the latest cycle of improvement of 13 tropical populations across 3 sites, Poza Rica, Tlaltizapan and Obregon, 1979.

P o p u l a t i o n	No.	Cycles of Impr.	Days to 50% silking			Plant height in cm			Yield Kg/ha			
			C 0	Latest Cycle	Diff.	C 0	Latest Cycle	Diff.	C 0	Latest Cycle	Difference in Kg	%
Tuxpeño-1	21	2	63.2	63.5	+ .3	202	198	- 4	5200	5429	+229	+ 4.4
Mezcla Trop. Bl.	22	3	63.3	63.3	0	220	211	- 9**	5398	5630	+232	+ 4.3
Blanco Crist. -1	23	3	61.6	61.2	- .4	208	202	- 6*	5130	5469	+339*	+ 6.6*
Ant. x Ver. 181	24	3	64.1	63.7	- .4	209	209	0	4560	5045	+485**	+10.6**
(Mix. Col. Gpo. 1xETO)	25	2	63.7	62.7	-1.0*	209	204	- 5	5172	5422	+250	+ 4.8
Mezcla Amarilla	26	2	61.8	60.8	-1.0*	199	197	- 2	4724	5017	+293	+ 6.2
Amarillo Crist. -1	27	3	64.3	63.4	- .9	227	225	- 2	4328	4916	+588**	+13.6**
Amarillo Dent.	28	2	64.8	64.1	- .7	234	228	- 6*	5015	5311	+296	+ 5.9
Tuxpeño Caribe	29	2	63.8	63.8	0	214	210	- 4	5423	5718	+295	+ 5.4
ETO Blanco	32	2	63.9	63.4	- .5	211	203	- 8*	4378	4442	+ 64	+ 1.5
Ant. x Rep. Dom.	35	2	58.5	57.8	- .7	185	181	- 4	4651	5029	+378*	+ 8.1*
Cogollero	36	2	64.9	62.9	-2.0**	239	227	-12**	4524	5414	+890**	+19.7**
La Posta	43	3	68.3	65.3	-3.0**	250	238	-12**	4669	5401	+732**	+15.7**
X̄			63.5	62.8	- .7**	216	210	- 6**	4867	5250	+383**	+ 7.9*

* and ** significant at the 0.50 and 0.01 level of probability, respectively.

Table 9. Days to 50 per cent silking, plant height and yield of C0 and the latest cycle of improvement of 13 tropical populations at Obregon, 1979.

P o p u l a t i o n	No.	Cycles of Impr.	Days to 50% silking			Plant height in cm			Yield Kg/ha			
			C 0	Latest Cycle	Diff.	C 0	Latest Cycle	Diff.	C 0	Latest Cycle	Difference in Kg	in%
Tuxpeño - 1	21	2	65.0	65.3	+ .3	196	194	- 2	2771	3177	+406*	+14.7*
Mezcla Tropical Blanca	22	3	61.5	64.8	+3.3*	214	206	- 8	3268	3745	+477*	+14.6*
Blanco Cristalino-1	23	3	61.8	63.3	+1.5	195	183	-12*	3491	3535	+ 44	+ 1.3
Ant. x Veracruz 181	24	3	65.3	65.3	0	199	198	- 1	2436	2903	+467*	+19.2*
(Mix. -1xCol. Gpol)ETO	25	2	65.0	64.5	- .5	205	198	- 7	2813	3252	+439*	+15.6*
Mezcla Amarilla.	26	2	62.3	62.5	+ .3	194	188	- 6	2845	3309	+464*	+16.3*
Amarillo Cristalino-1	27	3	65.5	64.5	-1.0	220	221	+ 1	2818	2791	- 27	0
Amarillo Dentado	28	2	67.0	65.8	-1.2	225	224	- 1	2972	3363	+391*	+13.2*
Tuxpeño-Caribe	29	2	65.5	65.5	0	206	201	- 5	2972	3018	+ 46	+ 1.5
ETO Blanco	32	2	65.3	64.5	- .8	201	200	- 1	2685	2757	+ 72	+ 2.7
Ant. x Rep. Dom.	35	2	60.0	59.5	- .5	175	163	-12*	3377	3507	+130	+ 3.8
Cogollero	36	2	66.0	63.8	-2.2	238	221	-17**	2981	3710	+729**	+24.5**
La Posta	43	3	70.0	66.5	-3.5*	244	231	-13*	2485	3046	+561**	+22.6**
Mean		2.38	64.6	64.3	- .3	209	202	- 7**	2916	3240	+324**	+11.1**

* and ** significant at the 0.05 and 0.01 level of probability, respectively.

42

Table 10. Number of Experimental Varieties developed from Advanced Unit populations and number of seed increases of Experimental Varieties (1978-1979).

No.	Population	No. of EVs	No. of seed increases
21	Tuxpeño-1	11	11
22	Mez. Tropical Blanca	6	10
23	Blanco Cristalino-1	4	7
24	Ant. x Ver. 181	5	3
25	(Mix. 1 x Col. Gpo. 1)ETO	8	8
26	Mez. Amarilla	9	10
27	Amarillo Cristalino-1	7	9
28	Amarillo Dentado	9	12
29	Tuxpeño Caribe	6	7
30 (old)	Blanco Cristalino	--	2
31 (old)	Braquiticos	1	7
32	ETO Blanco	4	7
33 (old)	Amarillo Subtropical	6	6
34	Blanco Subtropical	8	9
35	Ant. x Rep. Dominicana	5	6
36	Cogollero	6	7
37	Tuxpeño o_2	1	1
38	PD(MS)6 H.E.o_2	5	8
39	Yellow H.E.o_2	6	7
40	White H.E.o_2	6	9
41	Templado Amarillo H.E.o_2	8	10
42	ETO x Illinois	2	1
43	La Posta	3	7
44	AED x Tuxpeño	6	2
45	Amarillo del Bajío	2	2
48	Hungarian Composite	3	5
53	Highland early white floury	2	--
55	Highland early yellow dent	1	--
58	Highland intermediate white floury	1	--
60	Highland intermediate yellow dent	1	--
	T O T A L S: 30	142	173

Table 11. Distribution and recovery of data of international progeny and variety trials in 1978 and 1979.

Trial	1 9 7 8				1 9 7 9 up to June 30, 1980			
	Distr.	No. Countries	Recovery of data	Countries	Distr. trials	No. Countries	Recovery of data	Coun-try
IPTT's	76	24	72%	19	76	28	72%	18
EVT 12	38	28	58%	17	62	44	36%	16
EVT 13	47	33	55%	20	82	48	49%	30
EVT 14A	61	42	51%	24	--	--	--	--
EVT 14B	42	29	57%	20	--	--	--	--
EVT 15	35	27	46%	15	45	33	47%	18
EVT 16	51	34	33%	15	55	38	26%	14
EVT 17	21	11	48%	5	--	--	--	--
ELVT 18	94	48	47%	28	105	58	35%	24
ELVT 19	53	33	49%	21	59	42	36%	15
ELVT 20	59	36	46%	20	69	42	24%	12
TOTAL:	621	80	48%	46	615	85	37%	44

Table 12. Mean yield, days to silk and plant height of progenies for EV* development, population mean, best check and check mean of Advanced Unit populations tested in IPTT during 1978.

Pop. No.		Yield (% to Check x) of:			D-S diff. to Check x of:			PH diff. to Check x of:			CV (yield)	Name of Best Check	Value of Check x		
		EV*	Pop x	Best Check	EV*	Pop x	Best Check	EV*	Pop x	Best Check			Y	DS	PH
Pop. 22	Mez. Trop. Blanca														
	Mexico/Cotaxtla	144	107	140	-3	-3	+4	-19	-21	+11	19	Local V.	4.5	57	254
	Mexico/Poza Rica	165	129	129	-3	-2	0	-20	-26	- 8	16	Pop. 22-C 2	4.2	62	218
	Tanzania/Ilonga	148	125	113	-1	0	+1	-31	-24	-16	16	Ilonga 7621	4.0	56	188
	Bolivia/Chuquisaca (1)	150	120	120	-2	-1	0	-36	-36	-11	22	Pop. 22-C 2	5.9	65	246
	(3 Loc.) Across	143	121	129	-1	-1	+1	-23	-24	- 8	--	------------	4.2	58	220
Pop. 23	Blanco Cristalino-1														
	Colombia/Cali	136	109	127	-4	-3	+4	+ 2	-12	+11	15	Local V.	5.9	60	235
	Costa Rica/Diamantes	107	82	123	-1	-1	+3	-23	-26	-12	17	TICO VI	5.7	57	240
	Salvador/S. Andres (1)	133	107	114	+2	+2	+6	-15	-15	+ 3	16	Pop. 23-C 2	4.2	56	230
	Nicaragua/S. Rosa	138	110	117	+1	0	+1	-15	- 8	+ 7	17	Pop. 23-C 2	4.8	55	238
	Mexico/Poza Rica	125	98	130	-1	-2	-1	- 2	-19	-17	16	Pop. 23-C 2	4.7	60	207
	(5 Loc.) Across	114	100	122	-1	-1	+2	-14	-16	- 2	--	----------	5.1	58	230
Pop. 24	Antigua x Veracruz 181														
	Brasil/Sete Lagoas	151	106	128	--	--	--	-20	-21	- 6	17	Pop. 24-C 2	4.7	--	264
	Ecuador/Pichilingue	138	106	135	0	0	0	-11	-13	+40	15	INIAP-515	4.8	56	272
	Costa Rica/Guanacaste	112	86	124	0	0	+2	- 7	-10	-13	23	TICO VI	4.9	52	222
	Thailand/Suwan	120	77	146	+1	+3	+1	- 1	-10	- 6	27	Local V.	3.5	53	158
	Mexico/Poza Rica	139	104	128	-3	-1	-2	-13	-14	- 8	16	Pool 22	4.6	62	198
	(5 Loc.) Across	127	98	131	0	+1	0	- 4	-14	+ 1	--	----------	4.5	56	223
Pop. 27	Amarillo Cristalino-1														
	Peru/Satipo (1)	190	155	160	-2	-2	-3	-12	-11	-20	24	Pop. 27-C 2	2.8	59	255
	Ecuador/Pichilingue	135	102	120	0	+1	-1	0	- 4	+16	15	INIAP-515	4.6	56	274
	Costa Rica/Guanacaste	126	95	136	-1	+1	+1	-13	- 8	-27	27	X306B	3.9	51	233
	Guatemala/La Máquina	126	98	123	-1	+1	0	+4	+ 5	- 2	15	H-A 24	4.7	53	212
	Mexico/Poza Rica	128	104	122	-2	0	0	-20	-13	- 9	14	Pop. 27-C 2	4.6	61	242
	(4 Loc.) Across	118	102	125	+1	+1	0	- 7	- 4	- 5	--	----------	4.4	55	240
Pop. 32	ETO Blanco														
	Venezuela/Maracay	128	105	126	--	--	--	- 4	0	+10	19	Maquina 7422	3.9	--	243
	Egypt/Sakha (1)	124	95	129	+2	+4	+2	-24	-27	+34	22	VC-80	8.0	64	278
	Zaire/Gandajika	157	121	112	-3	-1	+2	+ 2	- 3	+16	20	Salongo	4.2	61	211
	Mexico/Poza Rica	131	106	125	-2	-1	-1	-22	-23	+ 1	13	Pool 23	4.8	62	217
	(4 Loc.) Across	127	106	125	0	0	+1	- 8	-13	+15	--	----------	5.2	62	252
Pop. 33	Amarillo Subtropical														
	Brasil/Rib. Preto	128	96	108	-3	-3	0	-10	-14	- 7	17	Local V.	6.4	66	255
	Nigeria/Ikenne	152	107	144	-1	0	+2	- 3	- 5	+19	19	TZB(51)C 7	3.8	54	209
	Mexico/Tlaltizapan	130	102	125	-2	-1	+1	-14	-12	+10	14	Across 7533	7.3	61	238
	(3 Loc.) Across	124	101	122	-1	-1	+1	-10	-10	+ 6	--	----------	5.9	60	234
	Bolivia/Chuquisaca (1)	150	117	125	-3	-2	0	-24	-24	-24	20	Tuxp. PB	5.9	62	264
Pop. 35	Antigua x Rep. Dom.														
	Brasil/Bahia	111	94	142	+1	+1	0	-41	-36	+48	13	Centalmex	8.0	54	221
	Ecuador/Pichilingue	107	83	136	-3	-3	+2	-25	-21	+35	16	INIAP 515	5.8	54	244
	El Salvador/S.C. Por.(1)	100	75	141	-4	-3	+1	-49	-39	+27	21	CENTA HE-4	6.5	52	255
	Panama/Tocumen (1)	90	59	124	-4	-5	-1	-23	-32	+ 8	29	TPB-778 Toc. 7428	4.7	55	202
	Haiti/Levy	156	113	131	-1	0	-1	-41	-45	-37	17	Pop. 35-C 2	4.0	53	217
	Mexico/Poza Rica	134	108	115	-3	-3	-2	-23	-25	-20	14	Pop. 35-C 2	4.4	59	210
	(5 Loc.) Across	103	85	131	-3	-3	-1	-33	-33	+ 2	--	----------	5.1	55	226
Pop. 39	Yellow H.E.O2														
	Peru/Satipo (1)	251	177	167	-4	-5	-1	- 9	-21	-10	22	Pop. 39-C 1	2.5	58	250
	Peru/Satipo (2)	208	177	167	-5	-5	-1	-14	-21	-10	22	Pop. 39-C 1	2.5	58	250
	Thailand/Suwan	131	89	191	-4	-2	0	+ 4	+ 2	+ 7	29	Suwan 1 (N)	2.5	54	157
	Mexico/Poza Rica	148	127	136	-3	-3	-1	-12	-14	- 9	12	Pop. 39 C 1	4.1	60	219
	(2 Loc.) Across	145	112	155	-2	-2	-1	+ 4	- 6	- 1	--	----------	3.3	57	188
	Bolivia/Chuquisaca (1)	135	108	130	-4	-4	-3	-16	-14	-11	18	Pop. 39 C 1	5.8	61	261
Pop. 42	ETO x Illinois														
	Bolivia/Chuquisaca	142	113	137	-2	-2	-2	-40	-34	-21	17	Pop. 42-C 2	7.1	63	266
	Bolivia/Chuquisaca (1)	142	113	137	-2	-2	-2	-39	-34	-21	17	Pop. 42-C 2	7.1	63	266
	Brasil/Sao Paulo	110	96	117	-1	-1	0	--	--	--	14	Pop. 42-C 2	6.2	64	---
	Mexico/Tlaltizapan	141	113	118	-2	-1	0	-10	- 7	- 1	13	P R. 7729 (E)	7.3	60	246
	Egypt/Sakha (1)	104	76	106	-1	+1	+7	-31	-23	+20	25	VC-80	9.2	61	275
	Zaire/Kisanga	192	119	167	-7	-6	-5	+11	0	+ 9	28	Pop. 42-C 2	2.5	73	171
	(5 Loc) Across	122	100	122	-2	-2	-1	-13	-16	+2	--	----------	6.5	64	240

44

Table 12. (Continued)

Pop. No.	Yield (% to Check x̄ of) EV*	Pop x̄	Best Check	D-S diff. to Check x̄ of EV*	Pop x̄	Best Check	PH diff. to Check x̄ of EV*	Pop x̄	Best Check	CV (yield)	Name of Best Check	Absolute value of Check x̄ Y**	DS**	PH**
Pop. 43 La Posta														
Guat./La Maquina	132	102	137	+1	+1	-1	+6	+9	+6	17	T 101	4.7	54	239
Mexico/Poza Rica	153	121	124	-2	-1	+1	-7	-1	-9	15	Pop. 43-C 2	4.8	64	234
(2 Loc.) Across	140	110	129	+1	0	-1	+6	+4	+7	--	------------	4.8	59	237
Ghana/Ejura (1)	161	113	127	+1	+1	+1	+6	+7	0	23	Comp. W.	4.9	52	228
Pop. 44 AED x Tuxpeño														
Mexico/Cotaxtla	121	83	133	-6	-5	0	-23	-24	+24	26	Local V.	4.4	57	240
Mexico/Tlaltizapan	135	108	122	-1	-1	-1	-9	-9	+4	14	Pop. 44-C 2	7.2	62	249
Egypt/Sids	101	66	138	0	0	0	-20	-18	+21	12	AED	4.8	65	262
Egypt/Gemeiza	130	83	125	+3	+3	-3	-10	-7	+8	20	GIZA-1	4.2	63	269
Egypt/Egypt (1)	115	74	132	+1	+2	-2	+1	-12	+14	--	------------	4.5	64	236
Zaire/Kisanga	120	92	133	-2	-2	+3	-9	-14	+16	14	PNM-1	8.4	72	239
(5 Loc.) Across	108	89	130	-1	-1	-1	-10	-14	+14	--	------------	5.8	64	238
Pop. 45 Amarillo Bajio														
Bolivia/Chuquisaca	147	119	121	-6	-5	-4	-32	-28	-23	20	Pop. 45-C 0	7.1	62	243
Bolivia/Chuquisaca (1)	152	119	121	-6	-5	-4	-16	-28	-23	20	Pop. 45-C 0	7.1	62	243
Mexico/Tlaltizapan	131	104	126	-2	-3	-4	-7	-3	+13	11	Sids 7542	6.8	58	232
Pakistan/Yousafwala (1)	n	o	d	a	t	a	(visual selected Fam.)							
(2 Loc.) Across	138	112	124	-4	-4	0	-16	-16	-5	--	------------	6.9	60	238
Pop. 53 Highland Early White Floury														
Mexico/Batan	152	102	127	0	+2	+2	0	0	+15	21	Pool 8	6.4	88	235
Mexico/Toluca	159	112	116	-1	0	-3	+9	+8	+2	18	Pool 8	6.8	124	200

* Selected families used for development of Experimental Varieties
Y = yield t/ha
D-S = days to 50% silking
PH = plant height in cm
(1) Indicates a country specific variety.
(N) = Normal endosperm maize variety.

Table 13. Selection pressure on AU population for the fourth cycle of improvement, based on 1978 IPTT information and performance of selected progenies over population means.

	Populations	No. of sites for selection	No. of sel. prog.	Sel. pressure %	Yield of Sel. FAM. % to Pop.x̄	% to Check x̄	Diff. to Pop. x̄ in: D-S*	PH* (cm)	EH* (cm)	ER* (%)	SL* (%)	RL* (%)
22	Mezcla Tropical Blanca	3	120	48	108	130	0	+2	+1	-1	-1	-3
23	Blanco Cristalino-1	4	115	46	106	107	0	0	0	-1	0	-2
24	Ant. x Ver. 181	5	100	40	111	108	0	+3	+3	-2	-1	-3
27	Amarillo Cristalino-1	4	76	30	107	107	0	-5	-2	-3	0	-1
32	ETO Blanco	3	98	39	108	113	0	0	0	0	0	0
33	Amarillo Subtropical	3	112	45	111	112	+1	+3	+2	-2	-2	-3
35	Ant. x Rep. Dom	5	110	44	104	91	0	0	0	-2	0	-4
39	Yellow H.E.o$_2$	2	125	50	109	123	0	+1	+1	-2	0	0
42	ETO x Illinois	5	85	34	113	112	0	+3	+3	-4	0	0
43	La Posta	2	115	46	108	120	0	-4	-3	-2	-2	-7
44	AED x Tuxpeño	5	90	36	110	98	0	+4	+3	-4	-1	-1
45	Amarillo Bajio	2	160	64	106	118	0	+1	+1	-1	-1	0
	Mean	3.6	109	44	109	112	0	0	+1	-2	-1	-2

* D-S = Days to 50% silking
PH = Plant height
EH = Ear height
ER = Ear rot
SL = Stalk lodging
RL = Root lodging

Table 14. Selection pressure on AU population (Group 2) for the next cycle of improvement, based on 1979 IPTT information and performance of selected progenies over population means.

Populations	No. of sites for selection	No. of selected progenies	Selection pressure (%)	Yield of the selected progenies in % to: Pop. x̄	Checks x̄	Difference to Pop. x̄ in: D-S*	PH* (cm)	EH* (cm)	ER* (%)	SL* (%)	RL* (%)	HC* (%)
21 Tuxpeño-1	4	96	38	113	112	0	+6	+4	-3	0	0	-2
25 (Mix.1-Col.Gpo.1)ETO	4	100	40	110	97	0	+1	+1	-2	-	0	-3
26 Mezcla Amarilla	5	86	34	110	107	-1	+2	+2	-2	0	-1	-5
28 Amarillo Dentado	5	92	37	108	107	0	0	-1	-3	-1	0	-3
29 Tuxpeño Caribe	5	84	34	111	111	0	+2	+2	-3	0	0	-2
30 Blanco Cristalino-2	5	96	38	109	97	0	0	0	-2	0	0	-2
31 Amarillo Cristalino-2	4	104	42	107	98	0	+2	0	-3	0	-1	-2
34 Blanco Subtropical	3	106	42	109	104	0	0	+1	-2	-2	-3	-1
36 Cogollero	3	110	44	113	125	0	0	0	0	-1	0	0
38 PD(MS)6 H.E.0$_2$	3	122	49	105	91	0	0	0	-1	0	-1	0
40 White H.E.0$_2$	4	93	37	108	98	0	-1	-1	-3	0	0	-3
41 Templado Amarillo H.E.0$_2$	5	98	39	107	94	0	0	0	-1	0	0	-5
Mean	4.2	99	40	109	103	0	+1	+1	-2	0	-1	-2

* D-S = Days to 50% silking
P.H. = Plant height
E.H. = Ear height
E.R. = Ear rot

S.L. - Stalk lodging
R.L. - Root lodging
H.C. - Bad Husk cover

46

Table 15. Mean yield, days to silk and plant height of progenies for EV development, population mean, best check and check mean for Advanced Unit populations tested in IPTT during 1979.

Pop. No.		Yield (% to check x̄) of: EV*	Pop x̄	Best Check	D-S diff. to check x̄ of: EV*	Pop x̄	Best Check	Pht diff. to check x̄ (cm) of: EV*	Pop x̄	Best Check	CV (Yield)	Name of Best Check	Absolute value of Check x̄: Y**	DS**	PHt**
21	**Tuxpeño-1**														
	Mexico/Poza Rica	130	106	133	-1	0	-2	-1	-2	-8	18	Pool 24	5.2	63	197
	Mexico/Cotaxtla	122	91	136	-1	0	+1	+3	-6	+17	16	Sint. M. La Posta	6.1	54	231
	Venezuela/Maracay	142	92	158	--	--	--	--	--	--	32	CENIA Exp. 2	6.0	--	--
	Costa Rica/Diamantes (1)	136	109	103	0	-1	-1	-23	-32	-17	23	TICO V-2	4.3	58	233
	(4 Loc.) Across	124	100	135	0	0	-1	-7	-14	0	--	------	5.4	58	221
25	**(Mix. 1 x Col. Gpo.1) ETO**														
	Venezuela/Maracay	148	95	130	--	--	--	--	--	--	28	Obregon (Hyb)	5.6	--	--
	El Salvador/S. Andres (1)	82	56	108	--	+1	+1	-9	-15	0	25	H-9 (Hyb)	4.5	57	228
	Mexico/Cotaxtla	122	95	126	-2	-2	+1	+2	-6	+29	15	Sint. M. La Posta	5.5	55	234
	Mexico/Poza Rica	144	107	134	-2	-1	+4	+15	+2	+58	17	H-507 (Hyb)	4.6	63	194
	(4 Loc.) Across	110	89	125	-1	-1	+2	-8	-7	+28	--	------	5.1	58	219
26	**Mezcla Amarilla**														
	Bolivia/Saavedra	133	109	143	-3	-2	+5	-25	-21	+6	14	Am. Portachuelo	5.1	59	191
	Panama/Tocumen	171	133	141	-2	-2	0	-4	-11	+5	15	Tocumen FB	3.4	54	196
	Peru/Piura (1)	97	68	121	-10	-10	+4	-70	-75	-22	25	Exp.-77-102	8.9	74	261
	Pakistan/Islamabad (1)	158	120	138	+1	+5	+4	-6	-13	-12	23	SYN 551	4.2	60	185
	Pakistan/Islamabad (2)	173	120	138	+6	+5	+4	-12	-13	-12	23	SYN 551	4.2	60	185
	Mexico/Poza Rica	104	93	119	-1	0	0	+7	+1	-1	25	Pool 22	3.9	61	160
	(4 Loc.) Across	115	94	128	-3	-3	+1	-25	-25	-8	--	------	5.1	63	201
28	**Amarillo Dentado**														
	C.R./Guanacaste	151	95	142	-1	-1	+1	-11	-12	+16	22	B 666 (Hyb)	3.0	52	267
	Guatemala/La Maquina	138	112	113	0	0	0	+3	-1	-1	13	ICTA A-10	4.3	53	220
	Mexico/Poza Rica (1)	159	117	118	-2	-4	+1	+4	-3	+1	25	V-254	2.5	70	179
	Ivory Coast/Ferke	108	88	133	-2	-2	0	-5	-6	+22	13	IRAT 81 (Hyb)	7.8	58	253
	Ivory Coast/Ferke (1)	105	88	133	-2	-2	0	-2	-6	+22	13	IRAT 81 (Hyb)	7.5	58	253
	Ecuador/Pichilingue	141	103	121	-2	0	+1	-7	-7	+20	17	INIAP-515	5.8	55	263
	(4 Loc.) Across	120	100	127	-1	-1	+1	-1	-7	+10	--	------	4.4	58	230
29	**Tuxpeño Caribe**														
	Guatemala/Cuyuta	138	104	115	0	0	0	-9	-9	+46	19	H-3 (Hyb)	4.1	56	232
	Honduras/El Paraiso	144	106	144	0	0	+1	-6	-17	-32	30	Hondureño FB	5.3	60	242
	Mexico/Cotaxtla	136	107	117	-2	-1	+1	+4	-1	+2	14	Cot. 18 1 CSMVES	5.3	54	232
	Egypt/Sids	124	89	128	+2	+3	+1	-7	-16	+18	18	Comp-2 EV-2	6.6	65	275
	Egypt/Sids (1)	119	89	128	+2	+3	+1	-14	-16	+18	18	Comp-2 EV-2	6.6	65	275
	Mexico/Poza Rica	126	100	127	-3	0	+4	+6	-3	+56	27	H-507 (Hyb)	3.8	65	181
	(5 Loc.) Across	123	100	127	0	0	+1	-4	-9	+18	--	------	5.0	60	232
30	**Blanco Cristalino-2**														
	Zaire/Kisanga	115	93	133	-13	-11	-?	-28	-31	+5	16	Mezcla Trop. Blanca	6.5	70	219
	Guatemala/Jutiapa	151	111	161	-1	0	-1	+8	-3	+11	22	ICTA B-5	3.0	53	159
	Guatemala/Jutiapa (1)	145	111	161	-3	0	-1	0	-3	+11	22	ICTA B-5	3.0	53	159
	El Salvador/S.C. Por.(1)	82	56	130	-4	-4	0	-33	-40	+25	28	H-5 (Hyb)	5.0	50	252
	Pakistan/Pirsabak (1)	119	100	134	-5	-4	0	-7	-1	+2	18	Obregon 7446	5.2	61	179
	Pakistan/Pirsabak (2)	113	100	134	-5	-4	0	-3	-1	+2	18	Obregon 7446	5.2	61	179
	Mexico/Poza Rica	122	95	120	0	-1	-4	+16	+7	+4	15	Comp.Sel. Precoz	4.7	56	181
	(5 Loc.) Across	101	89	134	-4	-4	-1	-17	-14	+8	--	------	4.9	58	198
	Tanzania/Ilonga (1)	116	92	121	-6	-5	+2	-38	-40	+30	19	Ilonga Comp.	2.6	66	167

47

Table 15. (Continued)

	Yield (% to check x̄) of:			D-S diff. to check x̄ of:			PHt diff. to check x̄ (cm) of:			CV (Yield)	Name of Best Check	Absolute value of Check x̄		
	EV* Pop x̄		Best Check	EV*	Pop x̄	Best Check	EV*	Pop x̄	Best Check			Y**	DS**	PHt**
Pop. 31 Amarillo Cristalino-2														
Ecuador/Pichilingue	113	88	120	-5	-5	+2	-51	-49	+17	14	Sint. Mej. Lineas	5.6	51	267
Panama/Tocumen	156	122	144	-6	-6	+4	-15	-20	+9	16	Tocumen 7527	3.3	53	196
Mexico/Poza Rica	117	92	120	-4	-3	+1	-5	-9	+5	18	Across 7635	4.0	58	173
Brazil/Sete Lagoas	95	76	129	-13	-13	+1	-23	-32	+28	14	C 121	7.9	65	222
Peru/Satipo (1)	(No data visually selected fam.)													
(4 Loc.) Across	105	89	127	-7	-7	+1	-26	-29	+14	--	-----------	5.2	57	215
Pop. 34 Blanco Subtropical														
Zaire/Kaniama	108	84	123	-7	-6	+1	-33	-27	-8	16	Shaba-1	7.1	72	227
Mexico/Tlaltizapan	136	106	109	-1	-2	-1	-12	-15	-9	14	Across 7734	6.1	63	230
Brazil/Sete Lagoas	127	98	154	-5	-5	+3	-24	-25	+26	17	C 121 (Hyb)	6.3	63	243
(3 Loc.) Across	117	95	128	-4	-4	+1	-18	-22	+4	--	-----------	6.5	66	233
Pop. 36 Cogollero														
Peru/Piura (1)	148	112	135	-9	-9	+4	-73	-61	+11	28	Exp. 77-102	6.2	74	267
Mexico/Obregon	149	107	131	-2	-1	0	-4	-6	-3	20	Across 7728	2.9	63	213
Mexico/Poza Rica	149	106	133	-6	-4	-3	-1	-6	-5	26	Across 7624	2.4	68	179
(3 Loc.) Across	139	110	133	-4	-4	+1	-24	-25	+1	--	-----------	3.8	68	220
Pop. 38 PD(MS)6 H.E.o2														
Mexico/Obregon	123	92	124	-2	-1	+1	-5	-8	-14	--	-----------	5.2	57	215
Mexico/Poza Rica	104	85	116	-1	-2	-1	-6	-7	+3	13	Pool 21 H.E.o2	5.3	58	209
Brazil/Jardinopolis	103	86	130	-4	-3	+2	-16	-12	+25	12	C 121	6.2	65	249
Pop. 40 White H.E.o2														
C.R./Guanacaste	142	98	166	-3	-2	+1	-7	0	+11	32	B 666 (Hyb)	2.0	53	210
Mexico/Obregon	145	104	132	-1	-1	0	-2	-3	+13	16	H-412 (Hyb)	3.2	61	202
Mexico/Poza Rica	129	98	136	-3	-2	-5	+6	-1	+18	25	White H.E.o2	3.9	63	190
Ivory Coast/Ferke	96	82	136	-4	-4	-1	-17	-17	+19	12	IRAT 81 (Hyb)	8.7	58	266
Ivory Coast/Ferke (1)	88	82	136	-4	-4	-1	-19	-17	+19	12	IRAT 81 (Hyb)	8.7	50	266
(4 Loc.) Across	108	91	138	-2	-3	-1	-4	-5	+15	--	-----------	4.5	59	217
Pop. 41 Templado Amarillo H.E.o2														
Brazil/Piracicaba	148	115	136	--	--	--	-19	-21	+6	20	AG 301 (Hyb)	1.7	--	164
Guatemala/S. Jeronimo	129	103	125	-2	-3	+2	-16	-29	-13	12	HA-34	6.7	61	229
Guatemala/S. Jeronimo(1)	127	103	125	-3	-3	+2	-18	-29	-13	12	HA-34	6.7	61	220
Mexico/Obregon	112	79	142	-2	0	+2	-2	-2	+37	19	HA-412 (Hyb)	3.8	56	183
Mexico/Tlaltizapan	110	88	130	-1	0	-1	-7	-11	-5	13	TL 7845	6.6	59	218
Chile/La Platina	93	78	132	+1	+2	+4	+4	-2	-1	12	P 3147 (Hyb)	12.2	83	217
(5 Loc.) Across	104	87	131	-1	0	+2	-9	-13	+4	--	-----------	6.2	65	202
Pop. 48 Comp. de Hungria														
Mexico/Tlaltizapan	122	92	127	-2	-3	+5	+6	-1	+17	15	H-412 (Hyb)	5.6	57	208
Chile/Quilamapu	115	97	110	+3	+2	+6	-3	-1	-4	10	INIA-8 (Hyb)	12.2	99	224

* EV - Selected families used for development of Experimental Varieties
** Y - Yield tons hectare

PH = Plant Height in cms.
DS = Days to 50% silking.

Table 16. Performance of best Experimental Varieties of EVT 12 compared to the best check in 21 countries, 1978 and 1979.

Country	Year	Location	Best Check	T/ha DS[1] - PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
1. Costa Rica	78	Diamantes	(TICO-VI)	4.7 - 59 - 230	12	Across	7643	126	+2	+30
						Poza Rica (E)	7729	109	0	+6
						Los Baños (1)	7622	105	-1	+9
						Guaymas	7721	102	0	-13
2. El Salvador	78	San Andres & Sta. Cruz P.*	(CENTA HE-4)	4.9 - 54.5-243	16 17	Los Baños (3)	7622	94	+1	-29
						Poza Rica	7643	93	+3	-18
	79	San Andres & Sta. Cruz P.*	(H-10)	4.8 - 51 - 253	14 15	Poza Rica	7822	95	+1	-23
						Poza Rica	7843	94	+2	0
						S. Andres (1)	7823	92	-1	-22
3. Guatemala	78	Cuyuta	(HB-31)	6.2 - 54 - 265	10	Poza Rica	7643	99	-1	+13
						Los Baños (2)	7622	96	-1	-17
	78	N. Concepción	(T-101)	1.7 - 56 - 198	29	Los Baños (2)	7622	124	-1	+10
						Poza Rica (E)	7729	123	0	+17
						Omonita	7643	122	+1	+22
						Ilonga (1)	7721	121	0	-5
						Poza Rica	7631	102	+1	-3
	79	La Maquina	(ICTA-B1)	5.5 - 53 - 212	8	La Maquina	7843	110	+1	+47
						Poza Rica	7843	106	+2	+32
						Across	7729	100	+1	+17
	79	Cuyuta	(Comp-2)	4.8 - 55 - 224	10	Poza Rica	7843	116	+2	+24
						Poza Rica	7822	104	+1	+11
						Across	7622	104	+1	+14
						Gandajika	7721	101	0	+10
4. Honduras	79	Las Acacias Chirinas*	Hondureño PB	6.1 - 56 - 223	11 11	Across	7622	122	-1	+18
						Poza Rica	7843	119	+1	+33
						San Andres (1)	7721	111	-1	+12
5. Mexico	78	La Huerta (Jal.)	(B-666)	5.2 - 71 - 273	16	San Andres	7622	136	-4	-28
						Ferke (1)	7643	125	-3	-18
						Ilonga	7729	125	-3	-28
						Palmira (2)	7631	117	-1	-63
						Ilonga (1)	7721	116	-2	-35
						Dholi (2)	7644	106	-5	-38
	78	Poza Rica	(Pool 24?)	5.8 - 61 - 205	12	Poza Rica	7721	113	+1	+3
						Ferke (1)	7622	108	0	+1
						Poza Rica	7631	105	+2	-21
						Across	7643	105	+1	+15
						Poza Rica (E)	7729	102	0	+6
	79	La Huerta (Jal.)	(T-47)	3.7 - 62 - 217	22	Alajuela	7725	116	-4	-27
						Poza Rica	7822	114	-3	-18
						La Maquina	7843	114	-1	+1
						Gandajika	7721	109	-3	-23
						Guanacaste	7729	106	-4	-11
						Santa Rosa	7823	103	-6	-21

Table 16. (Continued)

Country	Year	Location	Best Check	T/ha	DS[1]/	PH[2]/	CV(Y)[3]/	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
	79	Poza Rica	(H-507)	5.3	67	270	9	Poza Rica	7822	136	-4	-55
								La Maquina	7843	131	-4	-33
								Across	7729	129	-6	-58
								Gandajika	7721	115	-6	-57
								Cotaxtla	7623	113	-9	-64
								Across	7725	107	-7	-73
	79	Cotaxtla	(Cot-28 SMT)	6.2	55	273	7	Poza Rica	7822	108	-2	-41
								Poza Rica	7843	107	-1	-24
								Across	7929	101	-1	-55
								Across	7721	99	-3	-61
	79	Nayarit	(V-524)	2.7	53	232	10	Across	7622	121	-1	+49
								La Maquina	7843	117	+2	+72
								Kisanga	7729	116	-1	+42
								Gandajika	7721	111	-1	+15
6. Bolivia	78	Santa Cruz	(Tuxpeño)	5.1	84	215	19	Ferke (1)	7622	106	-5	-35
								Across	7643	105	-7	-10
								Palmira (2)	7631	104	-9	-57
	79	Chuquisaca	(Cub.Amar.)	7.1	84	213	17	Poza Rica	7729	136	-1	+21
								Gemeiza (2)	7644	135	-2	-4
								Ilonga	7721	131	-1	-27
								Poza Rica	7643	126	0	-12
								Ferke (1)	7622	126	-2	-7
								Palmira	7631	116	+1	0
	79	Gran Saavedra	(Tuxpeño)	3.9	64	223	17	Poza Rica	7843	149	0	-14
								Poza Rica	7822	140	-1	-15
								Across	7729	130	-1	-28
								Across	7632	129	-2	-22
								Gandajika	7721	126	0	-34
								San Andres (1)	7823	125	-1	-34
7. Brazil	78	Sete Lagoas	(HYB Linhagens)	6.0	77	254	16	Los Baños (3)	7643	98	+3	+7
								Los Baños (3)	7622	97	+1	-6
8. Colombia	78	Palmira	(Diacol H-253)	5.9	66	273	16	Nyankpala	7623	89	-1	-23
								Los Baños (3)	7622	87	-3	-36
	79	Turipana	(ICA H-154)	1.8	56	---	20	Across	7729	188	-2	---
								Poza Rica	7843	174	-1	---
								San Andres (1)	7823	173	-5	---
								Across	7721	173	-2	---
								Alajuela	7725	170	-4	---
								Across	7632	147	-4	---
9. Egypt	78	Gemeiza	(VC-80)	4.4	68	254	19	Yousafwala (1)	7644	124	-2	-54
								Dholi (2)	7644	119	-2	-47
								Los Baños (1)	7622	101	0	-46
	79	Sids	(Comp-2 EV-2)	10.0	65	297		Poza Rica	7822	87	+2	-20
								La Maquina	7843	82	+4	-2
10. Ghana	78	Ejura	(Comp. W)	6.3	59	249	19	Across	7643	124	-4	-49
								Palmira (2)	7631	115	-4	-75
								Poza Rica (E)	7721	114	-6	-51
								Poza Rica	7643	113	-4	-37
								Los Baños (1)	7622	113	-5	-59
								Dholi (1)	7644	113	7	-71

Table 16. (Continued)

Country	Year	Location	Best Check	T/ha DS[1] PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
									DS	PH
11. Nigeria	79	Nyankpala	(Comp. W)	3.3 - 60 - 257	25	Poza Rica	7843	157	0	-5
						Across	7622	149	-1	-27
						Across	7729	143	-1	-32
						Across	7721	132	0	-60
						Santa Rosa	7823	111	-6	-55
						Poza Rica	7832	105	-2	-40
	78	Mokwa	(FARI-23)	1.6 - 65 - 205	38	Egypt (1)	7644	149	-7	-13
						Poza Rica	7729	144	-5	-6
						Ilonga (1)	7721	137	-5	-33
12. Ivory Coast	79	Ferkesse-dougou	(IRAT 81)	7.4 - 60 - 270	11	La Maquina	7843	104	-2	+12
						Across	7729	98	-2	-18
						Poza Rica	7843	97	-2	0
						San Andres (1)	7721	96	-4	-25
13. Malawi	78	Ngabu	(PNR 95)	5.5 - 47 - 192	13	Poza Rica (E)	7729	104	+5	-10
						Los Baños (1)	7622	102	+4	-3
						Side (1)	7644	102	+1	-10
						Dholi (2)	7644	101	+1	0
	79	Ngabu	(PNR 353) HYB	3.8 - 40 - 220	53	San Andres (1)	7721	133	+3	-29
						Across	7523	121	+5	-28
						Ferke (2)	7622	115	+5	-37
14. Senegal	79	Sefa	(AC1xB1(5))	4.4 - 50 - 178	26	Santa Rosa	7823	79	+1	-5
						Kanima	7725	77	+3	-9
						Across	7729	69	+4	+9
15. Tanzania	78	Ilonga	(Ilonga 7621)	2.4 - 64 - 152	26	Obregon	7643	113	-1	+27
16. Zaire	78	Gandajika	(TuxpxETO)	4.9 - 59 - 231	18	Across	7643	144	+2	+12
						Los Baños (2)	7622	139	-2	-28
						Palmira (2)	7631	137	+5	-37
						Guaymas	7721	120	0	-26
						Ilonga	7729	119	-1	0
						Gemeiza	7544	112	-1	-25
17. Zambia	78	Mt. Makulu	(PNR-536)	8.8 - 73 - 249	18	Dholi (1)	7644	88	+2	-19
18. Philippines	78	Karsan	(Phil.DMR Comp. 2)	1.2 - 54 - 163	34	Poza Rica	7631	152	+6	-10
						Poza Rica (E)	7729	149	+4	+27
						Palmira (2)	7631	149	+9	-8
19. Yemen A.R.	79	Taiz	(Local Var.)	3.4 - 75 - 108	18	Dholi	7622	128	+1	+15
						Guanacaste	7729	123	+1	+4
						Poza Rica	7823	113	0	+4
						Poza Rica	7832	113	0	+2
20. Swaziland	78	Malkerns	(SR 52)	3.3 - 61 - 283	17	Dholi (1)	7644	126	+2	-35
						San Andres (1)	7622	123	+7	-28
						Tlaltizapan	7631	121	+7	-69
						Across	7643	118	+8	-17
	79	Malkerns	(SR 52)	9.2 - 84 - 261	14	Across	7532	93	-2	-47
						Kisanga	7729	83	+2	-33
21. Saudi Arabia	79	Hofuf	(Loc. Var.)	5.4 - 64 - 211	15	Dholi	7622	121	+3	-23
						Kisanga	7729	117	+2	-18
						Poza Rica	7843	114	+5	-11

1/ DS = Days to 50% silking
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

* Mean performance over 2 sites where best check was common.

51

Table 17. Performance of Experimental Varieties of EVT 13 compared to the best check in 34 countries, 1978 and 1979.

Country	Year	Location	Best Check	T/ha – DS[1] – PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
1. Costa Rica	78	Guanacaste	(TICO-VI)	6.2 – 53 – 219	15	La Calera (1)	7728	104	-1	+10
						Tlaltizapan	7736	101	+1	-3
	79	Guanacaste	(TICO-VI)	4.6 – 54 – 265	19	Sta. Cruz P. (1)	7835	101	-4	-68
						Across	7728	100	-3	-16
2. El Salvador	78	San Andres	(H-5)	4.3 – 59 – 231	12	Petrolina	7736	104	-2	-2
	79	San Andres	(H-101)	4.1 – 59 – 253	12	La Maquina	7827	102	-4	-22
	79	Sta. Cruz P.	(H-101)	3.8 – 56 – 254	14	La Maquina	7827	100	-4	+2
3. Guatemala	78	La Maquina	(T-101)	5.7 – 54 – 218	12	Chuquisaca	7728	112	+1	+15
						Tlaltizapan	7736	104	0	+7
	79	La Maquina	(ICTA A-4)	5.0 – 51 – 214	12	La Maquina	7827	105	+3	+7
						Across	7736	105	+1	+19
						Across	7726	101	0	+1
	79	Cuyuta	(HA-44)	2.8 – 52 – 234	19	La Maquina	7827	124	-1	+2
						Sta. Cruz P. (1)	7835	114	-2	-13
						Across	7728	113	+1	0
						Suwan	7726	110	-1	+4
						Dholi	7624	106	+1	+4
4. Honduras	79	Guaymas	(HA-504)	3.0 – 54 – 216	16	Sete Lagoas	7728	135	-2	+10
						Suwan	7736	134	0	+7
						La Maquina	7827	132	-4	-10
						Tocumen (1)	7835	128	-8	-24
						Suwan	7726	121	-6	-11
						Poza Rica	7824	120	-2	0
5. Jamaica	78	Grove Place	(MD-1)	3.2 – -- – 267	21	La Calera	7728	113	--	-2
						Petrolina	7736	109	--	-6
6. Haiti	79	Levy	(Cayes)	3.0 – 64 – 255	13	Across	7726	172	-9	-51
						La Maquina	7827	169	-8	-35
						Poza Rica	7824	168	-8	-46
						Across	7736	163	-8	-16
						Across	7728	159	-7	-21
						Sta. Cruz P. (1)	7835	156	-12	-52
7. Mexico	78	Poza Rica	(Pool 26)	4.4 – 61 – 188	12	La Calera	7728	118	+1	+18
						Palmira (1)	7627	110	+1	+3
	79	Poza Rica	(Tuxp. R.S.)	4.8 – 61 – 186	8	Poza Rica	7827	139	-2	+38
						Across	7728	134	0	+35
						Poza Rica	7824	129	-1	+20
						Across	7726	121	-2	+15
						Sta. Cruz P.	7825	115	-7	-17

Table 17. (Continued)

Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
											DS	PH
	79	La Huerta	(T-41)	2.9	60	248	18	Sete Lagoas	7728	161	-2	+7
								Poza Rica	7827	147	-2	-8
								Poza Rica	7824	128	-2	-13
								Across	7736	122	-2	-23
								Sete Lagoas	7726	117	-3	-18
								Tocumen (1)	7835	110	-5	-48
8. Puerto Rico	79	Isabela	(P 304 C) HYB	4.7	68	190	16	Poza Rica	7824	108	0	-6
								Tocumen (1)	7835	98	-5	-43
9. Panama	78	Tocumen	(UNP-1)	4.7	59	238	11	Tlaltizapan	7736	109	0	+1
								La Calera (1)	7728	107	0	-12
	78	Rio Hato	(UNP-2)	4.5	53	195	10	Tocumen	7728	113	0	+3
								Tlaltizapan	7736	111	-1	+21
								Poza Rica	7627	100	0	-9
	78	Alanaje	(Loc. Var.)	4.1	55	275	13	La Calera	7728	114	-1	-22
								Tlaltizapan	7736	112	0	-16
								Across	7627	101	-1	-9
	79	Tocumen EP	(UNP-1)	3.8	58	224	10	Across	7728	123	-1	-4
		Tocumen LP	(UNP-1)				8	La Maquina	7827	119	-3	-3
								Across	7736	116	-3	-3
								Poza Rica	7824	110	-3	-9
								Across	7726	105	-3	-21
								Tocumen (1)	7835	103	-7	-36
	79	Guarare	(X-306-B)	5.6	54	263	12	Across	7728	88	0	-49
	79	Rio Hato	(UNP-2)	3.8	53	213	17	Poza Rica	7824	138	0	-15
								Across	7728	133	+1	-8
								Across	7726	126	-1	-10
								Suwan	7736	116	0	-10
								Poza Rica	7835	114	-1	-28
10. Rep. Dom.	78	S. Cristobal	(CNIA-12)	3.3	51	223	14	Poza Rica	7728	138	+5	+12
								Across	7627	113	+4	-3
								Tlaltizapan	7736	110	+4	+2
11. Bolivia	78	Chuquisaca	(Comp. 101)	8.2	65	238	14	La Calera	7728	114	-1	-8
								Palmira (1)	7627	107	-1	-12
								Chuquisaca	7736	101	-1	-3
	78	Sta. Cruz	(S. PD(MS) 6)	4.7	58	265	18	La Calera (1)	7728	124	+1	+8
								Palmira (2)	7627	117	-1	-7
								Tlaltizapan	7736	105	0	-12

Table 17. (Continued)

Country	Year	Location	Best Check	T/ha DS¹/ PH²/	CV(Y)³/	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
12. Brazil	79	Gran Saavedra	(Cubano Am.)	4.5 – 63 – 225	19	Across	7736	135	0	-15
						Across	7726	130	-2	-17
						Across	7627	127	-3	-17
						Poza Rica	7835	125	-2	-37
						Sete Lagoas	7728	125	-2	-7
						Poza Rica	7824	124	-1	-11
	78	Ribeirao P.	(Loc. Var.)	7.3 – 67 – 299	14	La Calera (1)	7728	100	+1	-10
						Tlaltizapan	7738	98	0	-10
	78	Sete Lagoas	(HYB L.)	6.0 – 74 – 260	11	Chuquisaca	7728	90	+3	-1
	79	Jardinopolis	(AG 301)	6.1 – 66 – 243	12	Suwan	7736	101	-2	+20
						Across	7627	100	-3	-4
		Sete Lagoas	(AG 301)	7.8 – 62 – 285	9	Across	7728	101	0	-12
13. Colombia	78	Palmira	(ICA H-207)	5.8 – 65 – 271	9	La Calera	7728	113	-3	-19
						Tlaltizapan	7736	109	-2	-10
						Poza Rica	7627	106	-1	-16
	79	Turipana	(ICA H-107)	2.7 – 53 – ---	17	Across	7728	147	+2	--
						Across	7736	129	0	--
						La Maquina	7827	127	+1	--
						Tocumen (1)	7835	123	+4	--
						Sete Lagoas	7726	122	0	--
						Dholi	7624	112	+1	--
14. Peru	78	Montupe	(PMC 2)	3.9 – 67 – 188	18	Poza Rica	7728	116	-2	-22
						Chuquisaca	7736	114	-3	-39
						Obregon	7736	105	-4	-39
	78	Piura	(PM-701)	3.5 – -- – 211	19	Tlaltizapan	7736	140	--	-37
						Tocumen	7728	127	--	-36
	79	La Molina	(PM-210)	7.9 – 96 – 269	20	Poza Rica	7827	105	-7	-82
						Poza Rica	7824	101	-7	-86
						Sete Lagoas	7728	100	-3	-59
	79	Satipo (1)	(PM-701)	5.1 – 61 – 263	16	Across	7728	139	-5	-23
						Poza Rica	7824	120	-5	-35
						Suwan	7736	112	-4	-28
						Poza Rica	7627	112	-8	-23
15. Ecuador	79	Pichilingue	(Pichilin.504)	6.2 – 56 – 268	10	Across	7728	108	-1	-20
						Across	7736	108	-1	-7
						Poza Rica	7827	107	-1	-9
						Poza Rica	7824	104	-1	-9
16. French Guyana	79	Cayenne	(Local Var.)	2.7 – 55 – 174	9	Across	7728	106	-3	+6
						La Maquina	7827	103	-3	+17

54

Table 17. (Continued)

Country	Year	Location	Best Check	T/ha DS[1]/ PH[2]/	CV(Y)[3]/	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
17. Ghana	79	Nyankpala	(Golden Cristal)	2.6 - 59 - 220	29	Sta. Cruz P. (1)	7835	156	-6	-40
						Sete Lagoas	7728	140	0	-11
						Across	7627	128	-2	0
						Poza Rica	7824	126	+1	-9
						Suwan	7726	118	-2	-20
18. Ivory Coast	79	Ferke	(IRAT 81)	6.3 - 60 - 284	9	Across	7728	116	-5	-9
						Poza Rica	7824	105	-6	-18
						La Maquina	7827	102	-6	-14
19. Mali	79	Sotuba	(IRAT 85)	4.4 - 54 - 205	27	Across	7728	115	+3	+13
						Tocumen (1)	7835	108	-1	-22
						Sete Lagoas	7726	108	+2	+20
20. Sierra Leone	79	Rokupr	(Western Y)	2.0 - 73 - 145	34	Across	7728	175	-8	+30
						Poza Rica	7824	163	-8	-3
						Suwan	7736	159	-5	+10
						Across	7726	154	-8	+11
						Across	7627	153	-5	+21
						Across	7635	151	-10	+2
21. Nigeria	78	Mokwa	(Colomb. Comp)	2.2 - 64 - 269	26	Across	7627	145	-8	-64
						Suwan	7528	131	-5	-63
						Poza Rica	7736	111	-6	-67
22. Malawi	78	Chitedze	(Loc. Var.)	7.3 - 67 - 271	12	Poza Rica	7728	94	-2	-34
						San Andres (2)	7627	90	-2	-36
23. Senegal	79	Sefa	(AC1xB1(5))	3.6 - 50 - 164	20	Tocumen (1)	7635	101	0	-20
24. Upper Volta	79	Mogtedo	(Jaune D Fo)	1.7 - 55 - 245	30	Tocumen (1)	7835	176	-6	-39
						Suwan	7736	154	0	-20
						Across	7728	139	-1	-32
						Suwan	7726	137	-2	-49
						La Maquina	7827	135	-2	-25
25. Bangladesh	78	Ishurdi	(J-1)	3.9 - 87 - 155	25	Poza Rica	7728	148	+2	+35
						Chuquisaca	7728	117	+4	0
						San Andres (1)	7627	106	+2	+20
						Tlaltizapan	7736	105	+4	+10
26. Burma	78	Yezin	(TKS-1)	4.5 - 50 - 255	26	Poza Rica	7627	95	-3	-30
						Poza Rica	7728	93	+2	-24
	79	Yezin	(TKS-1)	2.2 - 51 - 191	25	Sete Lagoas	7728	130	-2	-8
						Sta. Cruz P. (1)	7835	118	-7	-35
						Across	7736	116	-2	-8
						Poza Rica	7827	116	-4	-10
						Poza Rica	7824	113	-7	-37
27. Pakistan	79	Yousafwala	(Akbar)	4.4 - 55 - 202	18	Sete Lagoas	7726	140	+3	-21
						Across	7736	131	+4	-10
						Poza Rica	7824	127	+4	-8
						Poza Rica	7835	125	-1	-19

Table 17. (Continued)

Country	Year	Location	Best Check	T/ha DS[1] – PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
28. Philippines	78	Karaan	(SMC-C1)	2.0 – 56 – 210	20	Chuquisaca	7728	176	+3	+38
						Poza Rica	7736	145	+2	+25
						Palmira (1)	7627	142	+3	+13
29. Saudi Arabia	78	Hofuf	(Tainan-11)	3.2 – 62 – 168	14	Poza Rica	7728	148	+21	+17
						Chuquisaca	7728	138	+19	-10
						Across	7627	136	+16	+10
						Tlaltizapan	7736	133	+15	+5
	79	Hofuf	(Loc. Var.)	3.2 – 59 – 171	12	Across	7728	168	+9	+17
						Suwan	7736	160	+9	+26
						Sete Lagoas	7726	157	+6	+4
						Dholi	7624	152	+5	0
						Poza Rica	7827	150	+9	+17
						Poza Rica	7835	109	+2	-24
30. Yemen A.R.	79	Taiz	(Loc. Var.)	3.5 – 59 – 158	13	Sete Lagoas	7728	155	+10	+13
						Poza Rica	7827	149	+10	+11
						Suwan	7736	142	+12	+15
						Poza Rica	7824	142	+6	+7
						Poza Rica	7835	121	+1	-14
31. Sudan	79	Halima	(Katumani Comp.)	2.1 – 61 – 205	22	Across	7736	191	+3	-8
						Suwan	7726	191	0	-10
						Poza Rica	7824	177	+5	-4
						Poza Rica	7827	163	+2	+14
						Sete Lagoas	7728	162	+1	+3
						Tocumen (1)	7835	146	-1	-12
32. Nepal	79	Rompur	(Local Var.)	6.4 – 55 – 240	15	Across	7736	129	+1	+3
						Poza Rica	7827	123	0	+2
						Across	7728	118	+1	-3
						Across	7726	113	+1	-42
33. Sri Lanka	78	Illuppa.	(Thai Comp.)	1.9 – 67 – 139	21	Obregon	7627	145	0	+31
						Chuquisaca	7728	135	0	+1
						Petrolina	7736	127	-2	+6
	79	Illuppa.(1)* (2)	(Bhadra-1) (Bhadra-1)	3.4 – 60 – 186	15 17	Across	7728	140	+1	+20
						Dholi	7624	124	-2	-4
						Poza Rica	7827	120	-1	+10
						Across	7736	117	-1	+6
						Across	7726	109	-2	-12
						Tocumen (1)	7835	104	-3	-22
34. Thailand	78	Suwan	(Suwan-1)	4.9 – 55 – 174	15	Poza Rica	7728	90	+3	+10
	79	Suwan	(Suwan-1)	6.0 – 55 – 233	8	Across	7728	95	+2	+5
						Suwan	7726	95	-2	-13

1/ DS = Days to 50% silking
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

Table 18. Performance of best Experimental Varieties of EVT 14A compared to the best check in 24 countries in 1978.

Country	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	Differences compared to best check in PH
1. Costa Rica	Guanacaste	(TICO-VI)	4.8	55	252	21	Santa Rosa (3) Chuquisaca	7624 7726	112 105	-1 -4	-9 -27
2. El Salvador	Santa Cruz P.	(CENTA M1-B)	4.4	55	256	15	Across	7635	89	-7	-39
3. Guatemala	La Maquina	(H-A24)	5.7	51	225	12	Chuquisaca	7726	91	-1	-12
4. Jamaica	Grove Place	(X-306 B)	3.9	--	260	12	Pichilingue Across Across	7726 7624 7635	99 97 93	-- -- --	-29 -12 -46
5. Mexico	Poza Rica	(Pool 21)	5.3	58	188	12	Santa Rosa (3)	7624	97	+3	-7
6. Panama	Río Hato	(Toc.-7428)	4.6	52	200	12	Across	7624	103	0	-6
	Tocumen	(UNP-1)	4.9	59	224	13	Sete Lagoas (1) Santa Rosa (3)	7726 7624	110 102	-2 -2	-1 -16
	Alanje	(Loc. Var)	4.4	55	271	12	Poza Rica	7726	100	-3	-47
7. Rep. Dom.	San Cristobal	(CNIA-12)	3.5	51	221	22	Sete Lagoas(1) Across	7726 7635	125 106	2 0	-13 -19
8. Bolivia	Santa Cruz	(Cub. Am.)	4.7	60	283	16	Sete Lagoas (1) Across Santa Rosa (3)	7726 7635 7624	110 103 102	-4 -10 -4	-38 -63 -48
	Chuquisaca	(Cub. Am.)	6.2	63	210	26	Across Ferke (2) Sete Lagoas (1)	7624 7635 7726	109 105 100	-1 -8 -2	-34 -42 -20
9. Brazil	R. Preto Sete Lagoas	(Loc. Var.) (Loc. Var.)	6.9 8.0	78 72	261 274	9 15	Sete Lagoas (1) Sete Lagoas (1)	7726 7726	81 73	-7 +1	-38 -34
10. Colombia	Palmira	(MB-223)	5.8	67	221	14	Across	7635	84	-10	-4
11. Peru	Montupe	(PM-701)	3.8	66	173	19	Across Santa Rosa (3) Poza Rica Across	7624 7624 7726 7635	123 121 115 107	-3 -3 -7 -9	-38 -45 -33 -52
	Piura	(PM-701)	3.7	--	208	25	Poza Rica Across	7726 7635	109 98	-- --	-30 -47

57

Table 18. (Continued)

Country	Location	Best Check	T/ha DS[1] PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
12. Botswana	Sebele	(Bco. Pak.)	1.5 - 54 - 166	41	Ferke (2)	7635	100	+5	+3
13. Egypt	Gemmeiza	(Giza-1)	5.2 - 59 - 248	18	Pichilingue	7726	93	+7	-26
14. Malawi	Chitedze	(Loc. Var.)	7.1 - 72 - 272	13	Santa Rosa (3)	7624	82	-8	-60
15. Rep. S. Afr.	Potchef.	(SA-6)	2.5 - 68 - 205	16	Poza Rica	7726	98	+7	-5
16. Senegal	Sefa	(AB No. 2)	4.9 - 50 - 195	9	Poza Rica	7726	89	+2	-2
					Across	7635	89	0	-22
17. Nigeria	Amakama	(Loc. Var.)	2.9 - 65 - 160	31	Poza Rica	7726	138	-6	-15
					Santa Rosa (3)	7624	119	-2	-9
18. Bangladesh	Jessore	(Sadaf)	3.6 - 79 - 182	22	Petrolina	7726	138	-2	+1
					Across	7635	124	-2	+8
					Poza Rica	7624	109	+5	-6
19. Burma	Yezin	(TKS-1)	1.9 - 54 - 209	45	Santa Rosa (3)	7624	169	-2	-18
					Across	7635	154	-6	-20
					Petrolina	7726	146	0	-32
20. Pakistan	Pirsabak	(Sarhad Y)	3.0 - 57 - 170	27	Chuquisaca	7726	119	+4	-5
					Ferke (2)	7635	118	+3	-30
21. Philippines	Karaan	(SMC-Cl)	2.1 - -- - 188	27	Santa Rosa (3)	7624	159	--	+5
					Chuquisaca	7726	155	--	0
					Ferke (2)	7635	139	--	-11
22. Sri Lanka	Illupa	(Thai Comp.)	1.3 - 67 - 141	12	Pichilingue	7726	201	-2	+3
					Across	7624	174	-2	-4
					Across	7635	130	-2	-8
23. Thailand	Suwan	(Loc. Var.)	4.6 - 52 - 178	19	Santa Rosa (3)	7624	72	+2	-15
					Ferke (2)	7635	71	-4	-31
24. Sudan	Halima	(Western Yellow)	4.2 - 56 - 177	21	Santa Rosa (3)	7624	122	+3	+3
					Pichilingue	7726	119	+2	+4
	Yei	(Western Yellow)	3.0 - 69 - 303	18	Pichilingue	7726	100	-12	-80
					Across	7624	95	-7	-50

1/ DS = Days to 50% silking
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

58

Table 19. Performance of best Experimental Varieties of EVT 14B compared to the best check in 20 countries in 1978.

Country	Location	Best Check	T/ha DS[1]/ – PH[2]/	CV(Y)[3]/	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
1. Costa Rica	Alajuela	(TICO H-4)	6.4 – 79 – 262	9	Maracay	7530	102	-8	-13
					San Andres (2)	7530	96	-8	-20
					Nyankpala	7623	95	-10	-40
					San Andres (1)	7632	94	-9	-44
2. El Salvador	San Andres	(H-5)	4.1 – 59 – 238	17	Nyankpala	7623	93	-2	-27
					San Andres (2)	7530	92	-2	-14
3. Guatemala	Cuyuta	(La Maquina 7422)	4.7 – 56 – 268	15	San Andres (2)	7530	109	-3	-15
					Pinsabak (1)	7523	108	-4	-10
					Across	7623	108	-2	-14
					San Andres (2)	7532	101	-2	-20
	Nva. Concep-ción	(T-101)	2.4 – 53 – 203	15	San Andres (2)	7530	137	-1	+15
					Across	7623	135	0	+17
					Nyankpala	7632	131	-2	+5
4. Mexico	La Huerta	(B-666)	5.9 – 70 – 263	12	Cali	7623	111	-5	-5
					Maracay	7525	109	-5	-10
					Ilonga	7530	109	-4	-38
					San Andres (1)	7623	106	-5	+2
	Poza Rica	(Pool 20)	3.7 – 61 – 169	15	Ilonga	7525	122	0	0
					Poza Rica	7623	120	0	+10
					San Andres (2)	7530	118	0	+27
					Los Baños (1)	7632	110	+1	-1
5. Bolivia	Santa Cruz	(Tuxpeño)	2.6 – 82 – 178	21	San Andres (2)	7632	131	-8	-38
					Cali	7623	124	-8	-28
					Concepción	7725	108	-5	-28
					Ilonga	7530	105	-6	-28
	Chuquisaca	(Am. Dentado)	4.1 – 66 – 225	12	Across	7525	121	-1	-20
					Ilonga	7530	119	-1	-22
					San Andres (1)	7632	117	-1	-21
					Cali	7623	113	-4	-17
6. Brazil	Sete Lagoas	(HYB LIN.)	5.5 – 77 – 269	13	Nyankpala	7623	103	-6	-33
					Los Baños (1)	7632	94	-4	-33
7. Colombia	Palmire	(Diacol H253)	4.8 – 68 – 267	19	Cotaxtla (2)	7530	93	-4	-27
8. Botswana	Sebele	(Kal. E.P.)	1.3 – 54 – 166	37	Alajuela (1)	7725	98	+9	-8
					Cotaxtla	7530	98	+8	+5
9. Egypt	Sids	(AED)	4.9 – 69 – 225	20	Ilonga	7530	105	0	-17
					Cotaxtla (1)	7530	104	0	-21
10. Ghana	Ejura	(Comp. W.)	6.1 – 58 – 241	23	Nyankpala	7623	95	-6	-46
					Cotaxtla (1)	7530	89	-2	-30
					Maracay	7525	85	-4	-56

Table 19. (Continued)

Country	Location	Best Check	T/ha DS[1] - PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
								DS	PH
11. Malawi	Ngabu	(PNR-95)	5.0 - 58 - 178	20	Poza Rica	7725	85	+2	-17
12. Nigeria	Ikene	(TZB-C7)	5.2 - 57 - 239	11	San Andres (2)	7530	113	-3	+1
					Poza Rica	7523	107	0	-20
	Amakama	(Loc. Var.)	3.5 - 65 - 198	24	Ilonga	7530	113	-4	-25
					Nyankpala	7623	107	-3	-31
					San Andres (1)	7632	103	-2	-31
13. Saudi Arabia	Gassim	(Tainan 11)	3.1 - 77 - 142	16	Pirsabak (1)	7525	95	+6	+13
					Across	7632	92	+7	-2
14. Senegal	Sefa	(ZM 10)	3.6 - 57 - 204	15	Cali	7623	127	-1	+6
					Ilonga	7530	126	0	+8
					Pantnagar (2)	7632	116	+1	-17
15. Tanzania	Ilonga	(Ilonga 7621)	4.2 - 61 - 181	10	San Andres (2)	7530	93	-1	+37
16. Zaire	Gandajika	(Salongo)	4.4 - 61 - 225	24	Ilonga	7725	127	-7	-17
					San Andres (2)	7530	124	-4	+7
					Cuyuta	7623	118	-2	-11
					Poza Rica	7523	114	-3	-17
17. Nigeria	Amakama	(Loc. Var.)	3.5 - 65 - 198	24	Ilonga	7530	113	-4	-25
					Nyankpala	7623	107	-3	-31
					San Andres (1)	7632	103	-2	-31
18. Bangladesh	Jamalpur	(Sarhad)	4.3 - 82 - 197	20	Cali	7623	106	+5	-15
					Ilonga	7725	97	+2	-15
					Across	7632	97	+3	-24
19. Nepal	Rampur	(Sarlahi)	2.1 - 69 - 168	24	Ilonga	7530	192	-4	-13
					Maracay	7525	181	-2	-15
					San Andres (2)	7632	178	-2	-27
					Cali	7623	176	-5	-6
20. Philippines	Karaan	(P. DMR C-1)	1.9 - 55 - 180	22	Los Baños (3)	7632	131	+3	+8
					Poza Rica	7623	128	+2	+10
					Poza Rica (E)	7725	118	+2	+15

1/ DS = Days to 50% silking.
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

60

Table 20. Performance of best Opaque-2 Experimental Varieties of EVT 15 and 15A compared to the best check in 24 countries in 1978 and 1979.

	Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EVI's		Yield % of Best Check	Differences compared to best check in DS	PH
1.	Costa Rica	78	Alajuela	(Cot. 7437 o2)	5.6	73	228	11	Tlaltizapan	7740	112	-3	-9
									Poza Rica (E)	7737	108	-1	-16
2.	El Salvador	79	San Andres	(H-9) (N) *	4.4	55	248	12	Ilonga	7740	86	-2	-30
3.	Guatemala	78	La Maquina	(F 101) (N)	5.6	54	209	11	Satipo (2)	7639	87	0	+11
		79	La Maquina	(Comp.-2) (N)	4.9	53	183	12	Ilonga	7740	89	-1	+50
4.	Mexico	78	Poza Rica	(La Posta) (N)	5.3	63	206	12	Poza Rica (F)	7737	96	-2	-12
									Poza Rica	7740	90	-3	-23
		79	Poza Rica	(Ac. 7739) (N)	5.5	62	161		Across	7740	73	0	+9
5.	Panamá	78	Tocumen	(Loc. Var.) (N)	4.8	60	235	12	Satipo (2)	7639	95	-3	-1
									Poza Rica	7740	93	-2	-26
		79	Tocumen	(Toc.-7428) (N)	4.4	56	210	6	Ilonga	7740	105	-1	-9
			Rio Hato	(Toc.-7428) (N)	3.8	53	200	16	Across	7740	105	0	-7
6.	Haiti	79	Levy	(Poza Rica 7427)(N)	3.0	56	218	15	Laguna	7740	110	-1	-12
									Poza Rica	7839	107	-2	-24
7.	Bolivia	78	Abapo-Izozog	(Loc. Var.) (N)	4.9	56	178	20	Tlaltizapan	7740	125	+1	+40
									Poza Rica (E)	7737	113	+4	+42
									Tocumen	7639	106	-1	+20
									Gemeiza (1)	7741	106	-4	+31
		78	Chuquisaca	(Cub. Amar.)(N)	2.1	64	164	15	Gemeiza (1)	7741	194	-1	0
									Tlaltizapan	7740	177	+2	+16
									Poza Rica (E)	7737	168	+2	+10
									Tocumen	7639	162	+2	+16
8.	Brazil	78	Sete Lagoas	(Loc. Var.) (N)	6.4	74	270	11	Obregon	7740	91	-4	-34
		79	Sao Paulo	(BR 1051) (N)	5.5	64	224	11	Ilonga	7740	107	-1	+7
									Across	7740	103	+1	+14
9.	Peru	79	Satipo (1)	(PM 701) (N)	4.4	59	255	14	Across	7740	105	-3	-55
									Suwan	7738	97	-4	-40
			La Molina	(PM 210) (N)	10.9	95	266	18	Across	7740	74	-4	-103
									Across	7738	68	-9	-87
10.	Ecuador	79	Pichilinque	(Pichilingue 504)(N)	6.3	54	269	10	Across	7740	91	+1	-26
11.	Colombia	78	Palmira	(ICA-H 207) (N)	4.2	65	266	20	Satipo (2)	7639	81	-1	-17
12.	Egypt	78	Sids	(AED(Tux.xL,P.)o2)	4.6	71	200	19	Poza Rica	7738	104	-3	-3
									Poza Rica	7740	100	-1	-21
13.	Ivory Coast	79	Ferke	(IRAT-81) (N)	5.6	61	215	20	Laguna	7740	95	-3	-19
									Poza Rica	7839	95	-6	-7
									Across	7738	92	-8	-7
14.	Senegal	78	Sefa	(BDS III) (N)	3.4	47	183	24	Obregon	7738	127	+2	-2
									Tlaltizapan	7740	123	+6	+23
									Poza Rica (E)	7737	113	+6	+12
									Tlaltizapan	7741	110	+2	-23
									Tocumen	7639	109	+5	+11
		79	Sefa	(AC1 x B1) (N)	3.7	50	154	11	Laguna	7740	89	+2	0
									Across	7738	86	+1	0

61

Table 20. (Continued)

	Country	Year	Location	Best Check	T/ha	DS¹/	PH²/	CV(Y)³/	Best EV's		Yield % of Best Check	Differences compared to best check in	
												DS	PH
15.	Sierra Leone	79	Rokupr	(Loc. o₂)	2.0	60	144	29	Ilonga	7740	134	+4	-11
									Suwan	7738	130	0	-10
									Poza Rica	7839	116	+4	-7
16.	Zaire	78	Gandajika	(Kasai 1) (N)	7.5	72	203	8	Obregon	7740	101	-3	-5
									Satipo (2)	7639	101	-1	-15
		79	Kisanga	(Kasai 1) (N)	7.9	68	190	14	Laguna	7740	92	-3	-33
17.	Malawi	79	Ngabu	(TNH 95) (N)	7.8	45	211	12	Across	7740	68	+4	+5
18.	Bangladesh	78	Jamalpur	Mean of all entries	3.1	163	83	14	Khumaltar	7741	126	-6	-18
									Poza Rica	7738	110	-1	-4
									Santa Rosa	7639	107	-1	-2
									Tlaltizapan	7740	103	+4	-4
19.	Burma	78	Yezin	(Loc. Var.) (N)	3.4	53	226	27	Poza Rica (E)	7737	137	+2	-17
									Tocumen	7639	127	-4	-17
									Khumaltar	7741	121	-5	-20
									Obregon	7740	112	-2	-20
									Poza Rica	7738	100	-4	-6
		79	Yezin	TC #1 Medok (N)	1.6	48	154	35	Ilonga	7740	126	+8	-5
									Across	7738	108	-5	-6
20.	Pakistan	78	Pirsabak	(Sarhady) (N)	3.6	55	172	21	Tocumen	7639	120	+2	+3
									Obregon	7740	119	+3	+32
									Poza Rica (E)	7737	116	+8	-20
									Tlaltizapan (E)	7741	111	+2	+32
		79	Islamabad	(SYN-551) (N)	4.9	59	186	24	Obregon	7738	105	+2	-15
									Poza Rica (E)	7739	118	+6	+32
									Across	7740	109	-10	+4
									Suwan	7738	109	+4	+15
21.	Philippines	78	Karaan	(Loc. Var.) (N)	1.9	57	183	26	Satipo (2)	7639	161	+1	+60
									Poza Rica	7639	144	0	+22
									Tlaltizapan	7740	144	+1	+22
									Obregon	7738	122	-2	+12
									Poza Rica (E)	7737	114	+2	+7
									Tlaltizapan (E)	7741	110	-2	+27
22.	Thailand	78	Suwan	(Suwan 1-C5) (N)	4.8	53	162	23	Poza Rica	7740	67	0	0
									Poza Rica (E)	7737	65	+1	-8
		79	Suwan	(Suwan 1-C6) (N)	6.4	55	220	8	Ilonga	7740	81	-1	0
									Suwan	7738	78	-3	-10
23.	Nepal	79	Rampur	(Loc. Var.)	6.2	54	231	9	Laguna	7740	120	+1	-23
									Poza Rica	7839	105	0	-12

1/ DS = Days to 50% silking.
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.
(N) = Normal without Opaque-2 gene.
* Check varieties failed.

Table 21. Performance of best Experimental Varieties of EVT 16 compared to the best check in 24 countries in 1978 and 1979.

	Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
												DS	PH
1.	Mexico	78	Tlaltizapan	(Pool 34)	6.0	60	236	9	Cali (2)	7642	138	+3	+5
									Pirsabak (1)	7734	137	+3	+6
									Tlaltizapan	7633	133	+3	+1
		79	Tlaltizapan	(V-521)	5.2	66	255	12	Tlaltizapan	7833	137	-4	-34
									Across	7734	131	-3	-29
									Tlaltizapan	7842	129	-3	-27
									Tlaltizapan	7845	125	-6	-39
									Tlaltizapan	7844	125	-2	-27
2.	Brazil	79	Sete Lagoas	(AG 301)	8.2	64	270	10	Tlaltizapan	7833	94	-6	-7
			Chapeco	(AG 54)	4.5	75	212	26	Tlaltizapan	7845	89	-10	-28
									Tlaltizapan	7842	79	-4	-20
									Across	7748	76	-16	-39
3.	Argentina	78	Pergamino	(Loc. Var.)	5.0	57	208	10	Obregon	7633	104	+15	+1
									Adapazari	7542	104	+8	+18
									Tlaltizapan	7744	102	+7	+5
4.	Bolivia	78	Abapo-Izozog	(Cub. Amar.)	5.7	55	206	17	Pirsabak (4)	7642	112	0	+2
									Tlaltizapan	7633	107	-1	-5
									Pantnagar	7734	101	0	+3
		78	Chuquisaca	(Comp. 101)	4.0	64	191	29	Dholi (2)	7633	142	-3	-17
									Pantnagar	7734	141	-4	-5
									Tlaltizapan	7642	123	-5	-31
5.	Ecuador	78	Pichilingue	(Pichilingue 504)	6.1	56	301	12	Across	7633	100	-3	-10
6.	Chile	78	La Platina	(Camelia)	10.0	74	260	9	Tlaltizapan	7734	121	+11	+25
									Across	7642	119	+14	+35
									Satipo (2)	7633	105	+10	+28
									Obregon	7748	103	-4	-25
		79	La Platina	(MA 4)	11.1	75	243	8	Across	7734	113	+11	+35
									Across	7633	109	+18	+50
									Tlaltizapan	7842	108	+11	+17
									Tlaltizapan	7844	107	+14	+30
									Tlaltizapan	7845	103	+6	+5
7.	Botswana	78	Good Hope	(PPK x 64R)	1.3	63	134	36	Obregon	7748	102	-3	-4

Table 21. (Continued)

	Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
8.	Egypt	78	Gemeiza	(Giza-1)	5.2	60	251	18	Sids (1)	7734	114	+5	-16
									Satipo (1)	7633	108	+2	-21
									Across	7633	105	-2	-6
		79	Sids	(Comp. 2)	7.5	67	274	14	Tlaltizapan	7844	102	-1	-18
9.	Lesotho	78	Thaba Tseka	(PPK x 64R)	2.7	98	144	30	Obregon	7748	127	-7	-19
									Pantnagar	7734	123	-1	+10
10.	Malawi	78	Bembeke	(Loc. Var.)	4.9	--	248	15	Tlaltizapan	7734	72	--	-54
11.	Nigeria	78	Ibadan	(TZB C-7)	3.5	60	206	19	Tlaltizapan	7633	116	-3	-10
									Palmira	7434	101	-4	-23
									Adapazari	7542	100	-4	-16
12.	Rep. S. Africa	78	Potchef.	(SSM 39)	4.7	81	163	11	Tlaltizapan	7734	96	+1	+7
									Cali (2)	7642	93	+1	+15
									Satipo (2)	7633	93	+2	+7
									Obregon	7748	90	+1	-10
		79	Potchef.	(MASGA-36 x M162W)	6.7	69	---	9	Tlaltizapan	7844	90	+9	---
13.	Bangladesh	78	Jamalpur	Mean of all entries *	2.6	97	153	23	Satipo (2)	7633	126	-2	+17
									Across	7642	117	+1	+8
									Obregon	7748	105	-6	-8
									Pirsabak (1)	7734	100	+3	-4
14.	Pakistan	78	Yousafwala	(Akbar)	4.8	52	199	20	Sids (1)	7734	123	+1	-2
									Satipo (2)	7633	123	0	+4
									Cali (2)	7642	119	+1	+11
		79	Pirsabak	Sarhad (W)	6.5	59	179	14	Across	7734	113	+2	+5
									Tlaltizapan	7842	107	+4	+9
									Yousafwala (1)	7845	103	-2	0
15.	Tanzania	78	Lyamungu	(UCA)	4.8	78	237	20	Njombe (1)	7734	101	-4	-38
									Tlaltizapan	7734	100	-9	-42
16.	Zaire	78	Gandajika	(Salongo)	6.6	75	197	13	Sids (1)	7734	101	-6	+1
17.	Mali	79	Sotuba	(Tiemante)	4.6	50	204	32	Across	7734	96	-2	-1
									Tlaltizapan	7842	94	+2	-1

Table 21. (Continued)

	Country	Year	Location	Best Check	T/ha	DS[1]	PII[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
												DS	PII
18.	Iraq	79	Abu Ghraib	(Neelum)	6.5	62	234	13	Tlaltizapan	7844	120	+2	-6
									Across	7734	118	+1	-6
									Tlaltizapan	7842	111	+1	-3
									Tlaltizapan	7845	107	-2	-27
19.	Burma	79	Yezin	(TC #1 Medok)	2.7	48	176	22	Tlaltizapan	7844	125	+5	-5
									Sids	7734	119	+5	+3
									Tlaltizapan	7833	118	+4	-2
									Yousafwala (1)	7845	117	+1	-25
									Tlaltizapan	7842	116	+3	-2
20.	Afghanistan	79	Lashkergah	(Loc. Var.)	2.8	58	146	17	Across	7748	157	-3	+25
									Yousafwala(1)	7845	137	+1	+54
21.	Yemen A.R.	79	Taiz	(Loc. Var.)	3.2	52	180	13	Tlaltizapan	7842	190	+7	-8
									Across	7633	174	+8	-8
									Tlaltizapan	7844	172	+8	-6
									Tlaltizapan	7845	169	+2	-18
									Sids	7734	168	+7	-12
									Dholi	7748	138	-3	-28
22.	Jordan	79	Deir Alla	(Loc. Var.)	3.0	52	216	27	Tlaltizapan	7842	117	+3	+10
									Tlaltizapan	7845	116	-1	+17
									Across	7748	100	-1	+4
23.	Morocco	78	Boulavane	(Loc. Var.)	2.5	100	170	27	Tlaltizapan	7734	139	+5	+70
									Satipo (2)	7633	137	+2	+65
									Obregon	7748	102	0	+56
									Tlaltizapan	7642	100	+5	+58
24.	Saudi Arabia	79	Hofuf	(Loc. Var.)	5.3	53	181	20	Tlaltizapan	7842	141	+10	+19
									Tlaltizapan	7845	132	-6	+17
									Across	7734	131	+7	+22
									Across	7633	115	+12	+17
									Across	7748	109	-2	+12

* Check varieties failed.

1/ DS = Days to 50% silking.
2/ PII = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

Table 22. Performance of best Experimental Varieties of EVT 17 compared to the best check in 5 countries in 1978.

C o u n t r y	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
1. Mexico	El Batan	(Pool 8)	5.5	90	220	15	Batan	7660	142	+1	+8
							Batan	7655	109	-11	-10
							Batan	7652	101	-10	-6
	Toluca	(Pool 8)	7.7	123	200	16	Toluca	7653	88	-3	-1
							Batan	7652	81	-3	-15
2. Colombia	Tibaitata	(ICA H-556)	5.0	128	---	---	Toluca	7654	88	-14	---
							Batan	7652	87	-6	---
3. Peru	Carhuaz	(PMV-662)	6.0	---	---	29	Toluca	7653	180	---	---
							Across	7654	142	---	---
							Batan	7655	113	---	---
4. Ethiopia	Alemaya	(Loc. Var.)	3.4	118	235	19	Batan	7660	157	-24	-50
							Batan	7652	129	-30	-74
							Batan	7653	125	-31	-70
							Batan	7655	120	-31	-71
	Awasa	(Pool 2)	2.6	68	181	24	Batan	7660	115	-1	+24
	Bako	(Loc. Var.)	3.6	81	369	14	Batan	7660	116	-24	-129
5. Lesotho	Thaba Tseka	(Pool 2)	2.8	88	132	11	Batan	7660	130	+4	+25
							Toluca	7654	125	-3	+25
							Batan	7652	115	+4	+14
							Toluca	7653	113	+4	+22
							Batan	7655	112	+4	-6

1/ DS = Days to 50% silking.
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

Table 23. Performance of best Elite Experimental Varieties of ELVT 18 compared to the best check in 38 countries in 1978 and 1979.

	Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	Differences compared to best check in PH
1.	Bahamas	78	San Andres	(Loc. Var.)	3.5	62	233	18	Ferke (1)	7526	124	-8	-11
									Across	7622	121	-4	-4
									Suwan	7535	115	-8	-48
									Across	7529	114	-3	-8
									San Ramon	7528	109	-2	-12
									Sta. Rosa (1)	7624	103	-5	-26
2.	Costa Rica	78	Alajuela	(Tico H-4)	6.2	79	248	12	Guanacaste	7528	97	-7	-18
									Delhi (1)	7622	91	-7	-34
		78	Los Diamantes	(Tico V-5)	3.6	60	247	20	Delhi (1)	7622	125	0	-11
									Across	7529	116	+1	-11
									Guanacaste	7528	113	0	-13
		78	Punta Arenas	(Tico V-1)	4.3	64	---	21	Across	7522	113	0	---
									Delhi (1)	7622	104	0	---
									Across	7536	103	0	---
		79	Los Diamantes	(Tico V-1)	3.7	56	230	17	Poza Rica	7643	132	0	-4
									Palmira (2)	7631	132	+1	-50
									Ferke (1)	7622	130	0	-12
									La Calera (1)	7728	129	+1	-7
									Ilonga	7529	126	0	-23
		79	Guanacaste	(B-666)	3.2	52	240	23	Poza Rica	7643	101	0	-12
3.	El Salvador	78	Texistepeque	(CENTA HE-1)	4.3	55	202	17	Across	7528	96	+4	+20
		78	San Antonio S.	(H-5)	5.7	55	204	10	Across	7522	105	+1	+10
									Ferke (1)	7520	102	+1	+6
									Guanacaste	7528	97	+1	+19
									Across	7526	97	0	-14
		78	Sta. Cruz P.	(H-5)	7.0	55	264	13	Across	7529	95	0	-19
									Palmira	7522	93	-1	-32
		79	Ahuachapan	(h-9)	5.6	60	245	10	Ilonga	7530	108	-1	+3
									Nyankpala	7623	103	-1	-10
									Poza Rica	7643	103	+1	+3
									Maracay	7522	100	+1	+6
		79	San Andres	(H-9)	4.3	58	231	15	Poza Rica (E)	7729	87	-1	-38
		79	Sta. Cruz P.	(H-9)	5.6	51	259	12	Poza Rica	7643	86	+1	-18
4.	Guatemala	78	Cuyuta	(HB-11)	5.4	55	244	11	Guanacaste	7528	93	+1	-1
									Across	7529	92	+2	+14
									Cotaxtla (1)	7543	92	+2	+20
									Across	7522	91	0	+9
		78	La Maquina	(HB-11)	5.4	53	208	10	Across	7522	107	+1	+17
									Across	7529	92	+2	+12
5.	Haiti	78	Levy	(Las Cahobas)	1.6	73	251	25	Ilonga	7521	172	-13	-67
									Palmira	7522	171	-12	-56
									Guanacaste	7528	169	-13	-39
									Sta. Rosa (1)	7624	155	-12	-63
									Ferke (1)	7529	155	-12	-44

Table 23. (Continued)

	Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
												DS	PH
6.	Honduras	78	Comayagua	(Hond. P.B.)	3.8	58	235	26	Delhi (1)	7622	149	0	-2
									Ferke (1)	7529	144	0	+19
									Ilonga	7521	134	0	-16
									Across	7528	126	+2	+14
									Ferke (1)	7526	126	-2	+5
									Across	7536	120	0	0
		79	Guaymas	Serena	2.9	57	210	14	Poza Rica	7643	124	-3	+15
		79	La Union	Amarillo 1	3.4	55	220	21	Chindwara	7536	113	-1	+33
									Poza Rica (E)	7729	112	-2	-12
									Ferke (1)	7622	110	-3	+2
									Tocumen	7728	110	-2	+7
									Ilonga	7530	109	-4	+7
									La Maquina	7721	108	-3	-11
7.	Jamaica	78	Bodles	(X-304A)	4.7	--	259	20	Across	7526	110	---	-25
									Across	7522	95	---	-36
8.	Nicaragua	78	Santa Rosa	(NB-2)	4.1	60	236	21	Across	7529	136	-1	+4
									Ilonga	7521	128	-2	-7
									Across	7522	125	-2	+4
									Across	7536	122	0	+7
									Guanacaste	7528	119	-4	+29
9.	Mexico	78	Poza Rica	(Pool 24)	5.8	61	205	11	Ilonga	7521	97	0	-24
									Palmira	7522	97	0	-11
		79	La Huerta (Jal.)	(T-47)	4.0	62	215	20	Ferke (1)	7622	150	-2	-15
									Poza Rica (E)	7729	143	-2	-7
									Poza Rica	7627	130	-2	-5
									Tocumen	7728	129	-2	+8
									La Maquina	7721	128	-2	-7
									Poza Rica	7643	125	-2	+15
		79	Cotaxtla	(H-509)	5.0	51	191	7	Poza Rica	7643	121	+3	+58
									Ferke (1)	7622	120	+2	+31
									Poza Rica (E)	7729	106	+3	+37
		79	Poza Rica	(H-507)	3.9	69	235	--	Ilonga	7529	140	-9	-45
									Ferke (1)	7622	137	-7	-49
									Poza Rica	7643	136	-6	-34
		79	Nayarit	(B 670)	2.6	55	294	9	Poza Rica	7643	114	0	-23
									Ferke (1)	7622	114	-2	-25
									Tocumen	7728	107	-1	-4
									Poza Rica (E)	7729	103	0	-30

Table 23. (Continued)

	Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
												DS	PH
10.	Panama	78	Guarare	(Sel. Azuero)	3.7	57	277	17	Delhi (1)	7622	109	-1	-48
									Across	7529	108	+2	-21
									Ilonga	7521	108	-1	-36
									Across	7536	103	-1	-16
									Guanacaste	7528	90	-1	-20
		78	Alanje	(Loc. Var.)	4.6	56	251	12	Across	7529	108	+1	-12
									Delhi (1)	7622	104	-2	-25
									Across	7528	100	-1	+2
		78	Rio Hato	(UNP-1)	5.2	56	214	12	Across	7522	103	-2	-9
									Ilonga	7521	101	-2	-24
		78	Tocumen	(UNP-1)	4.6	57	248	14	Guanacaste	7528	101	-3	-8
									Guanacaste	7528	102	-2	-5
		79	Tocumen (1)*/Tocumen (2)	(UNP-1)	3.5	55	214	19	Palmira	7522	99	-2	-5
									Poza Rica	7643	125	0	+8
									Ferke (1)	7622	114	-1	-2
									La Calera (1)	7728	110	-1	+4
									Chindwara	7536	109	-1	+3
		79	Rio Hato	(Toc. 7428)	4.1	54	204	14	Poza Rica	7643	121	0	-4
									Palmira (1)	7631	109	+2	-21
									Ilonga	7529	106	-1	-10
									Tocumen	7728	103	-1	+1
11.	Bolivia	78	Chuquisaca	(Comp. 101)	6.1	64	215	34	Palmira	7522	111	0	-25
									Delhi (1)	7622	99	+1	-30
									Across	7528	97	0	-22
									Guanacaste	7528	95	+1	-47
		78	Santa Cruz	(Cub. Amar.)	4.7	60	279	12	Across	7536	121	-3	-21
									Ferke (1)	7526	115	-6	-43
									Cotaxtla (2)	7543	114	-2	-4
									Across	7522	113	-3	-29
									Across	7528	111	-2	-19
12.	Brazil	78	Sete Lagoas	(Loc. Var.)	7.2	77	284	11	Across	7528	94	-1	-11
									Delhi (1)	7622	92	-4	-30
		79	Sete Lagoas	(AG 126)	7.9	66	269	12	Poza Rica	7643	92	-1	-13
									Ilonga	7529	90	-4	-25
		79	Jardinopolis	(AG 162)	6.4	68	229	14	Ilonga	7524	104	-5	-19
									Poza Rica (E)	7729	98	-3	-9
13.	French Guyana	79	Cayenne	(Loc. Var.)	3.1	59	194	18	Palmira (2)	7631	105	0	-43
									Chindwara	7536	100	0	-23
14.	Colombia	78	Palmira	(La Posta)	7.3	62	266	10	Across	7536	104	-3	*12
									Across	7522	100	-3	-27
		79	Turipana	(ICA H-154)	2.2	56	---	17	Poza Rica (E)	7729	179	-3	---
									Palmira (2)	7631	165	-1	---
									Ferke (1)	7622	160	-3	---
									La Maquina	7721	158	-2	---

Table 23. (Continued)

	Country	Year	Location	Best Check	T/ha	DS[1]/	PH[2]/	CV(Y)[3]/	Best EV's		Yield % of Best Check	Differences compared to best check in DS	Differences compared to best check in PH
									Tocumen	7728	151	-1	---
									Poza Rica	7643	149	-3	---
									Ilonga	7530	145	-4	---
									Tlaltizapan	7736	141	-3	---
									San Andrés (2)	7632	133	-3	---
									Poza Rica	7627	123	-3	---
									Sta. Rosa (3)	7624	121	-4	---
									Nyankpala	7623	118	-5	---
15.	Ecuador	78	Pichilingue	(V517 x M.A.)	4.7	54	276	11	Ferke (1)	7529	109	+3	0
									Palmira	7522	105	+2	-6
									Across	7536	103	+2	+7
		79	Pichilingue	(Pichilingue 526)	5.5	56	266	9	La Calera (1)	7728	115	+1	+19
									Maracay	7522	109	0	+19
									Tlaltizapan	7736	101	+1	+10
16.	Peru	78	Montupe	(PMC-2)	4.0	69	196	22	Ferke (1)	7529	137	-4	-42
									Ilonga	7521	121	-5	-67
									Across	7522	121	-6	-40
									Sta. Rosa (1)	7624	119	-6	-47
									San Ramon	7528	108	-3	-48
		79	Satipo (1)	(PM 701)	5.3	59	263	15	Poza Rica	7643	126	-1	-10
									Ilonga	7529	115	-2	-43
									Tocumen	7728	111	-1	-8
									La Maquina	7721	104	-4	-55
									Ilonga	7530	101	-3	-23
17.	Venezuela	78	Maracay	(SIMETO)	5.3	63	248	13	Across	7522	127	+1	-59
									Ferke (1)	7529	122	+1	-49
									Across	7528	120	-1	-24
									Across	7536	120	+1	-42
									Ilonga	7521	113	0	-78
18.	Botswana	78	Good Hope	(Kal. Early)	0.9	65	133	46	Ferke (1)	7635	109	-5	-18
		78	Sebele	(PP x K64 R)	0.7	53	153	46	Ferke (1)	7635	162	0	-4
									Guanacaste	7528	119	+15	+27
									Delhi (1)	7622	109	+15	+1
19.	Egypt	78	Sakha	(VC-80)	9.1	66	284	12	Across	7522	111	+3	-3
									Across	7528	108	+1	+6
									Delhi (1)	7622	107	+2	-20
									Ferke (1)	7529	103	+3	-22
		78	Sids	(VC-80)	7.2	67	321	19	Across	7522	62	0	-56
20.	Ghana	78	Pokoase	(Comp. W)	4.8	57	254	12	Across	7529	109	0	-58
									Delhi (1)	7622	105	0	-73

Table 23. (Continued)

	Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
21.	Haute Volta	78	Farako-Ba	(Syn. Mass.)	4.0	59	238	15	Across	7536	117	-4	+24
									Across	7528	114	-8	-31
									Ilonga	7521	103	-2	+26
		79	Farako-Ba	(Loc. Var.)	1.8	64	218	16	Tlaltizapan	7736	136	0	-15
									Ilonga	7529	128	-1	-29
									Ludhiana	7528	124	0	-17
									Nyankpala	7623	124	-3	-35
									Ilonga	7530	119	-1	-23
22.	Ivory Coast	79	Bouake	(IRAT-81)	5.7	62	216	12	Poza Rica	7643	114	0	0
									Palmira (2)	7631	104	0	-32
									Poza Rica (E)	7729	100	0	-13
									Ferke (1)	7622	99	+1	-10
									La Maquina	7721	97	-1	-10
		79	Ferke	(IRAT-81)	6.5	60	268	11	Ferke (1)	7622	121	-4	-14
									Poza Rica	7643	120	-2	+10
									Palmira (2)	7631	107	-1	-60
									La Maquina	7721	105	-4	-29
									Poza Rica (E)	7729	102	-3	-17
23.	Mali	79	Sotuba	(Boni)	4.7	49	176	34	Poza Rica (E)	7729	119	+5	+37
									Tocumen	7728	117	+3	+20
									Ferke (1)	7622	117	+1	+40
									Poza Rica	7627	110	+2	+37
24.	Senegal	78	Nioro	(BDS 111)	2.7	46	214	12	Ferke (1)	7529	98	+8	-5
									Delhi (1)	7622	94	+9	-4
		78	Sefa	(BDS 111)	4.8	51	199	15	Ferke (1)	7529	110	+4	-12
									Across	7522	109	+4	-4
									Ferke (1)	7526	107	+3	-9
									Delhi (1)	7622	107	+4	-25
		78	Sinthiou	(BD 111)	3.1	47	223	26	Delhi (1)	7622	114	+5	-12
									Ferke (1)	7529	101	+5	-1
		79	Nioro	(AC1 x B1)	4.2	51	221	11	Poza Rica (E)	7729	82	+5	-18
		79	Sefa	(AC1 x B1)	4.4	50	172	15	Poza Rica	7643	83	+6	+13
25.	Tanzania	78	Ilonga	(Ilonga 7621)	3.2	66	145	21	Ilonga	7521	113	-1	+11
									Across	7522	105	-2	+24
26.	Zaire	78	Kisanga	(Kasai 1)	8.0	71	210	12	San Ramon	7528	101	+2	+5
									Delhi (1)	7622	99	+1	-7
		79	Kaniama	Tuxp. x ETO	6.6	73	225	15	Poza Rica	7643	112	-3	+12
									Ferke (1)	7622	109	-4	+20
									Ilonga	7530	108	-3	+5
									Tlaltizapan	7736	106	-5	+1
									Sta. Rosa (3)	7624	104	-4	-19

Table 23. (Continued)

Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
27. Uganda	78	Kawanda	(White Star)	1.6	69	234	41	Suwan	7528	104	-3	+8
								Palmira	7522	95	-2	-73
28. Ethiopia	78	Alemaya	(Bukuri)	7.5	104	249	23	Cotaxtla (2)	7543	95	+12	-22
	78	Awassa	(Loc. Var.)	6.8	75	239	15	Across	7522	127	+6	+4
								Ferke (1)	7529	120	+6	+4
								Ilonga	7521	116	+6	-30
								Across	7529	81	+10	-13
								Across	7522	81	+13	-25
29. Somalia	79	Afgai	(Loc. Var.)	5.5	55	185	15	Ferke (1)	7622	95	+1	-25
30. Malawi	79	Ngabu	(PNR 353)	5.3	50	177	26	Ilonga	7530	109	-2	-4
								Tocumen	7728	109	+2	+30
								Palmira (2)	7631	103	+1	-33
								San Andres (2)	7632	100	0	0
31. Swaziland	79	Malkerns	(SR 52)	9.1	90	261	14	San Andres (2)	7632	75	-4	-62
32. Sri Lanka	79	Iluppallama	(Caribb. Comp.)	4.0	59	164	14	Tlaltizapan	7736	116	-1	+26
								Ilonga	7529	107	+2	+19
								Ferke (1)	7622	103	+2	+42
								Tocumen	7728	102	+3	+21
33. Burma	79	Yezin	(TC #1 Medok)	2.2	48	166	23	Poza Rica (E)	7729	150	+8	+1
								Tocumen	7728	139	+8	+1
								Nyankpala	7623	129	+7	-11
								Ferke (1)	7622	117	+9	-3
								Poza Rica	7643	115	+9	+7
								Ilonga	7530	114	+8	+5
								San Andres (2)	7632	108	+7	-9
34. Philippines	78	Karaan	(L. Tiniguib)	2.7	47	163	23	Ferke (1)	7529	121	+13	+50
								Suwan	7535	120	+5	+2
								Ilonga	7521	118	+12	+50
35. Thailand	78	Suwan	(Loc. Var.)	3.7	56	156	22	Palmira	7522	76	+1	-1
	79	Suwan	(Suwan 1)	6.1	55	222	12	Palmira (2)	7631	96	+2	-28
								Ferke (1)	7622	94	+3	-3
36. Indonesia	79	Bontoril	(Loc. Var.)	4.0	62	230	26	Tocumen	7728	75	+4	-12
37. Tahiti	79	Papeete	(Loc. Var.)	7.2	69	270	23	La Maquina	7721	112	0	-26
								Tocumen	7728	103	0	+1
								Ilonga	7530	102	0	-11
								Ferke (1)	7622	102	0	-19
38. Saudi Arabia	79	Hofuf	(Loc. Var.)	5.3	62	208	10	Ferke (1)	7622	121	+4	+6
								Tocumen	7728	115	+4	+12
								Poza Rica (E)	7729	112	+3	-2

* Combined data for 2 planting dates.

1/ DS = Days to 50% silking.
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

72

Table 24. Performance of best Elite Experimental Varieties of ELVT 19 compared to the best check in 26 countries in 1978 and 1979.

Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
											DS	PH
1. Costa Rica	78	Guanacaste	(TICO-V1) (N)	2.5	50	203	31	Ferke (1)	7537	74	+1	-37
2. Guatemala	78	Cuyuta	(T-101) (N)	5.5	56	256	11	Cotaxtla (2)	7537	85	0	0
	78	La Maquina	(T-101) (N)	5.2	54	199	18	Cotaxtla (2)	7537	81	+1	+21
3. Jamaica	79	Bodles	(X-304A) (N)	5.1	55	213	15	Cotaxtla (2)	7537	70	+1	+4
4. Mexico	78	Poza Rica	(Tuxp. Car.) (N)	7.1	61	221	6	Cotaxtla (2)	7537	80	0	-2
	79	Poza Rica	(V-524) (N)	4.4	67	185	7	Tuxpeño 1 H.E. o2		100	-6	+8
								Satipo (2)	7639	98	-5	+18
								Poza Rica (E)	7737	97	-4	-2
	79	Cotaxtla	(SM-COT 20) (o2)	5.4	55	235	8	Tlaltizapan	7740	104	-3	-4
								Poza Rica (E)	7737	99	-2	-15
								Tuxpeño 1 H.E. o2		92	-2	-13
								Satipo (2)	7639	90	-2	+9
	79	Nayarit	H-507 (N)	2.3	58	327	8	Tuxpeño H.E. o2		130	-6	-38
								Poza Rica (E)	7737	121	-5	-68
								Obregon	7740	111	-10	-48
								Satipo (2)	7639	110	-5	-49
5. Nicaragua	78	Santa Rosa	(Salco) (N)	4.5	57	229	13	Ferke (1)	7539	85	0	+25
6. Panama	78	Rio Hato	(UNP-1) (N)	4.2	54	205	12	Ferke (1)	7537	98	-2	+15
								Ferke (1)	7539	90	-3	+15
	78	Tocumen	(UNP-2) (N)	4.9	55	245	16	Ferke (1)	7537	77	0	-12
	79	Tocumen	(UNP-2) (N)	3.4	55	224	11	Tuxpeño 1 H.E. o2		106	-2	-5
								Satipo (2)	7639	103	-1	0
								Obregon	7740	102	-2	-10
	79	Rio Hato	(UNP-1) (N)	4.1	53	196	14	Poza Rica (E)	7737	115	0	0
								Obregon	7740	103	0	-20
7. Argentina	78	Pergamino	(Loc. Var.) (N)	4.9	60	188	10	Cotaxtla (2)	7537	88	+17	+25
8. Bolivia	78	Chuquisaca	(Comp. 101) (N)	4.5	65	219	17	Ferke (1)	7539	146	0	+39
								Ferke (1)	7537	145	0	+9
								La Maquina	7540	121	0	+37
9. Brazil	78	Sete Lagoas	(Loc. Var.) (N)	6.7	67	273	13	Ferke (1)	7537	86	+1	-37
								Cotaxtla (2)	7537	85	0	-28
10. Surinam	79	Tijgerkreek	(Pichilingue 7429)(N)	5.6	--	196	7	Poza Rica (E)	7737	108	---	-3
11. Colombia	78	Palmira	(Suwan 1) (N)	6.0	55	221	15	Ferke (1)	7539	93	+4	+11
								Ferke (1)	7537	85	+4	+2
12. Ecuador	78	Pichilingue	(Pich. 504) (N)	4.5	56	295	12	La Maquina	7540	92	0	-12
								Suwan	7539	91	0	-1
	79	Pichilingue	(INIAP 526) (N)	6.0	54	239	10	Tlaltizapan	7740	86	-1	-4
13. Peru	78	Montupe	(PMC-747) (N)	2.7	64	159	23	Ferke (1)	7539	154	-2	+3
								Ferke (1)	7537	151	-2	-10
	79	Satipo (1)	(PMC-747) (N)	3.7	57	225	16	Tuxpeño H.E. o2		133	-2	+3
								Poza Rica (E)	7737	128	-1	-25
								Poza Rica	7738	122	-4	-15
								Tlaltizapan	7740	120	-2	+18
								Tlaltizapan (E)	7741	118	-3	-30
								Satipo (2)	7639	116	-2	+13

Table 24. (Continued)

Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in	
											DS	PH
14. Egypt	78	Gemeiza	(AED x Tuxp.o₂)	5.7	64	261	15	Ferke (1)	7539	81	+3	-22
	78	Sids	(AED) (N)	4.5	68	299	19	Ferke (1)	7539	82	0	-34
15. Ivory Coast	79	Bouake	(IRAT 81) (N)	5.7	64	220	11	Poza Rica (E)	7737	92	-1	-11
								Obregon	7740	89	-5	-11
								Tuxpeño 1 H. E. o₂		85	-3	-15
	79	Ferke	(IRAT 81) (N)	6.2	61	224	14	Obregon	7740	93	-4	-25
								Poza Rica (E)	7737	87	0	-28
								Tuxpeño 1 H. E. o₂	7737	86	-3	-14
16. Malawi	78	Ngabu	(PNR 95) (N)	4.9	41	193	9	Ferke (1)	7537	87	+10	+10
	79	Ngabu	(R 201) (N)	2.2	48	160	41	Poza Rica (E)	7737	139	+1	+27
17. Senegal	78	Nioro	(BDS 111) (N)	2.0	47	187	21	Cotaxtla	7439	103	+8	+23
								Ferke (1)	7537	95	+8	-8
	78	Sefa	(BDS 111) (N)	4.5	47	193	13	Ferke (1)	7537	100	+8	-14
								Cotaxtla	7439	93	+7	+13
18. Zaire	79	Kisanga	(Kasai I) (N)	7.1	69	186	10	Tlaltizapan	7740	101	0	+36
	78	Sinthion	(BDS 111) (N)	4.3	47	213	17	Ferke (1)	7537	78	+7	-7
	79	Nioro	(AC1 x B1) (N)	4.7	51	219	11	Cotaxtla	7439	75	+5	+21
								Obregon	7740	81	+2	-6
	79	Sefa	(BDS 111) (N)	3.6	49	152	13	Satipo (2)	7639	74	+4	+5
								Obregon	7740	99	+3	+3
								Satipo (2)	7639	97	+4	+21
19. Tanzania	78	Ilonga	(Ilonga 7621) (N)	2.2	61	149	28	Ferke (1)	7537	104	+1	+21
20. Pakistan	78	Pirsabak	(Khyber) (N)	3.4	55	167	18	Ferke (1)	7537	126	+6	+11
								Suwan	7539	110	+4	+22
	79	Pirsabak	(Sarhod-Y)	3.9	56	156	21	Poza Rica (E)	7737	109	+6	+29
								Obregon	7740	106	+4	+8
21. Philippines	78	Karaan	(Imp. Tinigib) (N)	2.5	48	180	17	Suwan	7539	126	+8	+35
								Cotaxtla (2)	7537	124	+12	+25
22. Thailand	79	Suwan	(Suwan 1) (N)	6.8	55	218	9	Poza Rica (E)	7737	84	+2	-1
23. Burma	79	Yezin	(TKS-1)	1.1	55	160	34	Tlaltizapan (E)	7741	173	0	-18
								Poza Rica	7738	166	-1	-13
								Obregon	7740	160	0	-12
24. Somalia	79	Afgai	(Loc. Var.)	5.0	57	170	14	Tuxpeño 1 H.E.o₂		96	-2	-17
25. Nepal	79	Rampur	(Loc. Var.)	7.7	54	240	11	Poza Rica (E)	7737	94	+4	-22
26. Saudi Arabia	79	Hofuf	(Loc. Var.)	5.9	53	184	29	Tuxpeño 1 H.E.o₂		97	+17	+20

1/ DS = Days to 50% silking.
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.
(N) = Normal endosperm maize variety.

Table 25. Performance of best Elite Experimental Varieties of ELVT 20 compared to the best check in 22 countries in 1978 and 1979.

Country	Year	Location	Best Check	T/ha	DS[1]	PH[2]	CV(Y)[3]	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
1. Mexico	78	Celaya	(H-309)	3.0	91	158	25	Ukiriguru	7542	90	+1	-30
	78	Tlaltizapan	(Pool 31)	7.8	57	229	10	Ukiriguru	7542	111	+1	-1
								Sids	7534	101	+5	+14
								Khumaltar (1)	7633	100	+3	0
	79	Cotaxtla	(V-524)	5.9	52	208	7	Tlaltizapan	7633	94	-1	+11
								Across	7642	93	-1	+19
	79	La Huerta (Jalisco)	(T-41)	5.2	59	240	19	Sids (1)	7734	94	-5	-17
								Across	7644	91	-2	-20
	79	Tlaltizapan	(H-412)	5.9	64	205	11	Across	7644	125	0	+14
								Tlaltizapan	7633	123	-1	+15
								Across	7642	117	-1	+8
								Cali (2)	7642	90	-7	-51
2. Jamaica	78	Bodles	(X-304A)	3.4	--	222	27	Khumaltar (1)	7633	92	--	-6
3. Argentina	78	Pergamino	(Loc. Var.)	5.0	56	189	11	Obregon	7442	110	+11	+31
								Across	7433	95	+11	+20
4. Bolivia	78	Chuquisaca	(Mez. Am.)	3.8	60	203	14	Ukiriguru	7542	131	-3	-5
								Across	7433	127	0	+7
								Ukiriguru	7534	120	0	+16
5. Brazil	78	Riberao P.	(Loc. Var.)	7.2	66	286	14	Ukiriguru	7542	84	-3	-38
	79	Londrina	(AG-301)	6.4	68	247	13	Tlaltizapan	7644	103	-2	-4
	79	Sete Lagoas	(AG-301)	7.4	64	263	11	Across	7642	92	-4	-22
6. Surinam	79	Tijgerkreek	(Pichil. 7429)	5.4	--	183	18	Tlaltizapan	7644	108	--	+24
7. Chile	78	Antumapu	(Loc. Var.)	8.0	90	209	11	Sids	7534	84	+8	+60
8. Ecuador	79	Pichilingue	(Pichil. 504)	6.6	55	295	12	Tlaltizapan	7644	82	-1	-22
9. Egypt	78	Gemeiza	(Giza-1)	4.3	60	251	17	Khumaltar (1)	7633	111	+4	-25
								Ukiriguru	7534	95	+4	-30
	78	Sakha	(VC-80)	9.0	69	299	13	Obregon	7442	114	-6	-49
								Sids	7534	93	-3	-32
10. Ethiopia	78	Alemaya	(Loc. Var.)	6.0	116	269	23	Sids	7534	118	-12	-62
								Ukiriguru	7542	117	-17	-75
								Khumaltar (1)	7633	110	-17	-72
	78	Bako-Bako	(Loc. Var.)	4.4	78	346	10	Ukiriguru	7542	98	-14	-102
								Sids	7534	89	-9	-85
								Khumaltar (1)	7633	82	-11	-95
11. Somalia	79	Afgai	(Loc. Var.)	4.4	46	156	10	Gemeiza (2)	7644	133	+6	+2
								Across	7642	117	+5	+1
								Sids (1)	7734	115	+5	+7
12. Malawi	78	Ngabu	(PNR 95)	3.0	45	190	20	Khumaltar (1)	7633	132	-1	-7
								Ukiriguru	7534	131	+4	+8
								Pirsabak (2)	7642	116	0	-16
13. Rep. S. Africa	78	Potchefstroom	(SSM 75)	5.3	81	153	9	Ukiriguru	7542	99	+1	+12
14. Botswana	78	Good Hope	(PP x K64R)	1.3	65	133	28	Ukiriguru	7542	115	0	0
								Khumaltar (1)	7633	115	0	+6
	78	Sebele	(Kal. Early)	1.8	53	186	24	Ukiriguru	7534	96	+5	-7

Table 25. (Continued)

	Country	Year	Location	Best Check	T/ha	DS$^{1/}$	PH$^{2/}$	CV(Y)$^{3/}$	Best EV's		Yield % of Best Check	Differences compared to best check in DS	PH
15.	Zaire	79	Kaniama	(Kasai I)	6.2	70	263	19	Pirsabak (1)	7642	111	-6	-58
									Gemeiza (2)	7644	110	0	-48
16.	Mali	79	Sotuba	(Zanguerini)	5.1	54	208	25	Gemeiza (2)	7644	117	0	+10
									Pirsabak (1)	7642	108	0	+10
									Obregon	7748	107	0	+10
									Tlaltizapan	7633	104	-2	-5
17.	Haute Volta	78	Farako-Ba	(Massayomba)	4.0	55	263	14	Across	7433	94	-1	-46
18.	Jordan	78	Deir Alla	(Loc. Var.)	5.4	59	201	20	Pirsabak (2)	7642	123	+1	-1
									Ukiriguru	7534	108	+8	-8
									Khumaltar (1)	7633	103	+9	-13
		78	Wadi Yabis	(Loc. Var.)	5.0	57	159	40	Ukiriguru	7542	163	+1	+10
									Ukiriguru	7534	124	+4	-13
									Khumaltar (1)	7?3?	94	+2	-18
		79	Deir Alla	(Loc. Var.)	2.6	52	236	24	Across	764?	121	+5	-42
									Gemeiza (2)	764?	111	+2	-11
									Sids (1)	7734	109	+5	-37
									Obregon	7748	107	-1	-36
19.	Saudi Arabia	79	Hofuf	(Loc. Var.)	5.0	56	177	12	Gemeiza (2)	7644	140	+9	+21
									Cali (2)	7642	128	+4	+11
									Tlaltizapan	7633	124	+6	+25
									Sids (1)	7734	124	+5	+23
20.	Iraq	79	Abu Ghraib	(Neelum)	6.0	63	236	16	Tlaltizapan	7644	123	+4	-12
									Across	7642	117	+3	-8
									Tlaltizapan	7633	114	0	-17
21.	Nepal	79	Rampur	(Janaki Makai)	5.8	56	239	19	Gemeiza (2)	7644	120	-2	-8
									Tlaltizapan	7633	115	-1	-8
									Cali (2)	7642	101	-4	-12
22.	Pakistan	78	Pirsabak	(Sarhad Y)	2.3	64	144	30	Ukiriguru	7542	122	-3	+11
									Ukiriguru	7534	116	+1	-11
									Pirsabak (2)	7642	113	0	+11
		78	Yousafwala	(Akbar)	3.7	55	184	25	Khumaltar (1)	7633	108	0	+10
									Ukiriguru	7542	152	0	+6
									Pirsabak (2)	7642	133	+1	-1
									Ukiriguru	7534	130	+2	+10
									Khumaltar (1)	7633	112	+2	-9
		79	Yousafwala	(Frawan)	5.2	54	195	19	Gemeiza (2)	7644	116	+7	+9
									Sids (1)	7734	102	+4	+5
									Tlaltizapan	7633	101	+4	+9

1/ DS = Days to 50% silking.
2/ PH = Plant height in cms.
3/ CV(Y) = Coefficient of variation for yield.

76

Table 26. Contribution of maize populations throught IPTTs, EVTs, and ELVTs in 1978/79 to National Maize Programs around the world.

Population	No.	Central America, Caribb. & Mexico	Trop. S. America	Temp./Subtr. S. America	W/Central Africa	East/S. Africa	North Africa	Middle East	Asian sub-continent	S/East Asia	World-Wide Totals
		No. of countries in different regions where experimental varieties have performed better than the best local check:									
Tuxpeño -1	21	6	4	–	4	2	–	–	–	2	18
Mezcla Tropical Blanca	22	8	5	–	5	4	1	2	1	2	28
Blanco Cristalino-1	23	5	3	–	4	–	–	1	2	2	17
Ant.-Ver.181	24	8	5	–	4	–	1	2	3	2	26
(Mix.1-Col. Cpo.1)ETO	25	1	2	–	1	–	–	–	1	1	6
Mezcla Amarilla	26	8	4	–	5	–	1	1	4	3	27
Amarillo Cristalino-1	27	7	6	–	6	1	1	2	2	3	28
Amarillo Dentado	28	10	7	–	7	2	2	2	4	4	38
Tuxpeño Caribe	29	8	6	–	5	1	1	2	1	2	26
Blanco Cristalino-2	30*	2	–	–	–	–	–	–	1	–	3
Amarillo Cristalino-2	31*	1	2	–	–	–	–	–	–	–	3
ETO Blanco	32	2	4	–	4	2	1	1	1	2	16
Amarillo Subtropical	33	2	1	4	2	3	2	4	3	1	22
Blanco Subtropical	34	1	–	3	3	5	2	4	2	1	21
Ant.-Rep. Dom.	35	9	3	–	5	1	1	2	3	2	26
Cogollero	36	10	7	–	4	1	1	2	4	2	30
Tuxpeño-1 o2	37	3	3	–	1	1	–	–	1	2	11
PD(MS)6 H.E. o2	38	–	2	–	2	1	1	–	2	2	9
Yellow H.E. o2	39	3	2	–	3	–	–	–	3	2	13
White H.E. o2	40	4	3	–	3	–	–	–	3	2	15
Templado Amarillo o2	41	2	3	–	1	–	–	–	2	2	10
ETO x Illinois	42	1	–	4	3	4	2	4	3	1	22
La Posta	43	7	3	–	3	3	–	1	–	1	18
AED x Tuxpeño	44	1	–	4	4	2	1	4	2	1	19
Amarillo Bajío	45	1	–	3	–	–	–	4	2	1	11
Comp. Hungary	48	–	1	1	1	2	1	3	2	–	10
Highland Pop. 52, 53, 54, 55, 60		1	2	–	–	2	–	–	–	–	5
Old Pop. 30 Bl. Cristalino-2		5	3	–	4	1	1	–	1	2	17
Old Pop. 31 Braquiticos		3	3	–	3	2	–	–	–	2	13
Total :		11	8	4	8	9	3	4	5	4	54

(*) Pop. 30 and 31 only tested in 1979 in IPTT's.

Table 27. Countries of the world where EVs from improved maize populations have performed better than best local checks.

1.	Central America Caribbean and Mexico:	Mexico, Guatemala, Honduras, Costa Rica, Nicaragua, El Salvador, Panama, Bahamas, Haiti, Puerto Rico, Jamaica and Dominican Republic.
2.	Tropical South America:	Venezuela, Colombia, Brasil, French Guyana, Surinam, Ecuador, Peru and Bolivia.
3.	Temp./Subtr. America:	Brasil, Bolivia, Argentina and Chile.
4.	West/Central Africa:	Senegal, Mali, Sierra Leone, Ivory Coast, Upper Volta, Ghana, Nigeria and Zaire.
5.	East/South Africa:	Ethiopia, Somalia, Uganda, Tanzania, Malawi, Swaziland, Rep. S. Africa, Lesotho and Botswana.
6.	North Africa:	Morocco, Egypt and Sudan.
7.	Middle East:	Jordan, Iraq, Saudi Arabia and Yemen A.R.
8.	Asian Subcontinent:	Afghanistan, Pakistan, Bangladesh, Nepal and Sri Lanka.
9.	South/East Asia:	Thailand, Burma, Philippines and Tahiti.

In 54 of the countries which grew trials in 1978-79, CIMMYT maize varieties performed equal or better than the best check. There are many countries not listed here where CIMMYT maize populations have performed well in previous years. Some of these countries did not grow any trials in 1978-79.

Table 28. Performance of best varieties under medium to low yielding conditions in comparison to the best local hybrid varieties in different countries.

Country	Test site	Year	Best check yield local t/ha	Best check Hybrid (Name)	CV (yield)	Difference of best EV to best check for: Yield (%)	D-S	PH
Mexico	Jalisco	79	3.7	T-47	22	+16	-1	-27
	La Huerta	79	2.9	T-41	18	+61	-2	+ 7
	Nayarit	79	2.6	B-670	9	+14	-2	-25
Colombia	Turipana	79	1.8	H-154	20	+88	-2	---
	Turipana	79	2.7	H-107	17	+47	+2	---
Guatemala	Cuyuta	79	2.8	HA-44	19	+24	-1	+ 2
	Concepcion	78	2.4	T-101	15	+37	-1	+15
Honduras	Guaymas	79	3.0	HA-504	16	+35	-2	+10
Jamaica	Bodles	78	4.7	X-304A	20	+10	--	-25
Swaziland	Malkerns	78	3.3	SR 52	17	+26	+2	-35
Malawi	Ngabu	78	3.0	PNR 95	20	+32	-1	- 7
Peru	Piura	78	3.5	PM-701	19	+40	--	-37
Bangladesh	Ishurdi	78	3.9	J-1	25	+48	+2	+35
Sri Lanka	Illuppallama	79	3.4	Bhadra-1	16	+40	+1	+20

DS   Days to 50% silking
PH   Plant height in cms.

QUALITY PROTEIN MAIZE IMPROVEMENT

PARALLEL IMPROVEMENT

Since 1970, the dimensions of CIMMYT's maize improvement program have included research on the nutritional aspects of maize improvement. This work is a parallel and integral part of the total program.

In developing quality protein maize (QPM) materials, CIMMYT's principal strategy involves the accumulation of genetic modifiers to maintain protein quality and the stability of hard endosperm QPM families over environments. A set of complex and interrelated problems has been remedied through the exploitation of genetic modifiers of the opaque-2 locus. This approach has shown that it is genetically possible to combine high yield and high nutritional quality, while removing most of the defects associated with the opaque-2 gene that confers this nutritional advantage. The maize program now has a number of high-yielding, hard endosperm QPM (H.E.o_2) populations that look and taste like normal maize, yet have twice the nutritional quality of protein.

THE CONVERSION PROGRAM

Beginning in 1974, a program was initiated to convert all of the major normal materials being worked in the program into QPM versions. In converting this wide range of materials to QPM, the major emphasis was on selection for modified opaque-2 kernels to accumulate the frequency of favorable modifiers. Laboratory analyses usually are performed on all hard endosperm QPM families to eliminate those whose protein quality may have been affected adversely due to selection for vitreous endosperm.

QPM materials with good kernel characteristics and with a high frequency of modifier genes are used in additional backcrosses to the most advanced cycle of the recurrent parent populations. Also, since most of the materials have gone through several cycles of selection for genetic modifiers, the conversion scheme includes a procedure for screening the stability of hard endosperm QPM families over environments. A backcrossing-cum-recurrent selection scheme has been designed to meet this need.

In this strategy, one season is devoted to identifying families that are stable over environments. Also, in the same season, an effort is made to capitalize on within-family variation for attributes such as plant height, ear height, maturity, foliar diseases, ear rots, and kernel modification of the QPM ears. In the following season, the stable families are recombined (identified on the basis of data from at least two locations).

Conversion of Advanced Unit Normal Populations

At the end of 1979, a total of 21 Advanced Unit normal populations had undergone the conversion and selection process. During the 1978A cycle 2,947 QPM families were grown. Recombination among families generated new full-sibs in each population. At harvest, 4,326 ears were selected and later planted in Poza Rica, Tlaltizapan and Ciudad Obregon during 1978B. Of the families planted in two locations, a total of 2,508 within-family sibbed ears were selected from 2,556 stable families for planting in 1979A. Plant-to-plant crosses were made among families. At harvest, only 4,729 good, modified QPM ears were selected for planting in 1979B. Of these, 2,524 QPM families were evaluated for stability (table 1).

Conversion of Gene Pools

The steps listed above also were used in converting the tropical and temperate gene pools (tables 2 and 3). In 12 tropical pools, a total of 1,214, 1,266, 2,348, and 1,191 QPM families were handled during 1978A, 1978B, 1979A, and 1979B, respectively. During 1978B, most QPM materials were evaluated at two locations. In 1979B, however, only the more advanced gene pools were evaluated for stable performance as hard endosperm QPM families.

Conversion of Populations Being Selected for Earliness, Plant Efficiency, and Adaptation

Most of the Special Project materials which have been converted to QPM have demonstrated good kernel modification that is fairly stable over environments. The materials which have been converted to hard endosperm QPM are listed in table 4. Most of these materials, except for Selección Precoz, have been worked continuously in homozygous opaque-2 backgrounds, without backcrossing. The families are grown at Tlaltizapan and Ciudad Obregon during the "B" season, followed by recombination and regeneration of new families in the "A" season. During "B" season, within-family variation for plant and kernel characteristics is exploited.

Table 4 shows that Planta Pequeña Mazorca Grande H.E.o_2 was merged with Amarillo Bajio x Varios Templados H.E.o_2 during 1978A. During 1979A, two other materials (Mezcla Amarilla P.B. x Lin. III. H.E.o_2 and Amarillo Bajio x Varios Templados H.E.o_2), also were merged with QPM versions of Pool 34 and Amarillo Bajio x Maices Argentinos respectively. Another population (Maíz Tropical Selección Batán H.E.o_2) was merged with Amarillo Bajio x Mezcla Tropical H.E.o_2 during 1979A.

Two of the Special Project populations, Amarillo Bajío and Selección Precoz, have been promoted to the Advanced Unit as Populations 45 and 31, respectively. The equivalent QPM versions of these materials now will be handled as part of the Advanced Unit population conversion program using the back-crossing-cum-reccurent selection procedure.

Conversion of Disease Resistant Materials to QPM

Three of CIMMYT's normal maize populations (tropical late white dent, intermediate white flint, and yellow flint-dent) are being improved for levels of resistance to downy mildew, corn stunt, and streak. The corresponding hard endosperm QPM materials have been developed by pooling the QPM versions of different components that went into the genetic make-up of these normal populations. This collaborative disease research on normal populations now has been through several cycles of selection. Some progress on resistance to downy mildew and corn stunt is being shown. However, the quality protein versions still lack resistance to these diseases.

Using existing hard endosperm QPM versions as appropriate donors, three collaborative research populations were crossed during 1978A at Poza Rica. The F_1 families were advanced to F_2 during 1978B. The F_2 families will be further advanced for a few generations to accumulate modifiers before being tested in "hot-spots" for the above mentioned diseases. In addition to increasing the resistance of susceptible hard endosperm QPM versions to these major diseases, the materials are being continuously improved for other agronomic traits and for characters of major interest in quality protein breeding. The number of families handled in each of these materials is indicated in table 5. All three QPM populations now look very promising with respect to yield and other agronomic characteristics, and have normal-appearing endosperm with protein quality similar to soft opaque-2 types.

Selection for Stability of Hard Endosperm in the Conversion Process

The stable performance of the vitreous kernel phenotype is very important due to the value of this characteristic in the market place. Greater attention is being given to increasing this stability. Most QPM materials were planted during 1978 and 1979 in two locations within Mexico to screen for the stability of vitreous phenotype of the QPM kernel. Several families within each material performed well and seemed stable in the two environments. The mean

endosperm hardness rating of most materials undergoing conversion ranged from 2.14 to 2.84 (on a scale of 1 to 5; 1 highest, 5 lowest). Over different environments, only a small percentage of families in each material differed by more than one point in endosperm hardness rating (see table 6). Analyses of bulk samples have shown that levels of lysine in most materials ranged from 3.5 to 4.0 per cent in protein. Also, a comparison of different cycles of selection shows that there has been a gradual improvement in endosperm hardness over cycles.

In four tropical and three temperate QPM gene pools, four additional cycles of recombination were completed. Most of these pools have good kernel appearance and about 4.0 per cent lysine in the endosperm protein. Their endosperm hardness ratings range from 2.26 to 2.61. These pools, in their latest cycle, exhibited a reduced plant and ear height, greater endosperm hardness, and earlier maturity. The yield of these pools has not improved, except for two tropical yellow QPM pools that have shown significant improvements over the original cycle. The data also show that the latest cycles have a higher frequency of modified kernels with normal appearance. Also, the latest cycles show a considerable reduction in number of soft endosperm opaque-2 kernels.

Protein Content and Quality of QPM Materials

Hard endosperm QPM families from different materials are analyzed each season to discard those families in which the protein quality might have been adversely affected due to selection for vitreous endosperm. The selection process has increased the frequency of favorable modifiers that alter the phenotype of opaques from the soft endosperm type to a more completely vitreous or normal type with shiny appearance and with no adverse effect on protein quality.

Apart from family analyses, the bulk samples of selected materials also are analyzed for protein, tryptophan, and lysine in the endosperm and whole kernel. Table 7 shows the results of the analyses of tropical QPM conversions and subtropical-temperate hard endosperm QPM materials. Protein quality has been maintained similar to that of the soft opaques, although the kernel phenotype has been changed from a soft to a more normal-appearing endosperm. Most of the materials have a lysine content of 3.5 per cent and above in the whole kernel protein. Generally, the protein level in these materials in the whole grain is above 10 per cent.

Progress in the QPM Versions of Advanced and Back-Up Unit Materials

To evaluate the progress in the accumulation of modifiers in different materials, three different cycles or generations were included at the end of each plot of the same material in each location. These different generations were rated for endosperm hardness and most of the materials have shown steady progress in the accumulation of modi-

Through careful and systematic selection for high yielding materials with vitreous hard endosperm kernels and high lysine and tryptophane content, CIMMYT scientists have shown that it is genetically possible to develop nutritionally superior materials without the defects normally associated with the opaque-2 gene.

fiers. The maturity has not changed greatly, although some QPM materials have become earlier than the normal populations.

DEVELOPMENT OF HARD ENDOSPERM QPM GENE POOLS

Hard endosperm QPM gene pools are being developed to accumulate modifiers from as many different genetic sources as possible. Such gene pools can be formed by the genetic mixing of several diverse hard endosperm QPM varieties, variety crosses, and hybrids with similar climatic adaptation, maturity, grain color, and type. Alternatively, such pools can be created by crossing several normal materials with available QPM donor stocks with vitreous endosperm. For this purpose, a total of seven hard endosperm QPM gene pools with tropical and temperate adaptation are being maintained.

The major emphasis in all such QPM Back-Up Unit gene pools has been to increase kernel vitreosity without sacrificing protein quality. Kernel appearance is now acceptable. The four tropical pools have completed ten cycles of half-sib selection. Of the three temperate pools, two have been through ten cycles of selection, while the other has completed four cycles of selection.

Table 8 lists the values for protein, tryptophan, and lysine in bulk samples of four tropical and three temperate gene pools. Most of these materials have satisfactory protein and lysine values. The lysine values in the

whole kernel are equal to those found in the soft opaque materials.

During 1978B, various cycles of selection of some QPM pools were planted next to each appropriate pool to evaluate progress in the accumulation of modifiers (see table 9). In some QPM pools, these cycles were planted as observational plots, while in others they were replicated.

The most significant change that has occurred in these QPM materials is in the percentage of hard endosperm ears. There has been steady progress from cycle to cycle with respect to this character; however, the last few cycles did not show wide differences. Some progress also was evident in the incidence of ear rots, although differences between cycles were not significant. The yield differences between different cycles were negligible. This would be expected because of the very mild selection intensity and also because of several selection criteria that were of greater importance than yield *per se,* in the initial cycles of selection and recombination.

The trial evaluating cycles-of-selection was repeated during 1979B with seven QPM gene pools (see table 10). In most pools, the latest cycles were shorter in plant and ear height, and had lower endosperm hardness ratings compared to the C_0 cycle. In some pools, there was progress in ear rot resistance and a reduction in days to flower. The yield data show that only two tropical yellow QPM pools had significant yield increases as compared to the C_0 cycle. Table 11 shows the mean endosperm hardness rating of

81

families grown in each pool across two locations. The average rating of these pools ranged from 2.26 to 2.61 on the basis of ear appearance.

In some pools, additional information was obtained on variation for kernel phenotype in different cycles. Approximately 500 kernels from each of eight replications were classified in each cycle. Table 12 shows the frequency distribution of different classes rated on a scale of 1 to 5 for the C_0 and the latest cycle. The data clearly show an increase in frequency of the more normal-appearing classes with a rating of 1 and 2 in the latest cycle of each pool, whereas there was a decrease in frequency of the softer classes with a rating of 4 and 5. Thus, the mean endosperm hardness ratings were progressively lower from cycle to cycle, with a continuous increase in the frequency of phenotypes with normal appearance.

As noted, the tropical white QPM gene pools are being partially contaminated with pollen from normal yellow materials to accumulate modifiers with better kernel weight. In data obtained from only one season, the mean difference in kernel weight between normals and opaques was 4.3 per cent in the flint pool and 2.5 per cent in the dent pool. However, kernel weight varied widely between opaques and normals.

POPULATION IMPROVEMENT PROGRAM

The QPM population improvement program was initiated during 1979B with six conversions of Advanced Unit, Back-Up Unit, Special Project, and Collaborative Research materials, including La Posta H.E.o_2; Late White Dent H.E.o_2; Pool 23 H.E.o_2; Amarillo Subtropical H.E.o_2; Amarillo Bajio H.E.o_2, and Pool 34 H.E.o_2.

Although a mild selection intensity was used, the selection differential for yield in the three tropical populations was 8.45 per cent for La Posta H.E.o_2; 5.11 per cent for Pool 23 H.E.o_2; and 8.95 per cent for Late White Dent H.E.o_2. The mean of selected families showed a slight improvement in endosperm hardness and ear aspect, although the differences were very small. There was only a slight change in days-to-flower.

The selection differential for the three temperate-subtropical populations was 8.5 per cent for Amarillo Subtropical H.E.o_2; 10.08 per cent for Amarillo Bajio H.E.o_2; and 8.40 per cent for Pool 34 H.E.o_2. The other characters showed only a slight improvement.

Four QPM populations in the Advanced Unit are now being tested on a family basis in the international progeny testing trials. These are: PD (MS)6 H.E.o_2 (Population 38); Yellow H.E.o_2 (Population 39); White H.E.o_2 (Population 40), and Templado Amarillo o_2 (Population 41). All four populations have a vitreous kernel phenotype. Tables 13 and 14 show the distribution of progeny trials during 1978 and 1979. (The results of progeny trials and the development of site-specific and across-site experimental varieties are listed with the Advanced Unit data in this report.)

HIGHLAND QPM CONVERSION PROGRAM

The three main activities of the highland QPM program are outlined below.

Conversion of Non-Floury Highland Back-Up Gene Pools

All highland pools from 1 through 14 (except Pools 3 and 8) are being converted to hard endosperm QPM. These materials remain unsatisfactory in terms of genetic modifers. Additional generations are needed to improve the performance of these materials. Emphasis is being placed on the accumulation of modifiers in all pool conversions.

Good modified kernels from selected ears of the 1977 harvest were planted on a family basis at El Batan and Toluca in 1978, with the Toluca nursery treated as an observational nursery. The ears from the 1978 harvest showed considerable improvement in kernel modification.

In addition to highland non-floury gene pools, several other highland materials are being converted to hard endosperm QPM (see table 15). Development of vitreous endosperm, with near normal kernel appearance, is a major research priority. During 1979, white hard endosperm QPM families from Pools 1, 2, and 7 were merged to develop an equivalent early white QPM version of the newly-created Pool 5. Similarly, QPM families of Pools 4, 5, 9, and 10 were merged to form an equivalent early-intermediate yellow hard endosperm QPM version of the newly created Pool 6. Also, the families from Mezcla Amarilla P.B. H.E.o_2 and Planta Pequeña H.E.o_2 were merged; they will continue as Mezcla Amarilla P.B. x Lin. III. H.E.o_2.

Development and Improvement of Highland QPM Composites

Table 15 shows the four composites grown during 1978. These are: Highland Modified Opaque-2 Composite; Puebla Opaque-2 Composite; Composite I, and Puebla Opaque-2 x Barraza. The latter three composites have a soft kernel phenotype and have problems in farmer acceptance.

The Highland Modified QPM Composite has completed three cycles of selection for vitreous kernel texture. This material seems to perform very well and the frequency of soft segregates or completely soft ears has been greatly reduced. With additional cycles of selection, this material might serve as a good donor source for converting highland maize materials to QPM. It also could serve for direct use by different national programs.

Floury-Opaque-2 Conversion Program

In the conversion of soft floury materials to opaque-2, the main research thrust is on transferring the opaque-2 gene into those genetic backgrounds that will have wider use in the Andean region.

Opaque-2 versions of Pools 3 and 8 have been obtained; however, these conversions have not been backcrossed to the recurrent parent. The selected ears from 1978 in Pools 3 and 8 were merged to develop in 1979 a parallel early white floury QPM version of the newly-formed Pool 1.

82

Grain yields in some of CIMMYT's best quality protein maize materials are now about equal to their normal counterparts. In general these quality protein maize materials are also earlier maturing and shorter when compared to the original selection cycle.

A floury opaque-2 composite also has been developed. This composite has completed six cycles of recombination and selection and has been grown in trials in the Andean region. In general, it did fairly well, although it had a relatively higher incidence of ear rots. A total of 483 half-sib families in 1978 and 675 half-sib families in 1979 were grown at El Batan and Toluca.

SUGARY-2/OPAQUE-2 DOUBLE MUTANT

A sugary-2/opaque-2 conversion program began in 1977. This combination was thought to have considerable potential for solving some of the problems associated with opaque-2 maize. To assess this potential, many materials were converted to sugary-2/opaque-2 (su_2o_2).

Initial assessments of the su_2o_2 segregates suggested that a straight sugary-2/opaque-2 conversion program would not achieve the desired goals. A strong selection pressure for kernel phenotype, size, and absence of spaces between kernel rows is necessary to develop materials that will be comparable in performance to normal maize. All good families resulting from the conversion of su_2o_2 program were pooled to form a sugary-2/opaque-2 composite. A total of 672 half-sib families were handled in this composite during 1978A; 800 in 1978B; 490 in 1979A; and 418 in 1979B. Its plant type is excellent and the ear appearance has improved tremendously. The latest cycle (C_4) of this composite has improved in yield (Cycle 4 yielded 5,133 kg/ha, as against 4,500 kg/ha of the original cycle). This composite has improved phenotype and seed size, and the spacing between the rows on the ears has been reduced. Both protein content and quality are excellent. A few additional cycles of selection should prove its potential.

ACCUMULATION OF DRY MATTER IN THE HARD ENDOSPERM QPM MATERIALS

Three to four cycles or generations of some hard endosperm QPM materials were studied along with their normal counterparts to determine if the selection of genetic modifiers alters the dry matter accumulation pattern of hard endosperm QPM materials. Data from this study have not been summarized; however, initial data from one of the materials show that mean 100-kernel weight was improved by selection from F_4 to F_6. The differences in moisture percentage between the two generations and their normal counterparts were not clear-cut. It is hoped that data from other populations will provide more information on this aspect.

COMPARISON OF QPM AND NORMALS IN THE SAME GENETIC BACKGROUND

During 1978, a trial was designed to compare 10 hard endosperm QPM entries and their normal counterparts; it was conducted at Poza Rica, Tlaltizapan, and Ciudad Obregon (table 16).

83

The data from these sites clearly indicate that the yield performance of QPM versions of Tuxpeño 1, Mix.1 Col. Gpo. I x Eto, Mezcla Amarilla, Antigua-Republica Dominicana, and La Posta were fairly similar to their normal counterparts. The QPM materials, in general, showed a higher incidence of ear rots and some seemed to be somewhat earlier than their normal counterparts.

OFF-STATION TRIALS

During 1978B, two off-station QPM trials were conducted in farmers' fields. Five QPM entries were compared with Tuxpeñito at Zapatolillo and at El Jardín in the State of Veracruz (table 17). At Zapatolillo, Tuxpeñito produced somewhat higher yields than did the QPM entries, but the difference was not statistically significant.

At El Jardín, the three QPM entries (Mezcla Tropical Blanca, Tuxpeño Caribe, and La Posta) performed as well or better than did Tuxpeñito. The differences, however, were not significant.

Another trial with 5 QPM entries and one normal was conducted at two locations (Cañada Rica and Aeropuerto) during 1979A (table 18). All of the QPM entries were equal to or better than the best normal check entry.

INTERNATIONAL TESTING 1978 AND 1979

CIMMYT's international testing program with QPM maize materials had five major components in 1978-79: IPTTs, OMPT-IIA, OMPT-IIB, EVT-I5, and ELVT-I9. Only the OMPTs will be discussed here. The IPTT, EVT, and ELVT data on QPM materials are discussed under the Advanced Unit section.

OMPT-II, OMPT-IIA, and OMPT-IIB

On the basis of performance of hard endosperm QPM families in Mexico, a number of good, stable, hard endosperm QPM families were identified in several materials. Using remnant seed, the families from each material were recombined during 1978A at Poza Rica. The materials were harvested separately as bulks to provide entries for the opaque-2 maize population trial (OMPT-II). Distribution is shown in tables 13 and 14. Of 22 countries reporting data, 13 countries reported one or more QPM entries with performance equal to or better than the best normal checks. Table 19 shows the performance of the best QPM entry as compared to the best check in different countries. There were at least one or more QPM entries in most of the locations that had yield levels equal to, or better than, normal maize. The seven entries with very good performance were: White H.E.o_2; Late White Dent H.E.o_2; Mezcla Tropical Blanca H.E.o_2; Tuxpeño Caribe H.E.o_2; Blanco Cristalino H.E.o_2; and Amarillo Cristalino H.E.o_2. Even when compared with the best check for yield across locations, these entries performed well, with yields of 90 per cent and above. In other agronomic aspects, these materials were comparable and in some cases better than the best check entry.

In 1979, two trials (OMPT-IIA and OMPT-IIB) were sent to 44 and 17 countries, respectively (table 14). OMPT-IIA had 25 entries while OMPT-IIB had 13 entries. Results will be reported in 1980.

Table 1. Evaluation of hard endosperm QPM families of the Advanced Unit populations for stability of hard endosperm character.

Population No.	Pedigree	1977B No. evaluated	1977B No. stable	1978B No. evaluated	1978B No. stable	1979B No. evaluated	1979B No. stable
21	Tuxpeño-1 H.E.o_2	401	220	300	158	220	126
22	Mezcla tropical blanca H.E.o_2	154	94	252	107	182	107
23	Blanco Cristalino H.E.o_2	266	-	318	111	182	114
24	Ant. x Ver. 181 H.E.o_2	233	126	208	120	178	120
25	Mix. 1-Col. Gpo. 1 x Eto H.E.o_2	189	147	383	199	242	161
26	Mezcla Amarilla H.E.o_2	162	104	276	120	-	-
27	Amarillo Cristalino H.E.o_2	148	66	222	114	156	95
28	Amarillo Dentado H.E.o_2	228	144	413	244	333	214
29	Tuxpeño Caribe H.E.o_2	233	107	381	215	245	153
30	Blanco Cristalino-2 H.E.o_2	-	-	-	-	-	-
31	Amarillo Cristalino-2 H.E.o_2	-	-	-	-	-	-
32	Eto Blanco H.E.o_2	234	211	244	75	-	-
33	Amarillo subtropical H.E.o_2	243	134	261	79	211	100
34	Blanco subtropical H.E.o_2	165	32	158	39	-	-
35	Ant. x Rep. Dom. H.E.o_2	209	118	408	210	227	118
36	Cogollero H.E.o_2	36	4	90	27	-	-
42	Eto x Illinois H.E.o_2	74	32	56	19	-	-
43	La Posta H.E.o_2	288	147	280	187	187	94
44	Templado Blanco Dentado-2 H.E.o_2	-	-	-	-	-	-
45	Amarillo Bajío-2 H.E.o_2	-	-	-	-	161	76
48	Hungarian composite H.E.o_2	62	39	76	32	-	-
	TOTAL	3325	1725	4326	2056	2524	1478

Table 2. Evaluation of hard endosperm QPM families of tropical gene pools for stability of hard endosperm character.

Pool No.	Pedigree	1978B No. evaluated	1978B No. saved	1979B No. evaluated	1979B No. saved
15	Tropical early white flint	47	33	-	-
16	Tropical early white dent	143	141	-	-
17	Tropical early yellow flint	35	33	-	-
18	Tropical early yellow dent	60	54	-	-
19	Tropical intermediate white flint	226	91	103	48
20	Tropical intermediate white dent	254	87	103	45
21	Tropical intermediate yellow flint	164	72	82	36
22	Tropical intermediate yellow dent	207	96	115	53
23	Tropical late white flint	391	172	184	112
24	Tropical late white dent	254	87	122	52
25	Tropical late yellow flint	214	131	163	81
26	Tropical late yellow dent	353	194	141	69
	TOTAL	2348	1191	1013	496

Table 3. Conversion of temperate gene pools to QPM.

Pool No.	Name	Number of families handled				
		1977B	1978A	1978B	1979A	1979B
27	Temperate early white flint	109	39	75	28	136
28	Temperate early white dent	14	24	68	24	113
29	Temperate early yellow flint	61	65	97	37	187
30	Temperate early yellow dent	47	81	92	30	179
31	Temperate intermediate white flint	101	109	96	18	113
32	Temperate intermediate white dent	165	49	40	9	48
33	Temperate intermediate yellow flint	86	110	98	34	182
34	Temperate intermediate yellow dent	126	173	120	97	395
	TOTAL	709	650	686	277	1353

Table 4. Conversion of populations that are being selected for earliness, plant efficiency and adaptation.

Material	No. of families handled each cycle				
	1977B	1978A	1978B	1979A	1979B
Amarillo Bajío H.E.o_2	280	114	193	53	280
Amarillo Bajío x varios templados H.E.o_2	131	152	214	72[c]	-
Amarillo Bajío x Mezcla tropical H.E.o_2	144	77	127	38	116
Mezcla Amarilla P.B. x Lin.Ill. H.E.o_2	131	56	128	28[b]	-
Planta Pequeña Mazorca Grande H.E.o_2	30	62[a]	-	-	-
Amarillo Bajío x Maíces Argentinos H.E.o_2	92	59	80	18	168
Selección Precoz H.E.o_2	28	44	394	201	275
Maíz Tropical Selección Batan	80	86	52	40[d]	-
TOTAL	916	650	1188	450	839

[a] Merged during 1978A
[b] Merged with opaque-2 version of pool 34 H.E.o_2
[c] Merged with Amarillo Bajío x Maíces Argentinos H.E.o_2
[d] Merged with Amarillo Bajío x Mezcla Tropical H.E.o_2

Table 5. Conversion of collaborative research populations to QPM.

Population	No. of families grown each cycle				
	1977B	1978A	1978B	1979A	1979B
Late white dent H.E.o_2	146	124	430*	268	463
White flint H.E.o_2	-	58	333*	177	248
Yellow flint H.E.o_2	237	156	391*	238	219
TOTAL	383	338	1154	683	930

* Also includes backcrossed families

Table 6. Endosperm hardness ratings of different QPM populations grown at two locations during the year 1979.

	No. of fam. evaluated	Mean endosperm hardness rating		
		Poza Rica	Obregon	Mean
Tuxpeño-1 H.E.o_2	220	2.52	2.71	2.62
Mezcla Tropical Blanca H.E.o_2	182	2.19	2.69	2.44
Blanco Cristalino H.E.o_2	182	2.50	2.71	2.60
Ant. x Ver.181 H.E.o_2	178	2.64	2.75	2.70
Mix.1-Col.Gpo.1xEto H.E.o_2	242	2.43	2.85	2.64
Amarillo Cristalino H.E.o_2	156	2.21	2.92	2.57
Amarillo Dentado H.E.o_2	332	2.50	2.58	2.54
Tuxpeño Caribe H.E.o_2	245	2.52	2.63	2.57
Ant. x Rep. Dom. H.E.o_2	227	2.17	2.72	2.44
Pool 19 H.E.o_2	103	2.84	2.83	2.84
Pool 20 H.E.o_2	102	2.83	2.81	2.82
Pool 21 H.E.o_2	67	2.73	2.87	2.80
Pool 22 H.E.o_2	113	2.73	2.85	2.79
Pool 24 H.E.o_2	122	2.73	2.95	2.84
Pool 25 H.E.o_2	163	2.48	2.79	2.63
Pool 26 H.E.o_2	140	2.66	2.86	2.76
Yellow Flint H.E.o_2	218	2.41	1.86	2.14
White Flint H.E.o_2	103	2.84	2.83	2.84
Am. Bajío x Maíces Argentina H.E.o_2	168	2.56*	2.15	2.35
Am. Bajío x Mez. Trop. Amarilla H.E.o_2	116	2.61*	2.15	2.38

* These families were evaluated at Tlaltizapan.

Table 7. Values for protein, tryptophan and lysine in bulk samples of hard endosperm QPM materials. (Whole grain analysis.)

Pedigree	Whole grain defatted		
	% Protein	% Tryptophan in protein	% Lysine in protein
Tuxpeño 1 H.E.o_2	10.5	0.85	3.5
Mezcla Tropical Blanca H.E.o_2	10.1	0.91	3.7
Blanco Cristalino H.E.o_2	11.2	0.82	3.6
Ant. x Ver.181 H.E.o_2	10.9	0.92	3.9
Mix.1-Col.Gpo.1 x Eto H.E.o_2	10.4	0.90	3.9
Mezcla Amarilla H.E.o_2	11.2	0.86	3.9
Amarillo Cristalino H.E.o_2	11.6	0.83	3.6
Amarillo Dentado H.E.o_2	11.2	0.78	3.5
Tuxpeño Caribe H.E.o_2	10.5	0.84	3.7
Cogollero H.E.o_2	11.5	0.80	3.7
La Posta H.E.o_2	10.3	0.86	3.8
Ant. x Rep. Dom. H.E.o_2	10.4	0.89	3.7
Yellow o_2 B.U. Pool	10.6	0.85	3.9
Late White dent H.E.o_2	11.1	0.85	3.6
Yellow flint H.E.o_2	10.9	0.83	3.8
White flint H.E.o_2	10.8	0.83	3.7
Recombination of yellow dent fam.	11.0	0.85	3.6
Selección precoz H.E.o_2	10.0	0.87	3.8
Pool 15 H.E.o_2	10.4	0.90	3.8
Pool 16 H.E.o_2	10.8	0.83	3.9
Pool 17 H.E.o_2	9.7	0.84	4.0

Table 7. (Continued)

Pedigree	Whole grain defatted		
	% Protein	% Tryptophan in protein	% Lysine in protein
Pool 18 H.E.o$_2$	10.2	0.75	3.3
Pool 19 H.E.o$_2$	10.0	0.78	3.5
Pool 20 H.E.o$_2$	10.5	0.82	3.6
Pool 21 H.E.o$_2$	9.5	0.88	3.6
Pool 22 H.E.o$_2$	10.4	0.81	3.5
Pool 23 H.E.o$_2$	9.2	0.85	3.7
Pool 24 H.E.o$_2$	10.2	0.82	3.8
Pool 25 H.E.o$_2$	10.5	0.80	3.9
Pool 26 H.E.o$_2$	10.3	0.81	3.6
Amarillo Subtropical H.E.o$_2$	10.8	1.05	3.4
Blanco subtropical H.E.o$_2$	10.5	1.08	3.9
Eto x Ill. H.E.o$_2$	10.9	0.90	3.4
Hungarian Composite H.E.o$_2$	9.5	0.93	4.0
Pool 27 H.E.o$_2$	10.6	0.90	3.8
Pool 28 H.E.o$_2$	10.4	1.09	3.5
Pool 29 H.E.o$_2$	10.2	1.02	3.7
Pool 30 H.E.o$_2$	10.0	0.92	3.8
Pool 31 H.E.o$_2$	9.2	1.09	4.1
Pool 32 H.E.o$_2$	9.1	1.08	4.1
Pool 33 H.E.o$_2$	9.5	1.08	3.9
Pool 34 H.E.o$_2$	10.7	1.06	3.3
Amarillo Bajío H.E.o$_2$	9.5	1.09	4.0
Am. Bajío x Maíces Argentinos H.E.o$_2$	8.6	1.05	3.8
Am. Bajío x Varios templados H.E.o$_2$	8.1	1.01	4.1
Am. Bajío x Mezcla tropical bl. H.E.o$_2$	10.0	1.07	4.0
Maíz tropical selección Batan H.E.o$_2$	10.7	0.95	3.3
Mezcla Am.P.B.x Lin.Ill.H.E.o$_2$	8.6	1.19	3.8

Table 8. Values for protein, tryptophan and lysine in bulk samples of hard endosperm QPM materials. (Whole grain analysis.)

Pedigree	% Protein	Q.I.*	Whole grain, defatted	
			% Tryptophan in protein	% Lysine in protein
White o$_2$ B.U. Pool (Flint)	8.9	5.3	1.03	4.0
White o$_2$ B.U. Pool (Dent)	9.1	5.5	1.01	4.1
Yellow o$_2$ B.U. Pool (Flint)	9.1	5.2	1.01	4.2
Yellow o$_2$ B.U. Pool (Dent)	9.8	4.9	0.91	4.0
Temperate x tropical H.E.o$_2$ (Flint)	9.6	5.5	1.12	-
Temperate x tropical H.E.o$_2$ (Dent)	9.4	5.5	1.19	-
Temperate x White H.E.o$_2$	10.0	5.0	1.00	-

* Q.I. = Quality Index

Table 9. Evaluation of different cycles in QPM gene pools during the year 1978B.

	Cycle	Grain yield	Days to flower	Endosperm hardness rating	Hard endosperm ears (%)
Temperate x Tropical H.E.o$_2$ (flint)	C_0	4245	57.0	--	54.2
	C_8	4484	55.9	-	90.8
Yellow opaque-2 back-up pool	C_0	3774	56.0	3.9	59.6
	C_7	4328	56.0	2.1	92.7
White opaque-2 back-up pool	C_0	3537	57.0	2.6	54.1
	C_7	3477	56.0	1.6	94.3

Table 10. Evaluation of cycles of selection of tropical and temperate QPM gene pools during the year 1979B.

Gene Pool	Cycle	Yield kg/ha	Days to silk.	Plant Height	Ear height	Ear rot (%)	Endosperm hardness
White opaque-2 B.U. Pool (flint)	C_0	3398	59	211	109	15	4.9
	C_9	3256	58	200	104	9	2.4
White opaque-2 B.U. Pool (dent)	C_0	4589	60	204	109	15	-
	C_9	4583	59	196	101	10	-
Yellow opaque-2 B.U. Pool (flint)	C_0	2827	56	208	111	10	3.7
	C_{10}	3834	55	203	108	5	2.2
Yellow opaque-2 B.U. Pool (dent)	C_0	2613	56	198	108	9	3.9
	C_9	3483	55	198	109	6	2.6
Temperate x tropical H.E.o_2 (flint)	C_0	4021	60	199	116	0	3.6
	C_{10}	4223	58	193	110	0	2.5
Temperate x tropical H.E.o_2 (dent)	C_0	4132	60	210	123	2	3.8
	C_{10}	4340	57	187	105	3	2.3
Temperate white H.E.o_2	C_0	5009	58	193	115	0	3.1
	C_3	4697	57	191	112	0	2.5

Table 11. Endosperm hardness ratings of various QPM gene pools evaluated at two locations during the year 1979.

Gene Pool	No. of fam. evaluated	Mean endosperm hardness rating		
		Tlaltizapan	Obregon	Mean
Yellow o_2 B.U. Pool (Flint)	479	2.16*	2.44	2.30
Yellow o_2 B.U. Pool (Dent)	324	2.19*	2.33	2.26
Temp. x Trop. H.E.o_2 (Flint)	286	2.64	2.02	2.33
Temp. x Trop. H.E.o_2 (Dent)	294	2.83	2.39	2.61
Temperate White H.E.o_2	429	2.84	2.31	2.58

* These families were grown at Poza Rica.

Table 12. Frequency distribution of endosperm hardness of QPM kernels classified from different cycles of selection of four tropical QPM gene pools.

Gene Pool	Cycle of selection	Frequency of endosperm hardness rating* (%)				
		1	2	3	4	5
White opaque-2 B.U. Pool (flint)	C_0	2.25	10.87	30.65	23.87	30.27
	C_9	15.00	49.67	30.72	4.52	0.05
White opaque-2 B.U. Pool (dent)	C_0	2.67	15.87	32.52	25.40	23.50
	C_8	5.90	49.32	33.95	10.25	0.55
Yellow opaque-2 B.U. Pool (flint)	C_0	2.27	19.57	42.35	29.05	6.67
	C_9	6.60	47.25	40.70	5.22	0.17
Yellow opaque-2 B.U. Pool (dent)	C_0	2.32	18.52	35.20	35.32	8.62
	C_9	7.97	46.30	37.67	7.70	0.30

* Rated on a scale of 1-5 (1 = completely vitreous; 5 = completely soft).

Table 13. Distribution of progeny and Experimental Variety trials during the year 1978.

Trial No.	No. of entries	No.of sets distributed							Total
		South America	Central America	Caribbean	Mexico	Africa	Asia	Others	
IPTT-39	256	2	-	-	1	2	1	-	6
OMPT-11	25	5	14	7	5	6	6	1	44
EVT-15	25	9	4	3	5	9	6	-	36
ELVT-19	6	9	8	5	7	11	12	-	52

Table 14. Distribution of progeny and Experimental Variety trials during the year 1979.

Trial No.	No. of entries	No. of sets distributed							Total
		South America	Central America	Caribbean	Mexico	Africa	Asia	Others	
IPTT-38	256	2	-	-	2	-	-	-	4
IPTT-40	256	-	3	-	2	1	-	-	6
IPTT-41	256	2	1	-	2	-	1	-	6
OMPT-11A	25	5	9	8	6	9	7	-	44
OMPT-11B	13	7	-	-	3	4	3	-	17
EVT-15A	10	8	7	5	2	13	9	-	44
ELVT-19	9	9	8	5	6	15	15	-	58

Table 15. Highland QPM materials in the Back-UP stage of the program.

Population	Method of recombination	No.of fam.involved in recombination in 1978
Highland modified opaque-2 composite	H.S.	366
Puebla opaque-2 composite	H.S.	384
Composite I	H.S.	458
Puebla opaque-2 x Barraza	H.S.	130
Mezcla Amarilla P.B.x Lin. Ill. H.E.o_2	F.S.	65
Mezcla Amarilla P.B. - Lin.Ill. x precoces H.E.o_2	F.S.	49
Planta pequeña mazorca grande H.E.o_2	F.S.	38
Composite I H.E.o_2	F.S.	80
Modified o_2 families resulting from intercrosses among different families	F.S.	30
Highland White H.E.o_2 families	F.S.	33
		1633

Table 16. Comparison of QPMs and normals in ten genetic backgrounds during the year 1978B.

MATERIAL	Tlaltizapan N	o_2	% of N	Poza Rica N	o_2	% of N	Obregon o_2	N	% of N	Across Mean N	o_2	Percent of normal
TUXPEÑO 1	10122	10075	99.54	3920	3866	98.62	3151	3229	97.58	5757	5697	98.96
MEZCLA TROPICAL BLANCA	11488	9740	84.78	3678	2868	77.98	3108	3996	77.78	6307	5239	82.03
BLANCO CRISTALINO	10504	9024	85.91	3578	3134	87.59	3106	3600	86.28	5894	5088	86.33
MIX.1-COL.GPO.1 x ETO	9862	9263	93.93	3398	3862	113.66	3207	3448	93.01	5569	5444	97.76
MEZCLA AMARILLA	8773	8358	95.27	3004	3042	101.26	3131	2527	123.90	4768	4844	101.59
AMARILLO DENTADO	8295	8426	101.58	2902	3643	125.53	3039	2318	131.10	4505	5036	111.79
TUXPEÑO CARIBE	10271	9161	89.19	3822	3682	96.34	3820	4172	91.56	6088	5554	91.23
ANT. x REP. DOM.	8774	8411	95.86	2964	2962	99.93	3360	3336	100.72	5025	4911	97.73
LA POSTA	10376	9857	95.00	2627	3075	117.05	4131	3825	108.00	5609	5638	101.41
POOL 23	10218	9191	89.95	3918	3470	88.57	3120	3575	87.27	5904	5260	89.09

Table 17. Average yields (ton/ha) of QPM entries in off-station trials conducted during the year 1978B.

Entry	El Jardin	Zapotalillo	Average
Mezcla Tropical Blanca H.E.o_2	5.96	4.28	5.12
Mix. - Col. x Eto H.E.o_2	4.17	4.22	4.20
Tuxpeño Caribe H.E.o_2	5.18	4.21	4.70
La Posta H.E.o_2	5.14	4.25	4.70
Yellow (IPTT-39) H.E.o_2	4.66	4.37	4.52
Tuxpeñito (Normal)	5.28	4.93	5.11

Table 18. Off-station QPM variety trial 1979A.

Entry	Location Cañada Rica	Aeropuerto	Across Mean	Percent of normal
Mezcla Tropical Blanca H.E.o_2	4.47	3.30	3.88	107.2
Mix.1-Col.Gpo.1 x Eto H.E.o_2	4.52	3.50	4.01	110.8
Tuxpeño Caribe H.E.o_2	5.03	3.40	4.21	116.3
La Posta H.E.o_2	4.75	3.30	4.02	115.5
Yellow H.E.o_2	5.29	3.40	4.34	119.9
Tuxpeñito (Normal)	4.25	3.00	3.62	100.0

Table 19. OMPT-11 (1978)—Best QPM against best normal in 22 experimental sites.

Site	Country	Best Normal	Best Opaque	Percent of Normal
Yousafwala	Pakistan	3817	5694	149
San Andres	El Salvador	3276	3835	117
Grove Palace	Jamaica	2967	3472	117
Rampur	Nepal	4088	4696	114
San Cristobal	Dominican Republic	3091	3417	110
Guarare	Panama	2914	3185	109
Sete Lagoas	Brazil	5121	5517	107
Santa Cruz	Bolivia	5288	5570	105
Ibadan	Nigeria	6185	6437	104
Guanacaste	Costa Rica	1510	1555	102
Rio Hato	Panama	4127	4152	100
Kisanga	Zaire	8022	8003	99
Mayaguez	Puerto Rico	5040	5034	99
Cuyuta	Guatemala	5284	4971	94
Tocumen	Panama	4825	4516	93
Alajuela	Costa Rica	6352	5949	93
Potchefstroom	South Africa	3823	3570	93
Sids	Egypt	5612	5156	91
Santa Cruz	El Salvador	5202	4655	89
La Maquina	Guatemala	5527	4779	86
Poza Rica	Mexico	6816	5622	82
Ribeirao Preto	Brazil	7304	5780	79

COLLABORATIVE RESEARCH PROJECT IN MAIZE DISEASES

Collaborative Disease Research was initiated in 1974 to incorporate resistance to three important diseases in three broad-based populations of maize.

The diseases are (1) downy mildew (DM), found throughout the tropics and caused by different species of fungi in the genus *Peronosclerospora*; (2) corn stunt (STT) disease, widely distributed in the Americas and transmitted mainly by leafhoppers of the genus *Dalbulus*; and (3) corn streak (STK) virus, found in tropical Africa and transmitted mainly by leafhoppers of the genus *Cicadulina*. Three broad-based maize populations were chosen for this work: Tropical Late White Dent (TLWD), Tropical Intermediate White Flint (TIWF), and Tropical Yellow Flint Dent (TYFD). The selection of material resistant to these diseases cannot be done effectively at CIMMYT's facilities in Mexico. Thus, CIMMYT collaborates with strong national programs in countries where screening for resistance can be done more efficiently. Initial selections were made for downy mildew in Thailand and the Philippines, for corn stunt in El Salvador and Nicaragua, and for corn streak in Nigeria and Tanzania.

Selection for resistance to these diseases has continued each year at the time of highest incidence of the disease in the collaborating countries. This selection cycle is followed by recombination of resistant families in Mexico. Selection for disease resistance also involves simultaneous selection of agronomically desirable characters. (See *CIMMYT Report on Maize Improvement, 1976-77*.)

IMPROVEMENT OF CORN STUNT RESISTANT POPULATIONS

During 1978 and 1979, the second and third cycles of recombination (C_2 and C_3) were completed in populations selected specifically for stunt-resistance with the collaboration of El Salvador and Nicaragua (tables 1 and 2).

Full-sib families generated in Mexico were sent to the two Central American countries and evaluated for disease reaction under field conditions. The apparently–resistant plants were self-pollinated. Seed from selected S_1 ears was planted in the two collaborating countries and also in Mexico. Planting was delayed in Mexico to allow sufficient time for collection of data from the Central American region.

During 1978, all selected S_1 families were artificially inoculated in Mexico at Poza Rica. Ten 5-day-old seedlings of each family were inoculated with infectious leafhoppers for 24 hours in the greenhouse, and then transplanted to the field. For comparison, seed of the same S_1 family was planted next to the inoculated plants in the same row.

Using this information, along with the information on performance of the S_1's planted in Central America, the disease-resistant, agronomically desirable families were cross-pollinated at Poza Rica, thus developing a new cycle of improvement.

Stunt Disease Evaluation

In 1978, a preliminary trial was sent to Nicaragua and El Salvador to evaluate several cycles of selection for differences in resistance to stunt disease (table 3). Cycles were included in a randomized complete block design (RCBD) with four replications, 64 plants per replication. A susceptible local check was added in all trials. In general, cycles 2 and 3 of selection showed less stunt infection than did C_0, C_1, and local susceptible checks in both locations. The per cent of infection of all cycles of selection of population TYFD differed substantially from the susceptible local checks.

Effects of Selection on Yield and Other Agronomic Characters

In the summer of 1979, a trial was conducted at Poza Rica to evaluate the effect of cycles of selection on yield and other agronomic characters. All cycles of improvement in the three populations were included in a RCBD, with two replications, 48 plants per replication (table 4). The latest cycles of the populations TIWF (STT) and TYFD (DM) were superior (5 per cent level) in yield to their original cycles. Yields of the latest cycles of selection in TLWD (STT) or TLWD (DM) did not differ from those of the original cycles. However, gains were evident in shortening the plant.

To improve agronomic characteristics of the stunt-resistant base populations, reciprocal plant-to-plant crosses were made between selected S_1 families. Seed from these full-sib ears was sent to the collaborating countries for screening, as well as for a yield trial. Ninety-five such crosses from each base population, plus five checks, were

included in a 10 x 10 simple lattice design with two replications. Table 5 shows the number of S₁ families selected in C₃ and used in development of C₄.

IMPROVEMENT OF DOWNY MILDEW RESISTANT (DMR) POPULATIONS

Selection in Three Base Populations

Simultaneously with the evaluation and selection for stunt resistance in Central America, the three populations in this research project were screened for downy mildew resistance in Thailand and the Philippines. Selection cycle C₂ was obtained in 1978 and C₃ in 1979 (tables 6 and 7). Full-sib families generated in Mexico were sent to the two Asian countries where they were inoculated artificially with downy mildew conidia. The apparently-resistant plants were self-pollinated. Seed of the selected S₁ ears was handled by the methods described for the stunt disease studies.

Downy Mildew Disease Evaluation

In 1978, a preliminary trial was sent to Thailand and the Philippines to measure differences in resistance to downy mildew between several cycles of selection. Preliminary trials were managed and analyzed as described for the stunt disease trials. Table 8 shows the progress achieved in downy mildew resistance from selection in the three populations.

In 1979, a new site at Rio Bravo, Mexico, was added for downy mildew selection. Sorghum downy mildew (*P. sorghi*) has been endemic for many years at that location.

Selected S₁ families from Thailand, the Philippines, and Rio Bravo were cross-pollinated at Poza Rica. To improve agronomic characters of the downy mildew resistant base populations, reciprocal plant-to-plant crosses were made among the best S₁ families. Seed from these full-sib ears was sent to the collaborating countries for screening, as well as for a yield trial. These trials included a total of 95 crosses from each population, plus five checks, and were sent to several countries in Asia and Central and South America. Table 9 describes the number of S₁ families generated from C₃ and utilized in the development of C₄.

Conversion of Five Advanced Unit Populations to Downy Mildew Resistant (DMR)

In 1975, five Advanced Unit populations were selected for conversion to downy mildew resistance. These populations could be used by national programs, provided the levels of resistance were adequate. The selected advanced populations were: Tuxpeño I, Mezcla Tropical Blanca, (Mix.I x Col. Gp.I) x ETO, Amarillo Cristalino and Amarillo Dentado. In 1974, these five populations were initially crossed to Philippine DMR sources and are being improved by backcrossing, using the scheme shown in figure 1.

In 1979, the BC₃ was obtained in Thailand by protecting seeds of the susceptible recurrent parent with a

fungicide (Ridomil) seed treatment. Table 10 provides a summary of the results obtained in the different cycles of improvement.

Development of Two Temperate DMR Gene Pools

Downy mildew has spread rapidly in temperate and semi-tropical areas where the maize materials are susceptible to the disease. Thus, CIMMYT decided to develop two agronomically-desirable DMR populations, a white and a yellow, that could be used in temperate areas where the disease is a problem.

In 1978, temperate pools in the Back-Up Unit were crossed with several DMR sources from Indonesia and the Philippines. In 1979, F₁ or F₂ seeds of these crosses were planted at Rio Bravo and inoculated artificially with DM conidia (table 11). Disease resistant plants in agronomically desirable families were self pollinated.

Seed from selected ears in the yellow and white pools will serve as basis for the respective DMR temperate pools.

POPULATIONS WITH COMBINED STUNT AND DOWNY MILDEW RESISTANCE

Accumulation of genes for resistance to stunt and downy mildew in the three base populations has continued, following the scheme described in the *CIMMYT Report on Maize Improvement, 1976-77.*

Table 12 lists the percentages of downy mildew and stunt infection in C₂ of selection for all three populations.

Stunt and Downy Mildew Evaluation

In 1978, a preliminary trial was sent to collaborating countries in Asia and Central America to measure differences in resistance to stunt and downy mildew among populations selected against the two diseases over several cycles. Procedures for this trial were similar to those used in the study of stunt resistant populations. Table 13 shows, with the exception of populations TYFD in Thailand and TIWF in El Salvador, that the resistance of the various cycles of selection did not differ from that of the susceptible local checks.

During 1979, cycle C₃ of recombination was completed for the populations with combined stunt and downy mildew resistance. Table 14 shows the performance of the selected full-sib families in the different screening locations. Plants in families apparently resistant to both stunt and downy mildew were self-pollinated and the S₁ seed obtained was exchanged among the countries collaborating in the stunt and downy mildew selection scheme. Table 15 shows the across-location performance of selected S₁ families.

In general, the families selected in these three base populations performed poorly under both stunt and downy mildew conditions. An alternative breeding strategy to incorporate resistance to both stunt and downy mildew in the three base populations will be adopted in 1980.

FIGURE 1. Conversion of five advanced populations to downy mildew resistant (DMR).

	THAILAND		MEXICO

1975 (1) *

Cross advanced DM-susceptible
populations to Philippine DMR sources.

1975 (2)   Inoculate artificially, self pollinate
resistant plants.

1976   Plant S_1 ears and inoculate artificially.
Send data of % infection to Mexico.

Plant S_1 ears in half sib recombination block
Bulk of susceptible recurrent parent as male.
Using information from Thailand, reject ears
from susceptible S_1 families (BC_1) at harvest.

1977 (1)   Plant HS ears. Self-pollinate desirable
plants. Send S_1 seed to Thailand for
evaluation and development of BC_2

1977 (2)   Plant S_1 families and susceptible recurrent
parent. Inoculate artificially. Very high
incidence and recurrent parent 100%
susceptible.
Developed S_2's in resistant S_1 families.

1978 (1)   Plant S_2 seed and susceptible recurrent parent,
inoculate artificially. Make BC_2 pollinating
resistant S_2 plants with bulk pollen from
recurrent parent.

1978 (2)   Plant BC_2 families. Self-pollinate in agronomically
desirable families.

1979 (1)   Plant BC_2-El seed and treat with Ricomil recurrent
susceptible parent. Inoculate artificially. Bulk
pollen from recurrent parent and pollinate resistant
S_1 plants (BC_3)

1979 (2)   Plant BC_3 families. Self-pollinate agronomically
desirable plants.

* (1) = Early planting

(2) = Late planting

DEVELOPMENT OF STREAK RESISTANT POPULATIONS

In 1975, all families from populations TLWD, TIWF, and TYFD that had originally been sent to stunt and downy mildew areas, also were sent to Tanzania and Nigeria for screening against corn streak virus. Drought destroyed plantings in Tanzania and no information was returned from Nigeria, thus delaying the development of streak resistant populations by one cycle.

During 1976, half-sib families that had been selected under stunt and downy mildew conditions were sent to Tanzania. A new site in Zaire also was added. Plantings in both countries were made at the time of expected highest incidence of leafhopper vectors under natural field conditions. Apparently resistant plants were self-pollinated. Seed from selected S_1 ears was exchanged between Tanzania and Zaire for evaluation, and seed also was sent to Mexico. In Mexico, the planting in the winter season was delayed

sufficiently for collection of information on S_1 family performance in the two African countries.

Streak-resistant, agronomically desirable S_1 families were crossed in the winter in Mexico and a new set of full-sib families was developed for evaluation (C_1).

Following this same scheme during 1978 and 1979, C_2 and C_3 of recombination were developed in Mexico. Tables 16 and 17 summarize the information obtained in the various stages of the development of these populations.

In 1978, the International Institute for Tropical Agriculture (IITA) sent to CIMMYT a total of 437 white and 43 yellow S_1 progenies for observation. Progenies were obtained after artificial inoculation of their populations TZSR (White) and TZSR (Yellow). S_1 progenies from TZSR population were planted only in Tanzania, where streak resistant, agronomically desirable families were cross-pollinated. In the planting that followed, 58 crosses were selected from the TZSR (White) population and planted

next to the TLWD-C$_2$ (streak resistant) population. Apparently resistant plants were self-pollinated and 10 S$_1$ ears were saved.

Because of the irregularity observed in the incidence of the disease, it was decided to discontinue the work on selection for streak resistance. This could be continued when sufficient facilities are developed in the areas where the selection work is done. Primarily, the facilities needed are insect-rearing cages for mass production of leafhopper vectors.

DEVELOPMENT OF COMBINED STREAK AND DOWNY MILDEW RESISTANT POPULATIONS

During 1978, selection was begun to incorporate genetic resistance to both streak virus and downy mildew.

Seed from downy mildew-resistant (DMR) families in populations TLWD, TIWF, and TYFD (C$_2$) that had been selected under downy mildew conditions was sent to Tanzania and Zaire to be screened for streak resistance. Table 18 shows the performance of these full-sib families. Those plants in agronomically desirable families that were apparently streak resistant were self-pollinated; selected S$_1$ ears were planted in Tanzania, Zaire, and Mexico. Plantings in Mexico were delayed to allow time for collection of information on performance of these S$_1$ families planted in Africa.

Selection for resistance to these two diseases also will be discontinued until additional facilities can be developed in these countries.

DEVELOPMENT OF ARTIFICIAL INOCULATION TECHNIQUES

The development of artificial inoculation techniques has been underway in the program for several years. An adequate artificial inoculation can produce a more uniform distribution of the pathogen in higher concentrations than would occur under natural conditions, thus reducing the possibility of escapes while creating higher pressures for selection in the improvement program.

The studies to improve inoculation techniques have focused mainly on ear rots, stalk rots, foliar diseases, and corn stunt.

Stunt Inoculation

In 1978, facilities to mass rear the corn stunt leafhopper vector *Dalbulus* spp. were developed at Poza Rica. In this work, healthy maize plants are used to increase the leafhopper. Later, the second or third nymphal instars are allowed to feed on stunt-infected maize plants for 72 hours to acquire the pathogen. Insects are then transferred to feed on clean maize plants for 14 days to multiply the pathogen in their bodies. They are then ready to transmit the disease when allowed to feed on maize seedlings for 24 hours. After such inoculation, seedlings are taken to the field where they are transplanted and treated the same as in a regular planting. Depending on the weather, stunt disease

symptoms in susceptible genotypes may be conspicuous at 4 to 5 weeks after inoculation. This procedure has provided 100 per cent infection in susceptible varieties.

The possibility of mass releasing infectious insects in the stunt breeding nursery has been considered. To test this alternative and measure its efficiency, two trials were designed as described below.

Trial 1: *Dalbulus* spp. are extremely active insects and their hyperactivity is more noticeable in presence of light. This trial investigated how light might affect the activity of the insects and their capacity to transmit the stunt disease.

Seed of a 100 per cent susceptible cultivar was planted at Poza Rica. After six to seven days, seedlings were infested with an average of five infectious leafhoppers per seedling, using the "bazooka" technique. Insects were placed in the whorl at 9 AM, 12 PM, and 6 PM during two consecutive days. A check treatment was added, with no infestation. The four treatments were arranged in a RCBD, with three replications, one hundred plants in each replication. Table 19 shows that time of infestation produced no observable effects in amounts of plants infected with stunt, as compared to the nontreated check.

Trial 2: This trial investigated the possibility of using CO_2 to decrease the activity of the leafhoppers during infestation. Treatments included: (1) infectious leafhoppers released directly in maize seedling whorls, and (2) infectious leafhoppers treated with CO_2 and placed on the whorls using the bazooka method. A check with no leafhoppers was added. The trial was planted in a RCBD with 4 replications, 100 plants in each. Table 20 shows that treating the leafhoppers with CO_2 increased the number of infected plants; however, a large number of plants escaped infection. Similar experiments are being continued.

Ear Rot Inoculations

The ear-rotting organisms *Diplodia* spp. and *Fusarium* spp. are distributed worldwide and cause severe damage. Artificial inoculations of these two organisms were studied.

Diplodia spp.—Work is primarily with two species of this genus that have been isolated, *D. maydis* and *D. macrospora*, the former being the most common.

In 1979, an experiment at Poza Rica examined the reaction of different genetic backgrounds of quality protein maize to varying levels of spore concentrations of *Diplodia* spp. Five populations were studied: Tuxpeño o$_2$, Yellow H.E.o$_2$ (Hard Endosperm opaque-2), White H.E.o$_2$, Temperate x Tropical H.E.o$_2$, and Comp. Hungary, a normal population. Spore concentrations were: 25×10^3, 50×10^3, 75×10^3, and 150×10^3 per ml plus a non-inoculated check. Treatments were distributed in a split-plot design. Varieties were the main plot treatments and spore concentrations

FIGURE 2. Percent Diplodia ear rot infection in five populations inoculated at five spore concentrations. (Poza Rica 79A).
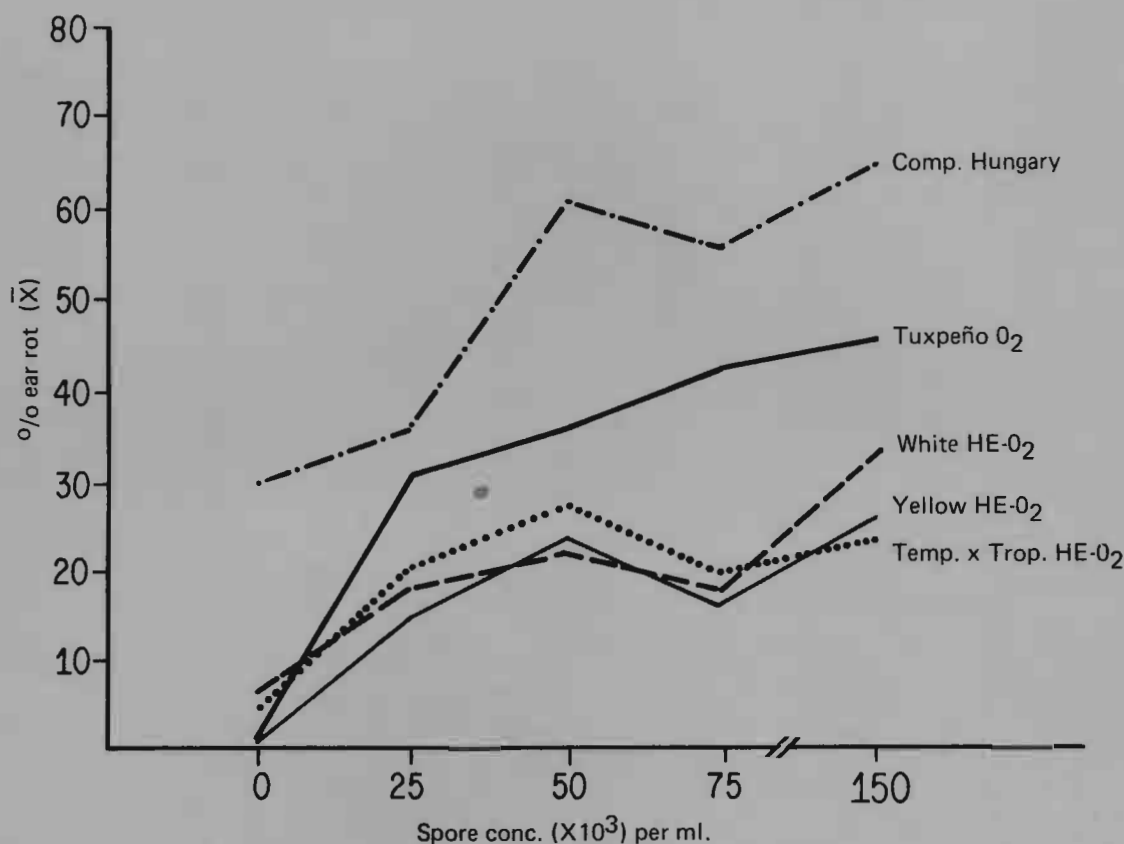
were the sub-plot treatments, with four replications, 32 plants per replication. Silks were sprayed with the spore concentrations about ten days after silking. Table 21 shows the varieties differed in levels of susceptibility.

Comp. Hungary was the most susceptible population to *Diplodia* ear-rot (figure 2). This population is adapted to temperate conditions where it is also susceptible to ear rots. Among all quality protein populations, no differences in amount of rotting were observed as a result of concentrations varying from 50×10^3 to 150×10^3 spores per ml. Yellow H.E.o_2, White H.E.o_2 and Temperate x Tropical H.E.o_2 had relatively lower degrees of ear rotting.

The effect of time of silking in inoculation of the ears by injection also was tested using different spore concentrations. An experiment was set up using a split-plot design. White H.E.o_2 was used in this experiment, where main-plot treatments were days-after-silk and sub-plot treatments were spore concentrations. The experiment was planted and analyzed as in the trial described above. Table 22 shows that there were no differences in ear-rotting due to the spore concentrations tested. However, there were differences in rottings when inoculating the ears at different times after silking. Results indicate that the earlier the time of injection, the heavier the damage.

Fusarium spp.—*Fusarium* has been found to be the most widely distributed ear-rotting organism. Primarily, there are

two species of this fungus that have been identified as damaging to maize: *F. graminearum* and *F. moniliforme*. Three experiments were planted at different locations during 1979 to select the inoculation technique that would be most useful in screening and selection under the various conditions in Mexico. The experiments were planted in the highlands (El Batan) and lowlands (Poza Rica) with populations adapted to such conditions.

(1) The first experiment at El Batan was planned to examine the inoculation techniques and their stability over time. Twenty families in each of four highland populations were planted and inoculated using 12 different procedures. A total of 32 plants per technique were inoculated, with no replications. Ears were collected from families that appeared most resistant or susceptible to the most efficient inoculation techniques. These ears will be inoculated in the 1980 planting to measure the efficiency of these techniques.

(2) A second experiment was designed to compare the effectiveness of the various techniques. The 12 techniques used in the first experiment (above) were tested in four maize populations, using a split-plot design, with populations serving as main plot treatments and inoculation techniques as the sub-plot treatments.

Table 23 shows that at El Batan there were differences between varieties in amount of rotting, but no differences between the inoculation methods tested. Higher percentages
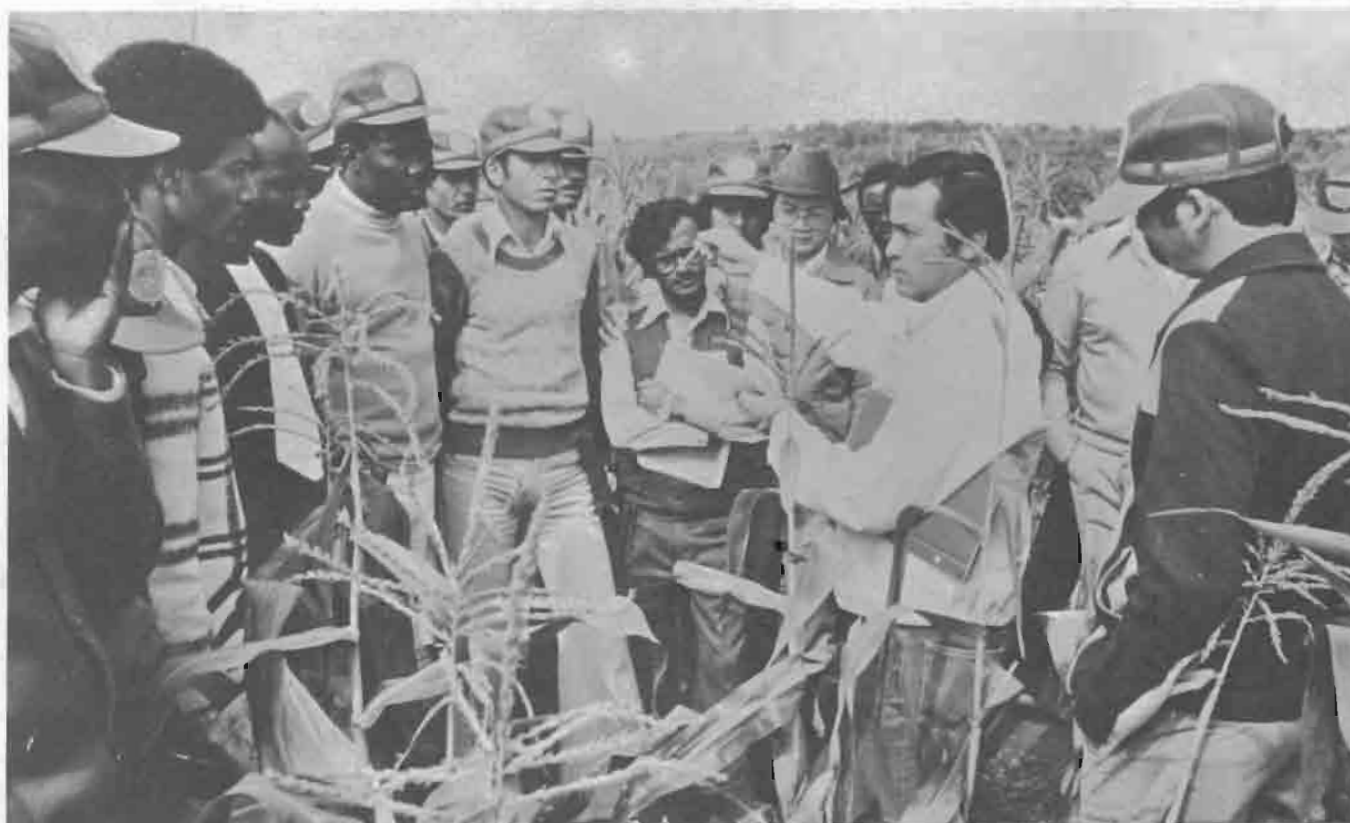
Starting in 1974, three collaborative breeding projects were organized between CIMMYT and six national maize programs to develop germ plasm resistant to three major diseases of maize in tropical areas—downy mildew, streak virus, and corn stunt. Here, a CIMMYT maize pathologist discusses the international breeding work for corn stunt resistance with CIMMYT maize trainees.

of rotting were produced in Pool 3 (HEW-Floury) and Lote 291 (Floury 1-o2 Composite).

(3) A third experiment dealt only with the injection technique. The effect of time of inoculation of three spore concentrations in 4 different maize populations was analyzed. The experiment used a split-split-plot design. There were three times of silking as main plot treatments; three spore concentrations as sub-plot treatments; and the populations served as sub-sub-plot treatments, in four replications, with 32 plants per replication. Results from the highland location in El Batan (table 24) indicates that level of ear rotting was associated with time of silking for inoculation, with spore concentrations, and with the populations used. The most efficient time of inoculation was at silking time, or ten days afterward, when silks began to dry after pollination.

The inoculum concentrations tested were not an important factor in determining degree of rotting when inoculations were made at silk emergence. Successful inoculations were obtained at ten days after silking only with high inoculum concentrations. The least amount of ear rotting was found in Pool 2 (HEWD) and Highland modified opaque-2 composite.

Table 25 shows the results obtained in a similar trial planted at Poza Rica. Differences in the amount of ear rotting could be attributed to inoculum concentration and the populations used. Higher concentrations produced higher percentages of rotting, except with the late inoculation. The least damaged population was Pool 23 (TLWF).

These techniques will be evaluated for consistency in future experiments.

Table 1.   Per cent stunt infection in three populations screened for stunt resistance (C_2) and number of S_1 ears selected (1978).

Population*	No. full sib families screened	Nicaragua	El Salvador			Total S_1 ears selected
		Selected S_1 ears	Range % infection	% infection ($\bar{x}$)	S_1 ears	
3. (TLWD) Stunt-resistant	383	211	0-100	42.9	230	441
6. (TIWF) Stunt-resistant	386	169	0-77	29.6	269	438
9. (TYFD) Stunt-resistant	249	205	0-95	29.6	239	444

(*) TLWD = Tropical Late White Dent
TIWF = Tropical Intermediate White Flint
TYFD = Tropical Yellow Flint-Dent

Table 2.   Per cent stunt infection in three populations screened for stunt resistance (C_3) and number of S_1 ears selected (1979).

Population	No. full sib families screened	Nicaragua			El Salvador			Total S_1 ears selected
		Range % infection	% infection ($\bar{x}$)	No. selected S_1 ears	Range % infection	% infection ($\bar{x}$)	selected S_1 ears	
3. TLWD (Stunt resistant)	461	0-100	74.4	278	5-100	46.7	209	487
6. TIWF (Stunt resistant)	400	0-100	60.4	287	0-100	36.2	214	501
9. TYFD (Stunt resistant)	444	0-100	57.0	269	0-100	30.1	221	490

Table 3. Per cent stunt infection after three cycles of selection in three base populations selected for stunt resistance.

Population	% infection ($\bar{x}$) Nicaragua	El Salvador
3. TLWD (Stunt resistant)		
C_0	50.5	45.7
C_1	58.7	53.7
C_2	35.7	37.7
C_3	31.5	33.5
Susc. Check	100	100
LSD (5%)	28.5	14.9
CV	33%	17%
6. TIWF (Stunt resistant)		
C_0	61	68.7
C_1	64.7	66.7
C_2	36.2	41
C_3	38.7	35.7
Susc. Check	100	100
LSD (5%)	23.5	12.8
CV	25.3%	13.3%
9. TYFD (Stunt resistant)		
C_0	61.5	57.5
C_1	58.7	62
C_2	41.2	47
C_3	36	45.5
Susc. Check	100	100
LSD (5%)	27.5	19.8
CV	33%	20.6%

Table 4. Effect of cycles of selection to stunt (STT), downy mildew (DM) or simultaneously stunt and downy mildew (STT+DM) on different agronomic characters of three base populations.

Population	Stage of selection	Yield (kg/ha)	Plant height (cm)	Ear height (cm)	Days to silk	Lodging (%)
TLWD	C_0 - HS[1]	5985	202.5	120	62	2.1
TIWF	C_0 - HS	4799	217.5	117.5	61	0
TYFD	C_0 - HS	5318	230	125	61	2.1
TLWD	C_1 - HS	6799	222.5	117.5	61	4.2
TIWF	C_1 - HS	4916.5	210	117.5	61	1.1
TYFD	C_1 - HS	5186	215	120	60.5	3.2
TLWD (STT+DM)	C_2 - FS[2]	6043.5	202.5	97.5	60.5	3.1
(DM)	C_2 - FS	4837	207.5	117.5	61	5.2
(STT)	C_2 - FS	6613.5	210	102.5	61	5.2
TIWF (STT+DM)	C_2 - FS	4971	205	110	60.5	0
(DM)	C_2 - FS	5053	210	100	61	0
(STT)	C_2 - FS	5429	217.5	117.5	60.5	3.1
TYFD (STT+DM)	C_2 - FS	4959.5	205	107.5	61	1
(DM)	C_2 - FS	5876	212.5	107.5	60.5	0
(STT)	C_2 - FS	5370	197.5	115	61	3.2
TLWD (STT+DM)	C_3 - FS	4741.5	197.5	105	59	0
(DM)	C_3 - FS	5617.5	205	107.5	61	1
(STT)	C_3 - FS	5959.5	205	107.5	61	0
TIWF (STT+DM)	C_3 - FS	4967.5	210	102.5	60.5	0
(DM)	C_3 - FS	4188.5	197.5	95	60.5	0
(STT)	C_3 - FS	6222.5	200	107.5	60.5	2.7
TYFD (STT+DM)	C_3 - FS	4410.5	197.5	95	59	5.2
(DM)	C_3 - FS	5142	202.5	107.5	61	2.1
(STT)	C_3 - FS	5303	200	100	60.5	3.1
LSD at 5% =	1 070					
CV =	9.6 %					

1/ HS = Half-Sib families
2/ FS = Full-Sib families

Table 5. Per cent stunt infection in three base populations (C_3–S_1) (1979).

Population	No. S_1 families screened	% Stunt ($\bar{x}$)*		No. selected S_1 families
		Salvador	Poza Rica (Mexico)	
3. TLWD Stunt-resistant	487	10.1	51.1	165
6. TIWF Stunt-resistant	501	9.6	66.1	94
9. TYFD Stunt-resistant	490	8.5	74.6	209

* Populations also planted in Nicaragua. No information obtained.

Table 6. Per cent downy mildew infection in three populations screened for downy mildew-resistance (C_2) and number of S_1 ears selected (1978).

Population	No. full sib families screened	Thailand			Philippines		Total S_1 ears selected
		Range % infection	% infection ($\bar{x}$)	S_1 ears selected	Range % infection	% infection ($\bar{x}$)	
2. TLWD (DMR)	559	0-100	27.8	623	16-100	69.8	623
5. TIWF (DMR)	551	0-97	23.3	486	0-100	66.3	486
8. TYFD (DMR)	623	0-100	36.9	459	0-100	53.2	459

Table 7. Per cent downy mildew infection in three populations screened for downy mildew-resistance (DMR)— (C_3) and number of S_1 ears selected (1979).

Population	No. full sib families screened	Thailand			Philippines			Total S_1 ears selected
		Range % infection	% infection ($\bar{x}$)	S_1 ears selected	Range % infection	% infection ($\bar{x}$)	S_1 ears selected	
2. TLWD (DMR)	270	0-71	6.3	385	0-100	57.5	--	385
5. TIWF (DMR)	240	0-22	2.6	413	0-100	48.2	--	413
8. TYFD (DMR)	465	0-24	3.3	410	0-100	51.1	--	410

Table 8. Per cent downy mildew infection in three base populations after three cycles of selection for DM resistance.

Population		Mean % infection	
		Thailand	Philippines
2. TLWD (DMR)	C_0	28	89
	C_1	34	79.7
	C_2	17.2	73.2
	C_3	30	66.2
	Susc. Check	55.2	98.2
	LSD (5%)	18.3	23.4
	CV	36	18.7
5. TIWF (DMR)	C_0	11.5	88
	C_1	18.5	83.5
	C_2	13.5	70.5
	C_3	1.2	64
	Susc. Check	23	92.2
	LSD (5%)	15.8	14.9
	CV	75.8	12.1
8. TYFD (DMR)	C_0	21	83
	C_1	26.5	100
	C_2	9.5	80
	C_3	1.	53
	Susc. Check	7.2	88
	LSD (5%)	10.7	31.8
	CV	53.6	25.5

Table 9. Per cent downy mildew infection in three base populations (C_3-S_1) (1979).

Population	No. S_1 families screened	% downy mildew ($\bar{x}$)			No. selected S_1 families
		Thailand	Philippines	Rio Bravo (Mexico)	
2. TLWD (DMR)	385	27.6	21.1	8.8	101
5. TIWF (DMR)	413	27.3	25.5	3.6	124
8. TYFD (DMR)	410	37.4	45.0	13.9	119

Table 10. Summary of number of families involved in back-crosses to downy mildew susceptible populations after artificial inoculations (Thailand 1976-1979).

Recurrent population	Stage	No. of S_1 families evaluated	% downy mildew $(\bar{x})$	No. families selected	% infection of S_1 families selected
Tuxpeño 1 (IPTT-21)	C_0-S_1	29	57.3	7	27
	BC_1-S_1	134	92.2	19	82
	BC_2-S_1	135	4.4	36	12
Mezcla Trop. Blanca (IPTT-22)	C_0-S_1	27	60.8	7	25
	BC_1-S_1	119	91.4	32	83.1
	BC_2-S_1	151	4.1	41	14.
(Mix.IxCol.Gp.1)xETO (IPTT-25)	C_0-S_1	28	66.3	6	30.1
	BC_1-S_1	105	90.5	24	84.6
	BC_2-S_1	153	5.3	34	14.8
Amarillo Cristalino -1 (IPTT-27)	C_0-S_1	28	67.8	7	26
	BC_1-S_1	108	83.4	68	77.7
	BC_2-S_1	272 (No information)		152	--
Amarillo Dentado (IPTT-28)	C_0-S_1	47	55.9	13	10.1
	BC_1-S_1	92	84.8	55	81.
	BC_2-S_1	233 (No information)		123	--

Table 11. Per cent downy mildew infection of families from six temperate pools crossed to DMR sources and artificially inoculated (Río Bravo, Mex. 1979).

Pool No.	Nomenclature	No. families screened	Range % infection	% infection $(\bar{x})$	% infection susc. check	No. S_1 ears selected
27	Temp. EWF	96	3-100	40.2	74	59
28	Temp. EWD	30	4-100	36.6	74	36
31	Temp. IWF	85	4-78	43.	75	14
32	Temp. IWD	42	3-78	39.	61	25
33	Temp. IYF	27	3-69	35.2	83	4
34	Temp. IYD	21	20-84	50.2	68	-

103

Table 12. Per cent downy mildew and stunt infection (C_2) in the three populations inoculated with downy mildew and planted under high incidence of stunt (1978).

Population	No. full sib families screened	Thailand			Philippines			El Salvador			Nicaragua	Total
		Range % infection	% DM ($\bar{x}$)	Selected S_1 ears	Range % infection	% DM ($\bar{x}$)	Selected S_1 ears	Range % infection	% DM ($\bar{x}$)	Selected S_1 ears	Selected S_1 ears	S_1 ears selected
1. TLWD (Stunt + DM)	137	4-100	54.8	130	47-100	87.1	0	0-90	49.3	171	156	457
4. TIWF (Stunt + DM)	175	0-100	55.2	137	12-100	77.7	0	0-95	37.6	180	117	434
7. TYFD (Stunt + DM)	96	0-100	71.6	44	31-100	76.9	0	0-88	28.6	228	128	400

Table 13. Per cent stunt and downy mildew infection in three base populations after three cycles of selection to both diseases.

Population	Stage	% stunt-infection		% DM infection	
		Nicaragua	El Salvador	Thailand	Philippines
1. TLWD (Stunt + DM)	C_0	59.2	48.5	36	95
	C_1	46.5	35.5	16	95.5
	C_2	64.7	30.5	33.2	94
	C_3	51	43	33	95
	Susc. Check	52	48.2	25.2	100
	LSD (5%)	44.4	34.4	27.4	6.9
	CV	22.7%	24.3%	22.1%	4.7%
2. TIWF (Stunt + DM)	C_0	68.7	92.2	18.7	99
	C_1	55.7	80	26	98
	C_2	53.5	71.7	19.7	92.5
	C_3	63.5	89.5	26.5	93.7
	Susc. Check	67	79	33.7	98.7
	LSD (5%)	29.6	19.3	16.5	7.7
	CV	21.2%	16.%	23.%	5.2%
3. TYFD (Stunt + DM)	C_0	25	70.2	25	92.2
	C_1	25.7	63.7	25.7	90.7
	C_2	18	69.2	18	87.7
	C_3	24.2	71.7	24.2	84.2
	Susc. Check	48.2	65.	48.2	100
	LSD (5%)	22.6	19.9	16.1	21.5
	CV	27 %	19 %	27 %	17 %

Table 14. Per cent stunt and downy mildew infections in three populations screened for combined stunt and downy mildew-resistance (C3), and number of S1 families selected.

Population	No.full sib families screened	Nicaragua Range (% infection)	% infection ($\bar{x}$)	No. selected S_1 ears	El Salvador Range (% infection)	% infection ($\bar{x}$)	No. selected S_1 ears
1. TLWD (STT + DMR)	429	5-100	45.4	250	0-100	49.7	150
4. TIWF (STT + DMR)	415	0-100	58.3	301	0-100	77.1	147
7. TYFD (STT + DMR)	353	0-100	39.0	235	5-100	56.6	133

Table 14. (Continued)

Population	Thailand Range (% infection)	% infection ($\bar{x}$)	No. selected S_1 ears	Philippines Range (% infection)	% infection ($\bar{x}$)	No. selected S_1 ears	Total No. S_1 ears selected
1. TLWD (STT + DMR)	0-100	17.8	138	0-100	72.4	--	538
4. TIWF (STT + DMR)	0-100	17.6	100	0-100	81.3	--	548
7. TYFD (STT + DMR)	0-83	19.9	170	16-100	88.0	--	538

Table 15. Per cent stunt and downy mildew infection in three base populations selected for resistance to both diseases (C3–S1) (1979).

Population	No. S_1 families screened	% downy mildew ($\bar{x}$) Thailand	Philippines	Rio Bravo (Mexico)	% stunt ($\bar{x}$)* Salvador	Poza Rica	No. selected S_1 families
1. TLWD (Stunt + DMR)	538	74.1	97.1	43.	23.3	--	--
4. TIWF (Stunt + DMR)	548	84.7	96.8	49.1	20.8	--	--
7. TYFD (Stunt + DMR)	538	87.6	95.2	46.1	8.0	--	--

* Populations also planted in
Nicaragua. No information obtained.

Table 16. Summary of per cent streak in the three base populations planted under natural incidence of the disease and number of S1 ears selected (1977-1979).

Population	Stage	No. families screened	Tanzania Range % infection	% Streak ($\bar{x}$)	Selected S_1 ears	Zaire Range % infection	% Streak ($\bar{x}$)	Selected S_1 ears	Total S_1 ears selected
10. TLWD (Streak-resistant)	C_0-HS	1560	0-100	42.8	132	0-100	56.5	315	447
	C_1-FS	542	0-100	51.7	251	5-100	42.9	252	503
	C_2-FS	497	0-100	71.4	352	0-57	11.1	149	501
11. TIWF (Streak-resistant)	C_0-HS	1228	0-100	31.7	249	0-100	64.1	169	418
	C_1-FS	513	0-100	50.2	258	0-100	53.7	242	500
	C_2-FS	393	0-100	58.6	249	0-43	6.1	249	498
12. TYFD (Streak-resistant)	C_0-HS	1802	0-100	32.5	167	0-100	57.1	289	456
	C_1-FS	646	0-93	35.6	379	0-100	66.7	121	500
	C_2-FS	540	0-100	56.9	371	0-100	14.2	174	545

Table 17. Summary of per cent streak of S_1 families in three base populations planted under natural incidence of the disease and number of families (1978-1979).

Population	Stage	No. S_1 ears screened	No. S_1 selected Tanzania	No. S_1 selected Zaire	No. S_1 families recombined	No. full sib families generated
10. TLWD (Streak-resistant)	C_0-S_1	447	412	-	223	542
	C_1-S_1	503	-	385	162	497
	C_2-S_1	501	226	-	226	456
11. TIWF (Streak-resistant)	C_0-S_1	418	372	-	227	512
	C_1-S_1	500	-	346	145	393
	C_2-S_1	498	272	-	272	663
12. TYFD (Streak-resistant)	C_0-S_1	456	432	-	264	646
	C_1-S_1	500	-	343	100	540
	C_2-S_1	545	279	-	279	582

Table 18. Per cent streak infection of full-sib families selected for downy mildew (C_2) when planted in conditions of high streak incidence (1979).

Population	No. full-sib families screened	Tanzania Range % infection	Tanzania % streak ($\bar{x}$)	Tanzania No. selected S_1 ears	Zaire Range % infection	Zaire % streak ($\bar{x}$)	Zaire No. selected S_1 ears	Total selected S_1 ears
2. TLWD (DMR)	307	23-100	75.3	200	0-100	7.4	182	382
5. TIWF (DMR)	318	0-100	58.3	95	0-50	11.7	256	351
8. TYFD (DMR)	305	-	-	-	0-81	20.2	451	451

Table 19. Per cent stunt infection by releasing infectious leafhoppers at different times of the day (Poza Rica, 1979).

Treatments	% stunt-infection ($\bar{x}$)
1. Infestation at 9 AM	37.0
2. Infestation at 2 PM	35.1
3. Infestation at 6 PM	34.4
4. No treatment	29.6

LSD (5%) = 9.37

CV = 13.6%

Table 20. Per cent stunt infection using different methods of infestation of leafhopper-vectors (Poza Rica, 1979).

Treatments	% Stunt-infection ($\bar{x}$)
1. Leafhoppers + CO_2	30.3
2. Leafhoppers alone	23.9
3. Check (no leafhoppers)	15.8

LSD (5%) = 13.1

CV = 22.6%

Table 21. Production of ear-rot spraying different concentrations of *Diplodia* spores in quality protein populations (Poza Rica, 1978).

Populations	Spore concentration $(\times 10^3)$ per ml					Population $(\bar{x})$
	0	25	50	75	150	
	% rotted kernels $(\bar{x})$					
Tuxpeño o₂	2.2[1/]	31.6	37.0	44.7	45.1	32.1
Yellow H.E.o₂	1.4	17.6	25.4	18.9	27.8	18.2
White H.E.o₂	8.0	20.0	25.6	19.0	33.2	21.1
Temperate x Trop. H.E.o₂	4.8	21.5	28.6	21.9	26.3	20.6
Comp. Hungary	30.8	37.9	60.4	57.3	63.7	50.0
Spore concentration $(\bar{x})$	9.4	25.7	35.4	32.4	39.2	28.4

LSD (5%) values: 1) Main plot treatments = 8.83; 2) Sub-plot treatments = 5.6; 3) Sub-plot treatments of main plot = 12.5; Main plot x sub-plot treatments = 14.2.

CV = 6.2%

Table 22. Production of ear-rots injecting different concentrations of *Diplodia*-spores at various days after silking (Poza Rica, 1979).

No. spores/ml	Days after silk				Spore concentration $(\bar{x})$
	10	15	20	Noninoc.	
	(% rotted kernels $(\bar{x})$)				
6,250	78	56.4	55.4	4.	48.5
12,500	74.4	74.1	75.1	12.5	59.0
25,000	93.3	75.1	61.8	15.3	61.3
Days after silk $(\bar{x})$	81.9	68.5	64.1	10.6	

LSD (5%): 1) Main plot treatments = 16.9; 2) Sub-plot treatments = 15.6; 3) Sub-plot treatments of main plot = 27.2; 4) Main plot x sub-plot treatments = 18.7.

CV = 17.2%

Table 23. *Fusarium* ear-rot using different methods of inoculations in different maize populations (Batan, 1979).

Population	Method of inoculation												Population $(\bar{x})$
	1	2	3	4	5	6	7	8	9	10	11	12	
	% rotted kernels												
Pool 2 (HgEWD)	38.8	49.8	49.1	40.4	40.2	45.5	42.8	47.1	41.2	44.9	36.8	44.2	43.4
Pool 3 (HgEWFR)	52.2	59.5	56.8	56.7	57.0	49.1	56.6	54.3	48.5	51.2	52.9	49.2	53.7
Lote 291 (Floury -1-o₂ Comp)	57.1	37.3	48.9	55.4	60.2	41.6	56.6	57.6	49.5	55.0	58.8	38.0	51.5
Lote 295 (Hg.mod. -o₂ Comp)	53.3	51.8	47.1	51.4	52.7	45.4	37.7	43.3	48.1	40.3	49.7	51.4	47.3
Method-$(\bar{x})$	50.3	49.6	50.4	50.9	52.5	45.4	48.4	50.5	46.8	48.0	49.5	45.9	

Methods of inoculation tested:
1) Injection (2x10⁵ spores/ml)
2)   "   (1x10⁵   "   )
3)   "   (0.5x10⁵   "   )
4) Fungus in toothpicks (tip of ear)
5) Fungus in toothpicks (butt of ear)
6) Ear worm (Heliothis sp.) sprayed with 1 ml. Fusarium 2x10⁶ spores/ml
7) Ear worm (Heliothis sp.) sprayed with 1 ml. Fusarium 1x10⁶ spores/ml
8) Spray silks (2x10⁶ spores/ml)
9)   "   "   (1x10⁶   "   )
10)   "   "   (0.5x10⁶   "   )
11) Ear worm alone
12) Non-inoculated check

LSD (5%): 1) Main plot treatments = 3.16; 2) Sub-plot treatments = 6.54; 3) Sub-plot treatments of main plot = 13.1; 4) Main plot x Sub-plot treatments = 12.0

CV = 19.0%

Table 24. Effect of time of inoculation and inoculum concentration in the incidence of *Fusarium* ear-rot in different populations (Batan, 1979).

Time of inoculation	Spore conc. (spores/ml)	Populations Pool 2 (HgEWD)	Pool 3 (HgEWFL)	Lote 291 (Floury-o_2 Comp.)	Lote 292 (Hg mod-o_2 Comp.)	Spore concentration ($\bar{x}$)	Time of inoculation ($\bar{x}$)
		(% rotten kernels)					
Silks emerging	2×10^5	55.7	49.0	55.5	43.3	50.9	
	1×10^5	42.3	58.2	50.1	45.8	49.1	
	0.5×10^5	45.4	58.2	47.6	48.2	49.8	49.9
10 days after silking	2×10^5	43.4	57.1	67.0	44.4	53.0	
	1×10^5	43.6	53.3	48.5	48.3	48.4	
	0.5×10^5	47.0	48.4	50.8	48.2	48.6	50.0
20 days after silking	2×10^5	39.7	47.6	53.9	46.0	46.8	
	1×10^5	34.7	53.2	57.2	38.4	45.9	
	0.5×10^5	37.9	54.4	55.2	44.8	48.1	46.9
Population ($\bar{x}$)		43.3	53.2	54.0	45.3		

LSD (5%) = 1) Main plot treatments = 2.79; 2) Sub-plot treatments = 4.52; 3) Interaction main x sub-treatments = 6.72; 4) Sub-sub-treatments = 4.32; 5) Interaction main x sub-sub-treatments = 7.1; 6) Interaction sub x sub-sub-treatments = 7.1; 7) Interaction main x sub-sub-treatments = 12.29.

CV = 17.0%

Table 25. Effect of time of inoculation and inoculum concentration in the incidence of ear-rot in different populations (Poza Rica, 1979).

Time of inoculation	Spore conc. (spores/ml)	Populations Pool 23 (TLWF)	Pool 24 (TLWD)	Lote 93 (Yellow-o_2BU Pool) Flint	Lote 94 (Yellow-o_2BU Pool) Dent	Spore-concentration ($\bar{x}$)	Time of inoculation ($\bar{x}$)
		(% rotten kernels)					
Silks emerging	2×10^5	29.4	26.6	26.0	32.1	28.5	
	1×10^5	19.7	25.0	29.9	36.1	27.7	
	0.5×10^5	25.5	23.7	30.8	29.2	27.3	27.8
7 days after silking	2×10^5	22.0	25.4	31.3	20.5	24.8	
	1×10^5	26.4	33.3	32.1	28.7	30.1	
	0.5×10^5	25.6	26.6	23.6	25.9	25.4	26.8
14 days after silking	2×10^5	25.3	23.1	23.2	27.4	24.7	
	1×10^5	20.8	17.1	29.5	31.6	24.7	
	0.5×10^5	26.5	29.5	34.7	26.6	29.3	26.3
Population ($\bar{x}$)		24.6	25.6	29.0	28.7		

LSD (5%) = 1) Main plot treatments = 2.93; 2) Sub-plot treatments = 4.01; 3) Interaction main x sub-treatments = 5.98; 4) Sub-sub-treatments = 3.32; 5) Interaction main x sub-sub-treatments = 5.45; 6) Interaction sub x sub-sub-treatments = 5.45; 7) Interaction main x sub x sub-sub-treatments = 9.44.

CV = 24.8%

SPECIAL PROJECTS

Special Projects research explores new ideas and investigates new techniques for improving specific characteristics of the maize plant. Four such special studies are now underway dealing with yield efficiency in tropical maize, drought tolerance, early maturity, and adaptation emphasizing day-length and temperature. These studies may require many years for completion, but the findings can ultimately be applied in the overall maize program.

YIELD EFFICIENCY

Tropical maize plants produce a relatively greater proportion of their total dry matter in the form of leaves and stems, and less in grain, as compared to maize varieties grown in the temperate latitudes. One avenue for improving yields of tropical maize would be the improvement of the proportion of the total dry matter of the crop in the grain (i.e., the harvest index). This might be achieved by: (1) selection within the tropical germ plasm, or (2) the introduction of the trait from temperate germ plasm. Some of the different approaches used to achieve these plant types are discussed below.

Short Plants

Based on accumulated data of several years of testing, both as varieties and in varietal crosses, a group of collections and two improved varieties of the maize race Tuxpeño were composited in 1965 to form a population called "Tuxpeño Crema I," the best of the race that had been identified at that time. These collections and varieties used were: Ver. 48, 143, 174; Mich. 137, 166; Colima Group I; Mix. I (Guat.); V520C and La Posta. (Wellhausen, unpublished data).

Various selection studies of this material were made to improve grain yield. By 1967, the problems of plant height and associated lodging had so convincingly demonstrated their importance in the agronomic management of this population that efforts were begun to substantially reduce its height.

In 1973, upon the designation of the maize program's Back-Up and Advanced Unit categories, the name Tuxpeño I (Population 21) was assigned to Tuxpeño Crema I cycle II of the short plant selection as its identification in the Advanced Unit. The Tuxpeño Crema I name has been retained in the Special Projects selection procedure for shorter plants over many cycles. The process of selection for shorter plants has continued in Tuxpeño Crema I and is now in the 18th cycle of selection.

Evaluation of Tuxpeño Crema I—1978

Various cycles of selection for reduced plant height in Tuxpeño Crema I were evaluated at three locations in Mexico in summer, 1978. These trials measured the progress in height reduction and documented changes that might have occurred in other traits for which specific selection had not been made. Such traits included grain yield, for which there had been mild, visual selection. (In this selection, short plant families that had been selected at flowering were rejected if they appeared to be substantially lower in yield at harvest.) It is possible that this simple visual selection for yield over a series of generations may exert an influence on yield in addition to the direct effect on reduced plant height.

Bulk remnant seed (representing Cycles 0, 6, 9, 12, and 15 for reduced plant height in Tuxpeño Crema I) was increased in Poza Rica in 1978A for use in Trial AT-201 in 1978B. Seed of the check variety (Tuxpeño I Population 21 C_2) was increased in Tlaltizapan in 1976B.

The entries in Trial AT-201 included:

Tuxpeño Crema I - C_0: the original composite prior to initiation of selection for plant height.

Tuxpeño Crema I - C_6: six cycles of full-sib selection for reduced plant height. The criteria for full sib selection was a visual selection (using the "running average" concept). Crosses between selected families were made on a plant-to-plant basis using approximately five plants per family, each plant being crossed with a plant in one of the other selected families. Two or three ears were saved from each selected family at harvest to retain approximately the same total number of families in each generation of selection.

Tuxpeño Crema I - C_9: three additional cycles of full-sib selection based on criteria similar to C_6.

Tuxpeño Crema I - C_{12}: three additional cycles of full-sib selection based on criteria similar to C_6.

Tuxpeño Crema I - C_{15}: having families that also were evaluated for their performance under high population density (104,000 plants/ha), with individual plants selected for synchronization of pollen shed and silking under density stress.

Tuxpeño I - Population 21-C_2: Tuxpeño Crema I C_{11} renamed as Tuxpeño-I (Population 2I), with two cycles of selection in the Advanced Unit International Testing Program.

Previous to Trial AT-201, experience had shown that the densities for optimum grain yield varied among the selection cycles. To evaluate each cycle at its optimum, a split-plot arrangement was used in the trial to allow for three population densities selected to span the optimum density. Two of these densities were common for each entry in the trial. Optimum plant densities and grain yield of optimum density were calculated based on the relationship between grain yield per plant and plant population described by Duncan (1958. Ag.J. 50:82-84).

The most obvious and striking effect of the selection has been the large and nearly linear reduction in plant height (table 1, figure 1). This reduction has been achieved through a change in both of the components of height— total number of nodes and mean internode length (table 1). The total number of nodes is associated with maturity. There has been no loss of yield (at optimum density) with the reduction in maturity over cycles (table 2).

To compensate for a reduction in individual plant size, population density must be increased for maximum

grain yield (table 2). Thus, optimum densities for these experimental conditions range from 48,000 p/ha for C_0 and 66,000 for C_{I5}. When grown at optimum density, there appears to be a linear increase in grain yield at an approximate rate of 3.8 per cent per cycle (base-mean yield) (fig. 2).

In the initial selections, reduction in lodging was an important factor in improved response to density, and for yield (table 1). In the later cycles, the reduction in the percentage of barren plants at increasing density appears to be of greater importance. For example, while leaf area indices at optimum density for C_9 and C_{15} are somewhat similar (around 4.5), the percentage of barren plants was I2 per cent for C_9 and 2 per cent for C_{15} (data not shown). The practice, from C_{I2} onward, of selecting families for regeneration when grown at both normal density (52,000 plants/ha)and high density (I04,000 plants/ha) may have improved the density tolerance of the more recent selections.

When grown at optimum densities, the total dry matter production at maturity was similar for the various cycles (table 3). The increase in grain yield with reduced plant height was associated with an increase in the harvest index (proportion of total dry matter as grain).

Previous CIMMYT studies have shown that a reduction in photosynthate around flowering is critical to yield. These

FIGURE 1. Relationship between plant height and cycles of selection for reduced plant height in Tuxpeño Crema I when grown at three locations in Mexico (Poza Rica, Obregon, Tlaltizapan, Summer 1978)

$$Y = 295.8 - 10.46 X + 0.198 X^2$$
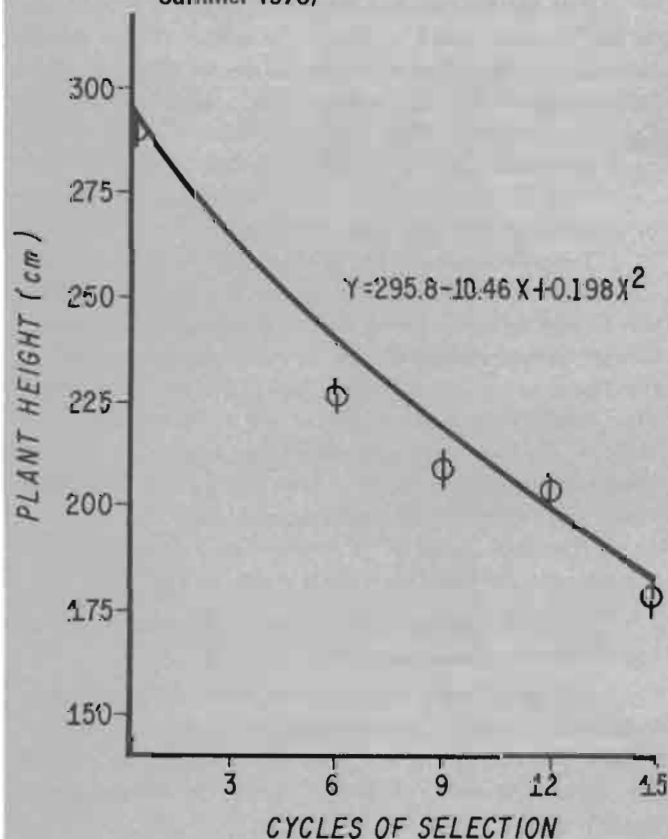
FIGURE 2. Relationship between grain yield and cycles of selection for reduced plant height in Tuxpeño Crema I when grown at Poza Rica (●) Obregon (△) and Tlaltizapan (◇) (φ Mean for all locations, Summer 1978)

LOS PO_5

$$Y = 5260 + 365 X - 7.67 X^2$$
$$Y = 3247 + 189.5 X$$
$$Y = 2524 + 210.0 X$$
$$Y = 1418 + 124.0 X$$
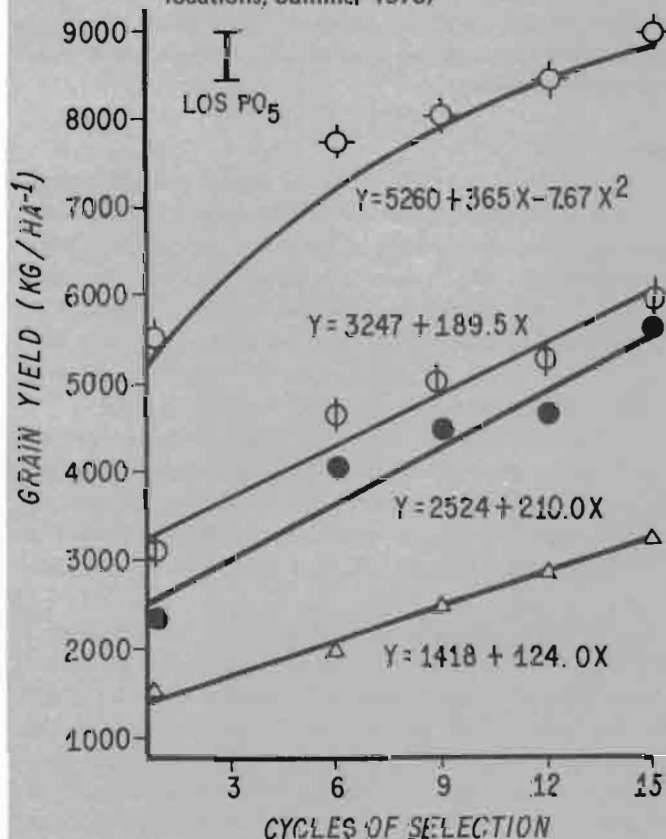
findings suggest that there may be considerable competition for substrate between plant parts, including stem, leaf, tassel, and female inflorescence at this stage of plant development. Reducing the demand for substrate by those parts that are not essential for yield may provide proportionally more of the dry matter for ear development. Data to support this view are found in the comparison of cycles for reduced plant height. After 15 cycles of short-plant selection, the percentage of dry matter in the stem at flowering was reduced from 59.5 per cent to 49.0 per cent of the total crop dry weight (at flowering). The percentage in ear weight was increased from 2.02 per cent for cycle 0 to 3.16 per cent for cycle 15. At optimum plant densities for yields, there was progressively more ear dry matter (on an area basis) at flowering in successive cycles of selection for shorter plant height. This was associated with a higher grain number (per unit area) at harvest (figure 3). This relationship suggests that a 1 kg/ha increase of ear dry matter at flowering would provide a 34 kg/ha increase in grain yield.

FIGURE 3. Relationship between ear dry matter at flowering and grain number at maturity in various cycles of selection for reduced plant height in Tuxpeño Crema I (data are means of two locations).
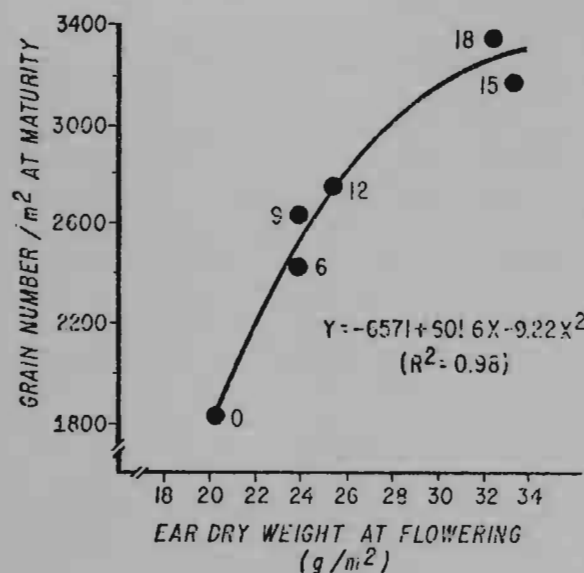
This trial was repeated in 1979 at the same sites, but included two additional entries—a later cycle of short plant selection (Cycle 17) and a local variety of Tuxpeño germ plasm (Criollo Alamo) from Alamo, Veracruz, Mexico. (This later entry was used to provide a more recent collection of Tuxpeño germ plasm for comparison with the original cycle in this study.)

Results from 1979 trials are similar to those of 1978 and are shown in tables 4 and 5. The linear reduction in plant height previously noted in C_0 through C_{15} appears to continue through to C_{17} (table 4) and this reduction is accompanied by a reduction in the days to flowering. Grain yield at optimum density tends to increase with selection at an approximate rate of 2.9 per cent per cycle up to C_{15} (table 5). With the exception of the Poza Rica site, C_{17} yielded slightly more than did C_{15} and the across-site yield increase between these two cycles was 1.4 per cent per cycle. This reduced rate of yield improvement may in part be explained by a reduction in the duration of the growing cycle. Again, there was an increase in the plant population for optimum grain yield (table 5).

These data for 1978 and 1979 are being combined with more detailed results to be published in 1980. However, Table 6 shows the combined results for some traits from the two years testing at three locations. There was a substantial decrease in lodging between cycle 0 and cycle 6. Yields increased at both normal density of 50,000 p/ha and at optimum density as the plant height was reduced.

In winter 1979, full-sib families of C_{17} were planted at Poza Rica for random recombination. Selection for reduced plant height will continue on this material as a Special Project. (A subset of the C_{17} recombinants was transferred to the Advanced Unit and tentatively named Blanco Dentado 2, population 49.)

In the Central American cooperative yield trials (PCCMCA) in 1979, bulk seed of the C_{17} for short plant selection was included as an entry (data not shown). Two important points in evaluating the yield performance were noted: (1) Tuxpeño PB C-17 was the earliest to flower in the group, and (2) it was by far the shortest in plant height (1.80 meters) at all sites. Evaluations were made at 50,000 plants/ha. In such trials, where the entries differ in maturity, optimum density requirement, and height, there should be considerable care taken in the assessment of relative yields. These are extremely important factors in assessing relative yields of varieties. In the PCCMCA trial, both Tico V-1 from Costa Rica and ICTA-B-1 from Guatemala, were increases of C_{11} of the same population Tuxpeño Crema I that was used in the plant height selection study.

Implications for Further Study—The substantial changes in plant architecture resulting from the recurrent selection for plant height, plus the increased optimum plant density for achieving maximum grain yields, highlight the need for further investigation into appropriate management practices, if the smaller and earlier plants are to be a commercial success. The increased grain yields in earlier maturing varieties, along with the greatly reduced lodging, are clearly advantageous. On the other hand, the higher plant density requires more seed and more labor input in planting, when hand planted. Confirmation in commercial fields is necessary to be sure that the experimental plot results also apply to wider-scale farm management conditions.

In 1980, some of these cycles of selection will be grown in farmers' fields to study agronomic implications of

CIMMYT scientists, using the lowland tropical maize population Tuxpeño, have been recurrently selecting for shorter plant height within successive cycles of this population. Plant height has now been reduced to approximately 50 percent of that of the original material. The ratio between grain and stover in the total plant dry matter in the more recent selection cycles is now 1 to 1, a ratio similar to the maize types grown in the U.S. Corn Belt.

planting densities and crop association possibilities. The more efficient short plants offer opportunities as mechanisms for intensification of production, both in intercropping combinations and in crop sequences. The smaller, shorter maize plants allow greater light penetration to reach associated plant species, and the shorter growing period required should permit greater flexibility in adding another crop, either before or after the maize. Of course, if the associated crop is a weed, there may be a detrimental effect on yield.

In addition to the agronomic considerations mentioned above, there are other implications regarding breeding and use of the short-plant type resulting from recurrent selection.

For example, these types could be used:

(1) As an open-pollinated variety for production purposes, just as any other open-pollinated variety.

(2) In the formation of inbred lines and hybrids: Short plant hybrids will result from combinations within this type of population. Intermediate height hybrids will result from crosses with other materials having very different plant heights. The height of the F_1 hybrid of such crosses is almost exactly at the mid-point of that of the parents. Thus, the additive quantitative genetic behavior can be exploited to produce intermediate height hybrids of the short plants, using other materials as varietal crosses, as crosses of inbreds, or as crosses of inbreds by varieties.

(3) As a source of shorter plant characteristics. Preliminary observations of the advanced generations of crosses between the short plants and tall materials

suggest that selection in F_2 and F_3 generations can be extremely effective in rapidly recovering a recombinant variety with almost the same height as the short parent. Plants as tall as the original tall parent in the segregating generations have not been observed in the fairly small numbers of segregating plants. This skewed distribution of plant height segregants is probably due to the intermixing of large gene blocks (linkages) that would tend to break up gradually in succeeding generations of mixing. Growing of large numbers of plants over several successive generations should improve the chances of recovering individuals similar to the tall parental type. Thus, it would seem that early backcrosses could be made to the tall parent to recover most of its genetic attributes, while at the same time rapidly reducing its height by the introgression of the short-plant gene blocks. Further work will be done to confirm these observations, but initial results are encouraging. The principal value of the presently available short plant Tuxpeño selection may well be in its contribution to shortening the plant height of other tall materials by judicious introgression.

The husk cover of the short Tuxpeño plant selection population, as expressed under certain environmental conditions, seems to have been modified unfavorably during the shortening of the plants, so that ear tips are less well covered. Under temperate conditions, this change might even be desirable; but, in the tropics, a good tight husk covering is needed to prevent entry of insects and moisture to the maturing

grain on the ear. The selection procedures for shorter plants have largely ignored husk cover; however, husk cover improvement seems desirable as a commercial consideration.

Reduced Foliage

Tropical maize has a lower grain number and grain yield per unit leaf area of plant, and a higher density of leaf area above the ear, when compared with temperate material grown in a disease-free environment in the tropics. The light environment of the crop around flowering has been shown to influence grain number and yield per plant (*Maize Improvement Report, 1975*). It is not clear to what extent the light environment of specific leaves (particularly those near the ear) is involved in this response. Data from translocation patterns in temperate maize, however, do indicate that at flowering the leaf subtending the ear contributes a greater proportion of its photosynthate to the ear than do the leaves at other positions. Thus, it seems logical to select for reduced foliage density above the ear leaf to improve the illumination of the leaves close to the ear. Selection for this trait is now underway in three populations: Tuxpeño-1, ETO Blanco, and Antigua-República Dominicana.

Six cycles of recurrent selection for reduced foliage have been made in Antigua-República Dominicana, and the latest cycles were evaluated at three locations (Poza Rica, Tlaltizapan, and Obregon) in Mexico during summer, 1979. This trial also included the latest cycle of selection (C_6) for reduced tassel size, and the F_1 combination of reduced leaf (C_6) and tassel (C_6). Compuesto Selección Precoz (C_5) was included as a check because of its similar maturity.

To evaluate each cycle at its optimum plant density, a split-plot arrangement of three population densities (50, 80, and 106 thousand plants/ha) was selected to span the range of optimum density. Optimum plant densities and grain yield at optimum density were calculated based on the relationship between grain yield and plant population described by Duncan (1958 Ag.J. 50:82-84).

Table 7 shows the change in leaf length and width and leaf area index of the crop (grown at 80,000 plants/ha) after six cycles of selection. The 14 per cent reduction in leaf area of the crop was due mainly to a reduction in leaf width (approx. 10 per cent) and to the number of leaves per plant (data not shown). This latter effect also was reflected in a reduction in days to maturity and plant height.

Table 8 shows the grain yield at optimum plant density and the optimum density for the various selections when grown at the three sites. In the selection for reduced leaf area, there was a significant increase in grain yield (11.8 per cent) across the three sites. However, there was no change in yield at the Poza Rica site (which may be explained by poor and abnormal growth of the crop in the early stages of development that appeared to be associated with unfavorable soil conditions at that site). At Ciudad Obregon, the yield advantage of the reduced-leaf selection was about 30 per cent; this could be due to relative differences in the

soil-atmosphere-water status at the time of flowering for each genotype. Conditions at this site during the summer may cause temporary (midday) water stress in the plant, which can be critical when it occurs at flowering. Timeliness of irrigation (and rainfall) relative to the acute critical phase of development of the crop may be an important factor in the evaluation of materials. Although the mean male flowering time was 2.5 days earlier in the reduced-leaf selection, there was no evidence from the irrigation schedule or rainfall to suggest that the yield difference could be attributed entirely to such differences. It is possible that selections that produce more grain per unit leaf area may have an advantage under these conditions--a consideration that requires further study.

At Tlaltizapan, optimum yield in the reduced-leaf selection was obtained at considerably higher plant densities (table 8). However, even at a plant density of 80,000 plants/ha that approximates the optimum for the original cycles, grain yield was greater for the reduced-leaf selection. This was attributed to an increase in the harvest index of the crop, while total dry matter production was similar (table 9).

Along with this improvement for grain yield, there was a reduction in the time to flowering. The original cycle of Antigua-República Dominicana and the check entry (Compuesto Selección Precoz C5) had similar across-site yield values, although the check was two days earlier to male flowering. However, the yield of the reduced-leaf selection was superior to that of the Compuesto Selección Precoz population, although their maturity indexes were similar. Selection for reduced foliage may be a useful means for improving the yield per duration of crop growth for those populations in which earliness is an important factor. However, the resulting plant type may require higher plant densities for optimum performance and the desirability of such densities requires further evaluation under farmer conditions. Different conclusions might be obtained, depending on whether the crop is grown in pure stands or in association with other crop species.

The population ETO Blanco has undergone six cycles of selection for simultaneous reduction in leaf and tassel size. Cycles 0, 2, 4, and 6 of this study, along with the most recent cycle of selection of the IPTT program, ETO Blanco- IPTT Population 32 (C_2), and C_{17} of the short plant Tuxpeño Crema I selection, were evaluated at Poza Rica, Tlaltizapan, and Ciudad Obregon in summer, 1979. The trial design was the same as that described for the evaluation of foliar reduction in Antigua Republica Dominicana.

Table 10 shows the change in plant leaf area and tassel size. By C_6, there had been a 25 per cent reduction in the leaf area per plant, a 30 per cent reduction in tassel branch number, and a 20 per cent reduction in tassel dry weight (per area) at flowering. There was a slight reduction in plant height and C_6 was approximately 2.0 days earlier to flowering.

Table 11 shows grain yield at optimum plant density at the three sites. There was a significant increase in grain yield (6.9 per cent) for C_6 across the three locations. However, as in the experiment reported above, there was no significant change in yield at the Poza Rica site, and again the trial was affected by poor soil conditions. Optimum yields for the later selections cycles were obtained at considerably higher plant densities (table 11). At the higher density of 80,000 plants/ha, total dry matter production was not altered and the increase in grain yield was due to the improvement in the harvest index (table 12).

The date of flowering for the second check entry Tuxpeño Crema I - Selection Reduced Plant Height (C_{17}) was similar to that of the C_6 selection of ETO, but had a higher grain yield. This was due to a better harvest index, rather than to any difference in total dry matter production.

The populations of Tuxpeño and ETO are known to have good general combining ability and are the basis for many commercial hybrids. The above findings suggest further study of how the performance of this cross might be improved by these morphological changes.

Antigua-República Dominicana and ETO Blanco are each being recombined in a random mating generation before continuing further selection cycles for the same traits. These materials also will be evaluated again (summer, 1980) in trials similar to those reported here.

A third population (Tuxpeño-I) also is being used in this study of effectiveness of reduced foliage, but has had only four cycles of selection; it will be evaluated in a similar manner after six selection cycles.

Reduced Tassel Size

Maize tassels have been shown to be considerably larger than is required for their function as pollen sources. Large tassels intercept and waste considerable incident radiation during the flowering and grain-filling periods, and may compete with the developing ear for nutrients during the preflowering and flowering period. The effects of reduced tassel size have been studied through selection for this trait in three populations: Tuxpeño-I, Eto Blanco, and Antigua-Republica Dominicana.

Six cycles of selection for reduced tassel size have been made in the population Antigua-Republica Dominicana, and Cycle 6 was included in the trial (reported earlier) that evaluated changes in leaf foliage in this population.

The dry weight at flowering of the tassel was reduced by 29 per cent and tassel branch number by 50 per cent. There also was a reduction in plant height and days to flower (table 7). Grain yield for the tassel selection averaged over the three sites was significantly higher (6.4 per cent) than that of the original cycles. Most of this increase was due to the improved performance (11.4 per cent) at the Tlaltizapan site (table 8). As previously mentioned, the trial at Poza Rica had adverse growing conditions.

Optimum yields in the reduced tassel selection were obtained at considerably higher plant densities (table 8). However, at Tlaltizapan, even at 80,000 plants/ha (which approximates the optimum for the original cycle) grain yield was greater for the reduced-tassel section. This was attributed to an increase (12. per cent) in the harvest index of the crops (table 9).

These selections will be evaluated again in the 1980 summer cycle. The population is presently being randomly mated before continuing selection for this trait. Selection also continues for a reduction in tassel size in Tuxpeño I, and these cycles will be further evaluated.

Increasing Ear Size and Grain Number

In addition to research projects aimed at reducing the weight of non-grain portions of the tropical maize plant, one research project is underway to increase ear size and grain number in one population while holding plant size constant. This population, called Planta Pequeña Mazorca Grande (PPMG), is composed of the following germ plasm:

1. Long Ear Composite-USA (Ear length)
2. Maíz Ancho-Mexico (Kernel size)
3. Toliman grueso C. Norteño-Mexico (High row number, deep kernel)
4. P. Rico 3, 16, 18, 20 Gpo. 5 Rep. Dom.-P. Rico and Dom. Rep. (Ear size, tropical)
5. St. Croix Long Ear 2, 3, Gpo 1-St. Croix Long Ear Tropical
6. Amarillo Bajío grano grande blanco-Mexico (Large deep kernel, includes 50 per cent Tuxpeño).

This population has a sub-tropical adaptation. The selection criteria is a visual assessment of the relative size of the ear (or ears) compared to the total plant size.

YIELD EFFICIENCY IN TROPICAL X TEMPERATE GERM PLASM

The problems of direct transfer of temperate region germ plasm to tropical areas and the logical alternatives for combinations between tropical and temperate germ plasm have been mentioned briefly in previous CIMMYT reports. As might be expected, the resulting plants are usually of an intermediate type in terms of the response of the recombinants to the normal disease and insect problems of tropical areas. An intermediate response is also apparent within the parameters of yield efficiency. Considerable variation occurs in these parameters, and is apparently related to the different sources of temperate and tropical germ plasm used in the combination.

If temperate-type plant architecture and dry matter partitioning are to be usefully recombined with disease and insect resistance from tropical sources, it is expected that systematic recombinations based on evaluations under the appropriate environments will be required over a series of generations.

Performance under tropical conditions is evaluated at Poza Rica, and expressions of grain yield are obtained at Tlaltizapan. Recurrent selection over a series of generations is expected to gradually improve disease-resistance characteristics, while retaining the architecture of the temperate-type plant. Two populations are being used: Amarillo Bajío[1] and Antigua-República Dominicana- Corn Belt[2].

The Antigua-República Dominicana combination was developed with the best material available for tolerance to insects (Antigua) and to stunt (República Dominicana), but has undergone fewer generations of selection than Amarillo Bajío.

While these materials were originally intended as introgressions of temperate germ plasm for use in the tropics, they might also be useful in the reverse direction —as a vehicle for moving tropical germ plasm into the temperate regions as source germ plasm for breeding programs there.

The Amarillo Bajío population now has been included in the Advance Unit series as Population 45.

ADAPTATION EMPHASIZING DAY LENGTH AND TEMPERATURE

Many attempts have been made to use "exotic" germ plasm in temperate regions to incorporate insect and disease resistances from tropical maize, and in tropical regions to incorporate the "efficient" plant type of temperate zone maize types. One complication results from the very different heat unit requirements of different genotypes, which are reflected in their relative maturities. The tendency is to select so-called "productive" varieties. However, those varieties that are "productive" types in tropical areas require such a long growing period under temperate conditions that they are not useful and eventually must be abandoned. Photoperiod sensitivity provides another formidable obstacle. Length of growing period is a major consideration in limiting "adaptation." The longer the growing period required, the fewer locations where a given material may be grown satisfactorily. This factor is of special importance in incorporating tropical germ plasm into temperate areas. Thus, earliness *per se* seems to be important in adaptation, and early maturity tropical types seem to be a logical choice for use in temperate areas.

The basic procedure for achieving wider adaptation in CIMMYT maize populations is the selection of the superior genotypes under a series of different environments, followed by their successive recombination through an indefinite number of such selection cycles. In all such materials, the aim is to include all possible appropriate germ plasm in the formation of the base population. In most cases, germ plasm is assembled from areas representing the extremes of the range of conditions for which the population is being developed. Then, after cycles of mixing, selection is done under different environmental conditions. An extreme example of this procedure has been applied with the population called "Estudio Reacción Largo del Día." It was first composited as a population in 1969.[3] Since then it has been grown in many sites around the world, in addition to five sites in Mexico. This range of latitudes and altitudes provides sufficient variation in day length and

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[1] A series of crosses were made over a period of several years involving tropical maize germ plasm with U.S. Corn Belt type. The general objective was to try to combine the insect and disease tolerance of tropical maize with the earliness and yielding ability of temperate maize for eventual use in tropical areas. Inbred lines from Dr. Ullstrup at Purdue, the single crosses of the hybrid U.S. 13, Pfister Hybrids 347, 381, 409, 418 and Ht. Xanth., the Corn Belt Composite from Nebraska, Stiff Stalk Synthetic from Iowa and other Corn Belt materials were used in the crosses which were principally with Tuxpeño from Mexico, Cuban flints, Puerto Rico mixtures and collections from the Dominican Republic. Crosses were made at San Rafael, Veracruz, and Tepalcingo, Morelos during the year 1961 to 1965. One bulk mixture derived from these crosses was grown for several years of mixing at Tepalcingo, Morelos, and El Roque, Gto., with no records kept of pedigree. When CIMMYT withdrew from working at El Roque Station this bulk mixture was referred to as "The Yellow Mixture from the Bajío station (El Roque), and the name has survived as "Amarillo Bajío".
Originally, only mixing was done for several years, and gradually mild selection pressure was initiated. In 1975 at Poza Rica Ver., one generation of selfing was carried out to permit elimination of a small percentage at Texas M.S. Cytoplasm carried over from the original U.S. hybrid. Selection pressure is primarily to maintain the Corn Belt plant type architecture with tropical disease resistance—a gradual change.

[2] Amarillo Bajío, mazorca larga (longer ear composites from Nebraska and Iowa), Illinois lines resistant to *H. turcicum* and *P. sorghi*, Alph (Iowa), Argentina Dent Composite, Hungarian Composite (Corn Belt Type) x Mezcla Amarilla (CIMMYT Tropical Composite), Early Cornell Corn Belt Type x Mezcla Amarilla, BSSS(R)C-6 and BSCB(R)C-6, Alph x Mezcla Amarilla, and Bolivia Composite of Corn Belt Type were all crossed to the Composite Ant.-Rep. Dom. to form this population using a minimum of 25 plants representing each of the listed populations and a total of about 500 ears harvested. Ant. = a composite of the 8 collections of maize from Antigua (Caribbean) and which have appeared to carry some insect resistance. Rep. Dom. = a composite of 39 collections from the Dominican Republic and which appeared somewhat tolerant to stunt. The objective was to combine disease and insect resistance of tropical germ plasm with yield and plant architecture of Corn Belt Types in a broad genetic base population.

[3] New England Flints: 213807, 213808, 213810, G8819, 214194, 214203, 214280, 217462, 223830, 245131, 255979, 255984, 255986, 255978, Peace River Early, Gaspé, Alaska Sweet Corn;
U.S. Corn Belt: Hybrids from Pfister, Pioneer, N. King, De Kalb and others. Lines CI21E, C-103, Ky128, Hy49, Mo14W, and others. Composite from Wisconsin, Iowa, and Nebraska. Corn Belt Composite, Alph, Stiff Stalk Synthetic and others.
Mexico: One or more collections from each of 25 described races with several from race Tuxpeño (Yellow Tuxpeño Composite, V-520C, SLP18, 23, 25, etc.);
Guatemala: Comiteco.
Caribbean: Dom. Republic Composite (39 collections), Cuba Composite (25 collections), Antigua Comp. (8 collections), others.
S. America: Argentina Composite, Cuzco, Amarillo Calca, Blanco Urubamba, ETOBlanco, Chocleros, Uruguay Composite, Brazilian Yellow, and many others.
In total, crosses among nearly 500 collections were composited to form the original germ plasm of the population.

A special project was initiated in 1977 to determine whether there might be sufficient variability within maize for drought tolerance to merit more specific breeding attention, and whether a practical methodology could be developed to make selections for this trait. Preliminary observations indicate that it is possible to select genotypes with improved yielding ability under drought-stress conditions which do not lose their capacity to perform well under adequate moisture conditions. Here a visiting CIMMYT scientist measures leaf stomatal resistance of maize plants.

temperature environments for selection of superior genotypes that are then returned to Mexico to be included in the recombination. This procedure has continued since 1969.

It has been observed that selections for early maturity and short plant height made in Wisconsin and Germany show no differences in these traits when grown in Mexico. This finding suggests that the plants selected in the higher latitudes were simply relatively photoperiod insensitive genotypes, rather than earlier or shorter, *per se*. However, while such variation for insensitivity exists within the population, studies in South Africa (using artificial light to provide short and long days) indicate that the population remains somewhat photoperiod sensitive (Spencer, personal communications). This population might be converted relatively easily to photoperiod insensitivity, with the resulting possibility of greatly enlarging the area of potential use of such materials.

The Toluca station at 2,650 meters altitude has very cool growing conditions, and it might be expected that selections from there would be the very earliest to flowering. Such an expectation is not borne out by the flowering dates of the selections when grown under the warmer conditions of Tlaltizapan—where they were actually slightly later to flower than the selections made in the hot climates of Poza

Rica and Obregon. This suggests that earliness and the ability to grow and produce seed under low temperatures are independent attributes.

EARLY MATURITY

The sacrifice in grain yield associated with very early maturing varieties has long been recognized as a major problem in maize variety development. One of the natural results has been that most breeding programs focus their attention on longer-maturity varieties that will provide good grain yields. However, CIMMYT continues to study the relative importance of various aspects of early variety development and performance to determine the potential for improvement. These studies include different types of germ plasm and the effects of selection for different plant developmental characteristics.

In 1975, a broadbased population (referred to here as Compuesto Selección Precoz) was formed from genotypes of intermediate and late maturity.[1] The objective of this work was to develop earlier maturity from later types, while retaining relatively high yields. Two cycles of selection each year have been conducted since 1976, with plantings at Poza Rica, Tlaltizapan, and Ciudad Obregon. A half-sib recurrent selection program is being used, with primary

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[1]   Blanco Cristalino IPTT-23; Ant. Ver.181 IPTT-24; (Mix.1-Col. Gpo.1) Eto Blanco IPTT-25; Amarillo Dentado 2 IPTT- 28; Tuxpeño Caribe 2 IPTT-29; Amar. Crist. 1 IPTT-27; Mezcla Amarilla IPTT-26; Eto Blanco P.B.; Amarillo Dentado Misc.; (Tuxpeño x Nicarillo) Sint. 10 lineas; /(Mix. 1-Col. Gpo.1)Eto/ Sint. 10 lineas; Amar. Bajío x Argentinos; Amar. Bajío x Misc.; Ant. Rep. Dom., and Thai Comp. Early.

selection for early flowering. Within this work, selection is also based on high grain yield with low moisture content at harvest. Although there has been no critical evaluation of changes due to selection, table 13 shows the trends in flowering and yield between cycles 0 and 5. Days to flower has been reduced by about I day per cycle of selection, with an accompanying 2.4 per cent loss in grain yield per cycle. These data are from comparisons made at only one plant density (50,000 plant/ha). It might be expected that with selection for earlier and, to some extent, for smaller-statured plant types, the optimum density for yield would be higher for the latest cycle of selection. A trial comparing various cycles of selection at a range of plant densities is planned for 1980.

Data presented in the *Maize Improvement Report, 1976-77*, suggested that it may be possible to genetically modify the relative duration of the pre-flowering and grain-filling stages of the crop and to determine their effects on grain yield. A graduate student research project was initiated in 1978 to develop four sub-groups within the population Compuesto Selección Precoz with varying durations in these two phases of plant development. The trends in maturity indices and yield after two cycles of full-sib selection are shown in table 14. A comparison of Groups 1 and 3 (early flowering) shows that days to flowering were essentially the same, yet the indices of grain maturity (black layer and grain moisture content) indicate that Group 3 had a longer post-flowering development period. Yield for Group I is slightly lower than that for Group 3.

Groups 2 and 4 (late flowering) had similar flowering dates, but were later than Group I and 3. Both indices of maturity were more advanced in Group 2 than Group 4, and yield was slightly lower. This data showed a positive trend for selection and the procedure is being continued for further evaluation. It is anticipated that information provided in this study will influence the selection criteria used for the development of better yielding, early maturity materials, based on the relative importance of the pre- or post-flowering periods in determining grain yield.

Another method of developing very early maturing tropical varieties consists of assembling the earliest maturity genotypes from wherever they are found and improving their yield and disease-resistance characteristics. Sources of this material were listed in the *Maize Improvement Report, 1976-77.* After several cycles of recombination within three major groups (Precoces Pakistan—Mata Hambre—Guajira 314; Mata Hambre-Guajira 314 Blanco; and Mata Hambre—Guajira 314 Amarillo), progeny trials were conducted to identify the better families in each group (table 15). The better families from each group were recombined to constitute a population referred to as Componente Precoz, and these progenies were yield-tested in the summer of 1979 at a population density of 100,000 plants/ha. Table 16 provides an indication of the potential for yield selection within this population. There seems to be a substantial

yield improvement as compared to the original collection (yields of Mata-Hambre-Guajira C_0 and Componente Precoz were 3.23 and 3.72 ton/ha, respectively). This population will continue to be improved through progeny yield evaluation and recombination over several cycles.

The basic objective in both of the above approaches is to provide relatively high yielding, early maturing germ plasm. Tables 15 and 16 show the performance of Compuesto Selección Precoz as compared with that of Componente Precoz. (The data however, are not from the same trial and are given only to provide an approximate comparison of performance.) In winter, 1978, the best 100 family selection from the Pakistan-Mata Hambre-Guajira population (Table 15) produced a yield-per-day (to harvest) of 48.5 kg/day, compared with 50.0 kg/day for the best selection of Compuesto Selección Precoz. In summer 1979, the yield-per-day values were 47.9 kg/day for Components Precoz and 52.7 kg/day for Compuesto Selección Precoz (Table 16). In a series of trials conducted in Guatemala that included Compuesto Selección Precoz and Mata Hambre-Guajira, Tillmans reported yields of 5.5 and 4.0 ton/ha, with flowering dates of 56 and 49 days, respectively. This represents a yield of 99 and 81 kg/ha/day (to flowering) for Compuesto Seleccion Precoz and Mata Hambre-Guajira respectively.

Other considerations appear to be at least as important as earliness *per se* in eventually producing a superior yielding early variety. The trend toward earliness in Compuesto Seleccion Precoz is clearly evident (table 13). However, there also seems to be a loss in yield, which may be due to the smaller plant size. Further study is needed to determine whether this yield loss per plant can be compensated for by higher plant densities per unit of land area.

The effects of length of growing period can also be analysed by comparing the yields obtained in the cool winter season (table 13) with those obtained in the summer season (table 16). Cycle 5 of Compuesto Seleccion Precoz required 76.5 days to reach flowering in winter and yielded 7.3 ton/ha, whereas in the summer period, flowering occurred at 55.5 days, with a grain yield of 5.8 ton/ha. Thus, the grain yield per day was about the same for the winter and summer cycles. The influence of temperature on relative maturities is obvious, and the longer period to absorb and convert solar energy in the field produces the higher grain yields, just as is found with genetically later-maturity types. Since grain yield per day in this material tends to remain constant, it seems reasonable to expect that genetically very early maturing varieties would be lower in grain yield as a direct result of the shorter length of time to convert solar energy.

DROUGHT TOLERANCE

Evidence presented in the *Maize Improvement Report, 1976-77*, suggested that there were genetic differences for drought tolerance within the population Tuxpeño-I.

Based on this evidence and using the techniques described in that report, a recurrent selection program for improved performance under drought has continued, using the Tuxpeño-I population. Approximately 250 full-sib families were evaluated in the winter (dry) cycle at Tlaltizapan under controlled non-stress and stress conditions. The non-stress treatment was that of adequate irrigation for normal growth. The stress treatment involved one irrigation at planting, to aid in germination and to provide soil moisture at field capacity. There was no further rain or irrigation.

The soil moisture of this treatment at germination, at flowering, and at final harvest is shown in table 17. During the pre-flowering period, there appears to have been water usage by the plants to a depth of approximately 90 cm. With continued stress into the grain-filling period, there was further depletion of water in this zone, and to a greater depth. At the time of soil sampling at harvest, roots had reached a depth of 150 cm.

The mean grain yield for the 250 progenies when grown under non-stress and stress treatments was 6.3 and 1.6 ton/ha, respectively. Data on the mean performance of the best twenty families selected on the basis of criteria for non-stress conditions and for drought tolerance are shown in table 18. As suggested previously, there appears to be an interaction in the yield performance of progenies when grown under non-stress and stress conditions. The coefficient of correlation between yield under these two treatments was low ($r = 0.17$ $N = 250$) (table 19), which is further evidence of an interaction between stress and non-stress conditions.

Table 19 shows the correlections between the parameters used for the evaluation of drought tolerance (relative leaf elongation rate, interval between pollen shed and silking, and leaf tissue death) and grain yield under non-stress and stress conditions. These three characters appear to be reasonable indicators of ability to perform under water stress.

A selection index, incorporating these characters as well as grain yield (non-stress and stress), was used to identify 80 superior families, and remnant seed of these selected families was planted in the summer cycle at Poza Rica for progeny regeneration. The improved cycle (C_2) consisting of 250 full-sib families will be tested under similar treatments in Tlaltizapan in winter 1980. This sequence will be continued for a number of cycles before a detailed evaluation of progress is made.

HETEROTIC EFFECTS

It is well established that the variety Eto Blanco (from Estación Tulio Ospino in Colombia) combines well with the race Tuxpeño (from Mexico), and several hybrid combinations are available commercially. Several countries have expressed interest in different germ plasm complexes for possible use as hybrid progenitors. However, relatively little information is available about the combining abilities of populations being developed in CIMMYT's maize program. To gather such information without causing major dislocation of the present program activities, most materials of both the Advanced Unit and Back-Up Unit were crossed to Tuxpeño and to Eto Blanco. Cycle 17 of the Tuxpeño selection for short plants and C_2 of Eto Blanco IPTT 32 were chosen to represent the two materials. Most of the crosses to both materials were made during the 1979B season, with the remaining combinations to be completed during the 1980A season. Yield trial evaluations will be conducted during 1980 so that preliminary information on the combining ability of the several populations in the CIMMYT program should be available by the end of 1980.

Some of the CIMMYT tropical populations were used in a series of inter-varietal crosses in Guatemala. Results of trials of these crosses were presented at the annual meeting of the Programa Cooperativo Centro Americano de Cultivos Alimenticios (PCCMCA) in Tegucigalpa, Honduras in 1979.

Table 1. Morphological characters for various cycles of selection for reduced height in Tuxpeño Crema I. (Data are the means over three locations in Mexico—Poza Rica, Tlaltizapan, and Obregon, Summer 1978).

Cycles of Selection	Days to Flower		Height		Node Number		**LAI	Lodging (%)
	Male	Female	Plant (cm.)	Ear (cm.)	Total	Above Ear		
0	68.7	73.2	293	198	24.9	6.0	4.76	46
6	64.6	67.9	227	138	23.2	6.0	4.64	3
9	64.6	67.4	210	122	23.1	6.1	4.74	3
12	63.7	66.6	205	116	22.6	6.0	4.59	2
15	60.9	62.7	179	99	21.9	5.8	4.12	0
*Check-1	62.3	65.4	213	121	22.8	6.1	4.57	5
L.S.D. P.05	0.9	1.3	8	6	0.5	0.3	0.42	8

*Check-1 - Population 21 (C_2)
** Leaf area index at optimum density, for Tlaltizapan and Poza Rica sites.

Table 2. Grain yield (0%/o moisture) at optimum plant density and the calculated optimum plant density for various cycles of selection for reduced plant height in Tuxpeño Crema I when grown at three locations in Mexico (Summer 1978).

(a) grain yield

Cycle of selection	Grain Yield at Optimum Plant Density (Kg/ha)			
	Poza Rica	Tlaltizapan	Obregon	Across sites
0	2320	5434	1520	3091
6	4117	7818	2008	4647
9	4508	8025	2509	5014
12	4686	8556	2903	5382
15	5722	9099	3353	6058
Check-1	5424	8862	2927	5737
LSD P. 05	540	632	317	338
C.V.%	8.3	5.4	8.5	---

(b) optimum density

Cycles of selection	Optimum Plant Density (1000 plants/ha)			
	Poza Rica	Tlaltizapan	Obregon	Across sites
0	42	63	50	48
6	45	73	43	54
9	55	79	51	61
12	53	78	40	57
15	57	89	51	66
Check-1	41	67	43	50
LSD P. 05	13	15	16	10

* Check-1 - Population 21 (C_2)

Table 3. Total (above ground) and grain dry matter at maturity and harvest index for various cycles of selection for reduced plant height in Tuxpeño Crema I when grown at near optimum density. (Data are for two sites—Poza Rica and Tlaltizapan; Summer 1978).

Cycles of Selection	Total dry matter (Kg/ha)	Harvest index	Grain yield (Kg/ha)
0	15180	0.29	4562
6	15745	0.40	6453
9	16444	0.42	6713
12	16408	0.42	6884
15	16152	0.49	7786
*Check 1	16699	0.43	7205
L.S.D. P.05	1770	0.05	850

*Check 1 - Population-IPTT 21 (C_2)
(Total dry matter x Harvest index = Grain yield)

Table 4. Morphological characters for various cycles of selection for reduced plant height in Tuxpeño Crema I. (Data are the means from three locations in Mexico—Poza Rica, Tlaltizapan and Obregon; Summer 1979).

Cycles of Selection	Days to Flower Male	Days to Flower Female	Height Plant (cm)	Height Ear (cm)	** LAI	Lodging (%)
0	66.4	69.5	270	184	4.57	52.8
6	62.8	65.3	212	129	4.96	13.8
9	62.3	64.4	207	113	4.75	18.3
12	61.0	63.5	201	113	4.38	9.8
15	59.6	60.6	182	101	4.39	10.0
17	58.0	58.9	156	80	3.95	7.9
*Check-1	61.0	63.0	195	106	4.64	9.5
Check-2	65.5	67.6	271	173	3.99	36.7
L.S.D. P.05	1.6	1.4	15	13	0.54	14.3

* Check-1 - Population 21 (C_2)
  Check-2 - Criollo Alamo
** Leaf area index at optimum density; for Tlaltizapan and Poza Rica sites.

Table 5. Grain yield (0º/o moisture) at optimum plant density and the calculated optimum plant density for various cycles of selection for reduced plant height in Tuxpeño Crema I when grown at three locations in Mexico (Summer 1979).

(a) grain yield

Cycle of Selection	Grain yield at optimum plant density (kg/ha)			
	Poza Rica	Tlaltizapan	Obregon	Across Sites
0	3738	4715	1283	3245
6	4652	5589	1558	3933
9	4523	5593	1741	3952
12	4966	6487	1973	4475
15	5333	6753	2148	4745
17	5176	6965	2448	4732
Check-1	5218	6002	1880	4366
Check-2	3316	4376	1391	3027
LSD P.05	546	976	500	505
CV %	7.8	11.0	18.1	--

(b) calculated optimum density

Cycles of Selection	Optimum plant density (1000 plants/ha)			
	Poza Rica	Tlaltizapan	Obregon	Across sites
0	43	53	37	44
6	56	65	42	54
9	56	53	38	49
12	52	77	41	57
15	68	79	47	65
17	76	77	56	70
*Check-1	58	61	53	58
Check-2	42	59	37	46
LSD P.05	16	20	17	12

* Check-1 - Population 21 (C_2)
Check-2 - Criollo Alamo

Table 6. Plant height, lodging, optimum planting density and the grain yield of various cycles of selection for reduced plant height in Tuxpeño Crema I when grown at their optimum density and at 50,000 plants/ha. (Data are the means of two years testing at three locations—Poza Rica, Obregon and Tlaltizapan, Mexico).

Cycle of Selection	Plant Height (cm)	Grain Yield t/ha		Lodging (%)	Optimum Density (plants /m²)
		Optimum Density	50,000 plants/ha		
0	282	3.17	3.13	49	4.6
6	218	4.29	4.24	9	5.4
9	210	4.48	4.31	10	5.6
12	202	4.93	4.71	6	5.6
15	179	5.40	5.03	5	6.5
L.S.D. P.05	7	0.32	0.36	12	1.2

Table 7. Morphological characters for selection for reduced leaf and tassel size in the population Antigua—Republica Dominicana when grown at 80,000 plants/ha. (Data are means of three locations in Mexico—Poza Rica, Tlaltizapan and Obregon; Summer 1979).

Cycle of Selection	Flowering (Days) Male	Female	Plant Height (cm)	Leaf size Length (cm)	Width (cm)	+ LAI	Tassel size (at flowering) (Kg/ha)	no. branches
C_0	55.8	58.3	196	73	5.5	3.25	476	18
Reduced leaf C_6	53.4	54.0	180	70	4.8	2.80	386	13
Reduced tassel C_6	54.3	54.8	178	70	5.2	2.78	338	9
Reduced leaf C_6 x Reduced tassel C_6	53.7	54.2	177	69	5.1	2.64	364	11
Check	53.7	54.7	193	73	5.6	3.28	464	21
L.S.D. P.05	1.2	1.4	14	2.4	0.4	0.28	44	1.1

* Data from Tlaltizapan only.

** Check - Compuesto Selección Precoz (C_5)

+ Leaf area index (LAI)

Table 8. Grain yield (0⁰/o moisture) at optimum plant density and the calculated optimum plant density for selections for reduced leaf and tassel size in the population Antigua-Republica Dominicana when grown at three sites in Mexico (Summer 1979).

(a) grain yield

Cycles of selection	Grain yield (Kg/ha) Poza Rica	Tlaltizapan	Obregon	Across sites
C_0	4366	6741	3512	4873
Reduced leaf C_6	4405	7398	4535	5447
Reduced tassel C_6	4256	7530	3764	5183
Reduced leaf (C_6) x Reduced tassel (C_6)	4018	7430	3980	5143
*Check	4028	6314	3836	4726
L.S.D. P.05	387	392	384	252
CV %	6.0	3.6	6.4	---

(b) optimum density

Cycle of selection	Plant density (1000 plants/ha) Poza Rica	Tlaltizapan	Obregon	Across sites
C_0	74	72	70	72
Reduced leaf C_6	107	102	67	92
Reduced tassel C_6	94	105	77	92
Reduced leaf (C_6) x Reduced tassel (C_6)	84	105	64	85
*Check	65	73	54	64
L.S.D. P.05	18	12	12	9

*Check - Compuesto selección precoz (C_5)

Table 9. Total dry matter production, harvest index, and grain yield of various cycles of selection for reduced leaf and tassel size in population Antigua-Republica Dominicana when grown at 80,000 plants/ha at Tlaltizapan (Summer 1979).

Cycle of Selection	Total dry matter (kg/ha)	Harvest index	Grain yield (kg/ha)
C_0	15,501	.40	6,277
Reduced leaf C_6	15,037	.44	6,592
Reduced tassel C_6	16,121	.45	7,217
Reduced leaf (C_6) x Reduced tassel (C_6)	15,135	.46	7,008
*Check	14,817	.39	5,745
$LSD_{P.05}$	1,350	0.04	786

* Check – Compuesto selección precoz (C_5)

Total dry matter x Harvest index = grain yield.

Table 10. Morphological characters for various cycles of selection for reduced leaf and tassel size in the population Eto Blanco. (Data are means from three sites in Mexico—Poza Rica, Tlaltizapan and Obregon; Summer 1979) (Density 80,000 p/ha).

Cycle of Selection	Flowering (Days) Male	Female	Plant height (cm)	**Leaf Size Length (cm)	Width (cm)	+ LAI	** Tassel size (at flowering)** kg/ha	no. branches
0	60.2	62.8	205	74.8	5.4	3.39	529	22.9
2	59.3	61.2	208	73.7	5.2	3.17	466	18.8
4	57.4	59.3	202	72.7	5.0	2.92	491	17.9
6	58.5	59.8	195	72.5	4.8	2.56	426	14.0
*Check-1	60.8	63.8	208	76.4	5.5	3.40	499	23.9
Check-2	57.9	59.0	161	72.3	5.3	2.76	550	15.3
$LSD_{P.05}$	1.0	1.1	11	1.8	0.3	0.32	47	2.5

*Check-1 Population 32 (C_2)
Check-2 Tuxpeño Crema I – Reduced plant height (C_{17})

** Data from Tlaltizapan only.

+ Leaf area index.

123

Table 11. Grain yield (00% moisture) at optimum plant density and the calculated optimum plant density for various cycles of selection for reduced leaf and tassel size in the population Eto Blanco when grown at three sites in Mexico (Summer 1979).

(a) Grain Yield

Cycles of selection	Grain yield kg/ha			
	Poza Rica	Tlaltizapan	Obregon	Across sites
0	4952	5843	3000	4598
2	4552	6055	3340	4653
4	4944	6335	3490	4890
6	5067	6248	3430	4915
*Check-1	4553	5903	2847	4454
Check-2	5268	7196	3287	5250
LSD$_{p.05}$	560	418	457	309
CV %	7.0	4.4	9.4	–

*Check-1 - Population 32 (C_2)
Check-2 - Tuxpeño Crema I - Reduced plant height (C_{17}).

(b) Optimum Density

Cycles of selection	Plant density (1000 plants/ha)			
	Poza Rica	Tlaltizapan	Obregon	Across sites
0	76	65	55	65
2	70	66	62	67
4	89	89	59	75
6	101	78	70	83
*Check-1	63	62	53	59
Check-2	94	89	93	79
LSD$_{p.05}$	18	15	21	11

Table 12. Total and grain dry matter production and harvest index of various cycles of selection for reduced leaf and tassel size in population ETO Blanco when grown at 80,000 plants/ha. (Data are means from Tlaltizapan and Poza Rica; Summer 1979).

Cycle of selection	Total dry matter (kg/ha)	Harvest index	Grain yield (kg/ha)
0	13884	0.37	5128
2	14201	0.39	5522
4	14170	0.40	5629
6	13724	0.40	5491
*Check-1	13000	0.30	4787
Check-2	13240	0.45	5960
LSD$_{p.05}$	1430	0.04	489

*Check-1 - Population 32 (C_2)
Check-2 - Tuxpeño Crema I - Reduced plant height (C_{17})
(Total dry matter x Harvest index = Grain yield).

Table 13. Comparison of cycles of selection for earliness in Compuesto Seleccion Precoz (Lote 81) grown at Tlaltizapan 1978 Winter Cycle.

Cycles of selection	Days to flower (50% silking)	Plant height (cm)	Grain yield (t/ha)
C_0	81.5	199	5.58
C_5	75.0	182	5.01
Change per cycle (%)	-1.60	-1.71	-2.04
LSD$_{p.05}$	2.95	22.7	0.81

Table 14. Trends in maturity indices and grain yield after two cycles of selection for variable durations of phenology in Compuesto Seleccion Precoz (Tlaltizapan 79A).

Seleccion	Days to flower (50% silking)	Maturity index: Grain moisture (%)	Black layer score	Grain yield (kg/ha)
Group 1- Early Flowering Early Maturity	72.5	27.3	92	5276
Group 3- Early Flowering Late Maturity	71.6	29.8	83	5407
Group 2- Late Flowering Early Maturity	75.9	24.1	96	4985
Group 4- Late Flowering Late Maturity	76.6	27.5	92	5567
LSD$_{.05}$	2.3	--	18	1278

* Each group harvested 63 days after flowering.
** 100 = max black layer development at harvest.

Table 15. Some data on the performance of populations being improved for early maturity and grain yield (Special Projects TLAL. 79A). (Data are from separate experiments of progeny evaluation).

	Days to flower (50% silking)	Plant height (cm)	Grain yield (t/ha)	Grain moisture content (%)	Days to harvest
Precoces Pakistan-Mata Hambre-Guajira (lote 88)					
Mean (250F)	60.4	165	5.69	18.0	134
Selected (100F)	60.2	167	6.50	18.6	134
Mata Hambre-Guajira 314 (Blanco) Lote #9A					
Mean (250F)	67.1	146	4.71	21.0	134
Selected (100F)	66.7	146	5.49	21.3	134
Mata Hambre-Guajira 314 (Amarillo) Lote 89B					
Mean (250F)	68.9	161	5.33	20.1	134
Selected (100F)	67.5	161	5.60	22.8	134
Seleccion Componente Precoz (C$_5$) Lote 81					
Mean (329F)	76.5	---	7.10	30.0	136
Selected (100F) (approx.)	75.0	---	7.80	20.0	136

Table 16. Some observations on the performance of populations Compuesto Seleccion Precoz (Lote 81) and Componente Precoz (Lote 89) when grown at the same time and place (but different experiments) (Tlaltizapan 79B).

	Days to flower (50% silking)	Grain yield (t/ha)	Grain moisture (%)	Days to black layer
Compuesto Seleccion Precoz (C$_5$) Lote 81	55.5	5.80	--	110
Componente Precoz (C$_1$)				
Population (300F)	52.9	3.72	30.5	95 (approx.)
Selected (80F)	52.7	4.55	29.1	--
* Pool 29	49.3	3.37	27.5	--
* Mata Hambre-Guajira (C$_0$)	52.2	3.23	27.5	--

* Check entries.

Table 17. Soil moisture of stress treatment at germination flowering and maturity (Tlaltizapan 79A).

Sampling stage	Depth (cm)	Soil moisture (% by vol.)	Soil tension (bar)
GERMINATION	0-30	45.0	-1.8
	30-60	44.0	-1.8
	60-90	47.0	-1.0
	90-120	48.0	-1.0
	120-150	46.0	-1.0
	150-180	45.1	-1.0
FLOWERING	0-30	23.0	-11.6
	30-60	31.4	-6.9
	60-90	33.5	-3.0
	90-120	41.9	-2.7
	120-150	42.2	-2.4
	150-180	43.0	-2.2
MATURITY	0-30	17.4	-15.5
	30-60	26.4	-9.0
	60-90	29.7	-7.8
	90-120	35.3	-6.1
	120-150	36.1	-4.7
	150-180	36.8	-4.5

125

Table 18. Mean performance of the population and twenty best families selected for non-stress and stress conditions (Tuxpeño-1 selection for drought C_1; Tlaltizapan 79A).

Population and selections	(Grain yield (kg/ha))		Plant height (cm)	Days to flower (50% silking)
	Irrigation	Stress		
Best families (no-stress)	7891	1837	176	86.0
Best families (stress-index)	6854	2549	176	86.9
Population	6314	1654	178	87.6
S.E.	923	550	12	2.8

Table 19. Coefficient of correlation of the various parameters used for selecting drought tolerant families with grain yield under no-stress and stress (Tlaltizapan 79A).

Variable	Grain yield (non-stress)	Grain yield (stress)
Grain yield (stress)	0.17*	1.00**
Relative leaf elongation rate	0.06	-0.26**
Interval between anthesis and silking (stress)	0.04	-0.36**
Leaf tissue death	-0.15	-0.48**

* Coefficient of correlation significant P.05 (N=250)

** Coefficient of correlation significant P.01

WIDE CROSSES

Wide cross research in the maize program is designed to assess and exploit the potentially useful germ plasm in two alien genera, *Tripsacum* and *Sorghum.*

In general, the aim is to produce a more environmentally stable maize crop; for example, to confer to maize better insect and disease resistance from *Tripsacum,* and more drought resistance and tolerance of waterlogging from sorghum. Three basic objectives are to: (1) identify an efficient and convenient method for producing usable hybrids in quantities sufficient to generate the genetic variation required for selection in plant breeding, (2) estimate the practical use of the alien germ plasm in maize improvement, and (3) use such germ plasm in the overall improvement program, if found feasible.

MAIZE X TRIPSACUM CROSSES

During 1978-79, approximately 14,000 crosses were made between maize and *Tripsacum,* and 15 hybrids were identified (table 1). Of the 15, eleven were classical hybrids that retained the expected gametic number of chromosomes from both parents. These hybrids had a greater resemblance to *Tripsacum* than to maize (figure 1a) and are perennial; to date, none has flowered.

The other four hybrids were non-classical, having 20 maize chromosomes and various numbers of *Tripsacum* chromosomes in different root tip cells. As in similar hybrids identified previously, the cells sampled from younger plants had more alien chromosomes than did cells sampled at later stages of growth. Chromosome loss was erratic and progressive. Most of the cells examined of each of these hybrids contained 20 maize chromosomes and no tripsacum chromosomes; other cells contained 20 maize chromosomes and up to ten chromosomes of *Tripsacum.* At flowering, less than 2 per cent of the cells had one or more alien chromosomes and, in some plants, no alien chromosomes were observed at this stage. These non-classical hybrids were more maize-like and are annual; all reached the stage of flowering within six months of germination (except one, which required eight months). Individual non-classical hybrids varied in their expression of floral parts. One plant had neither a female nor a male flower (figure 1d). Another plant produced a female and male flower, both of which were sterile. Two plants produced

sterile male flowers, but these two plants set some seed on backcrossing to maize, although fertility was low.

The identification of two types of hybrids confirms previous CIMMYT findings. The *classical* hybrid seems to be produced by a fusion of normal reduced gametes, whereas the *non-classical* hybrid results from the fusion of an unreduced or doubled egg cell with a normal male gamete, followed by chromosome elimination. Previously, these non-classical hybrids had been obtained from tissue culture only. However, in 1978, two non-classical hybrids were obtained from mature seed germination. Thus, the cytological abnormalities characteristic of this type of hybrid are not due to tissue culture.

Table 1. List of maize x tripsacum hybrids produced 1978-79.

♀ Maize	♂ Tripsacum	No. Hybrids Produced	Chromosomes: Number	Type
Pool 15	T. dactyloides 7214-3	2	20-22 20-25	M M
Pool 33	T. dactyloides 65-1234	1	46	C
Pool 33	T. dactyloides 65-1234	1	46	C
Pool 33	T. dactyloides 65-1234	1	46	C
Pool 33	T. dactyloides 65-1234	1	46	C
Amarillo Bajío	T. dactyloides 65-1234	1	46	C
Amarillo Bajío	T. dactyloides 65-1234	1	46	C
Amarillo Bajío	T. dactyloides 65-1234	3	46	C
Amarillo Bajío	T. dactyloides 65-1234	1	46	C
Pool 33	T. dactyloides 7130-6	1	46	C
Pool 33	T. dactyloides 65-1234	1	20-30	M
Pool 33	T. dactyloides 7130-3	1	20-25	M

C= classical hybrid
M= non-classical hybrid (mosaic cytology)

Fig. 1. F_1 hybrids of maize x Tripsacum
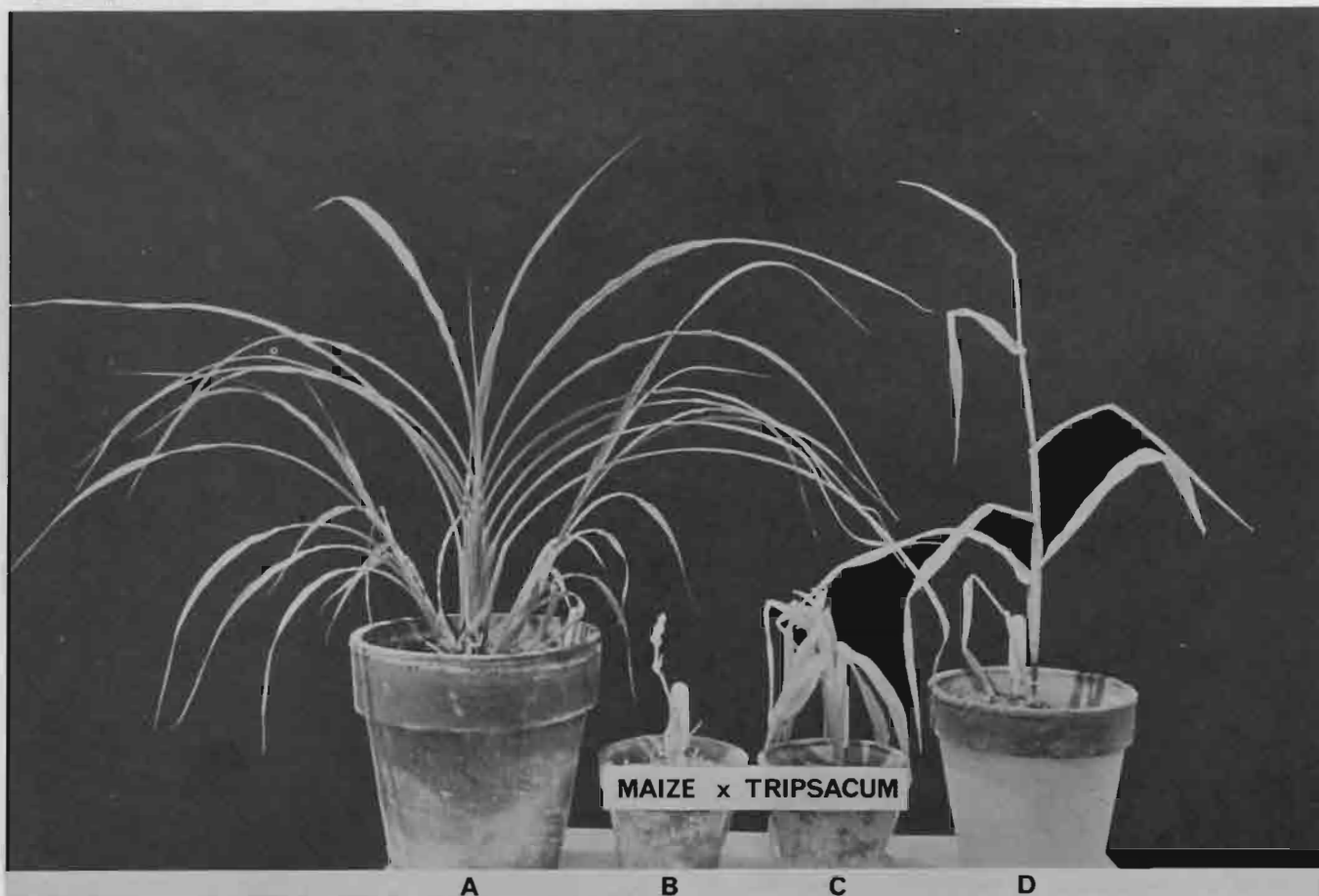
a—classical hybrid
b, c +d—Non-classical hybrids

Progress of Hybrids from Previous Cycles

Of the 19 maize x *Tripsacum* hybrids produced in previous cycles, none of the 14 classical progeny has produced seed: three died without flowering, and the remaining 11 have been sterile. Of the 11 sterile progeny, three died after flowering, two in 1978 and one in 1979. The eight remaining sterile plants have been cloned by tillers, and replicate clones have been planted in different environments in an attempt to induce fertility, and for observation. Some of these tillers also have been treated with colchicine in an attempt to double the chromosome number and thus induce fertility. In addition, tillers of these eight surviving hybrids have been innoculated with corn stunt. The results will be reported in 1980.

Of the five non-classical hybrids produced previously, three have set seed. One fertile hybrid produced three seeds and another produced five seeds; however, all eight seeds collapsed and their embryos died in culture. The third fertile hybrid produced six backcross progeny, five of which appeared to be cytologically normal maize (although three of them were completely sterile, having empty anthers and no ears).

One of the three fertile BC_1 progeny had the same variable number of *Tripsacum* chromosomes as did the female parent. The three fertile progeny were pollinated with maize and the BC_2 progeny have been regenerated by intra-family pollinations. For the formation of subsequent generations, selected ears were planted on an ear-to-row basis. In addition, replicate rows of each of those selections with sufficient seed were planted in trials in 1979 to test for resistance to drought, insects, and disease.

The seven fertile hybrids produced in previous cycles are now in various generations (G) derived from the original hybrid (G_1). As with similar maize x *Tripsacum* hybrids, F_1 plants are initially backcrossed to maize, with the following generations formed by selfing or crossing of plants of the same family. Selected ears of later generations are then planted on an ear-to-row basis for further regeneration.

The first hybrid (produced in 1976) had progeny in G_7 in 1979. Those progenies with sufficient seed also were planted in trials to test for drought, insect, and disease resistance, and were placed in different environments for observation.

MAIZE X SORGHUM CROSSES

During 1978-79, over 23,000 crosses were made between maize and sorghum, with 9 hybrids identified (Table 2). All nine hybrids were non-classical aneuploid mosaics, as described above for maize x *Tripsacum* crosses. Each cell examined had 20 maize chromosomes; some of these cells also had as many as eight sorghum chromosomes. Alien chromosome loss was erratic and progressive, but was more complete than that of the maize x *Tripsacum* hybrids. At flowering, less than 1 per cent of the cells of any one hybrid contained only one or two alien chromosomes. In most hybrids, no alien chromosomes were observed at this stage.

Table 2. List of maize x sorghum hybrids produced 1978-79

Maize	Sorghum	No. Hybrids Produced	Chromosome No.
Amarillo Bajío	SI	1	20-23
Tuxpeño	R12	2	20-22
			20-23
Pool 34	R13	1	20-24
Tuxpeño	S7B	1	20-28
Pool 4	02-18	2	20-25
			20-24
Pool 21	R8	1	20-22
Tuxpeño	R8	1	20-24

These plants were more maize-like in morphology, and all flowered within seven months of germination. All had reduced tassel size, with only one, or very few, branches. One plant bore a tassel with a reduced number of florets that were clustered in three apparently random areas; the remainder of the tassel was bare stalk. The tassel of another plant dried completely, immediately after emergence. No hybrid had viable pollen, but six set some seed (I to 43) on pollination with maize.

As with similar hybrids produced in maize x *Tripsacum* crosses, these hybrids appear to result from a fusion of an unreduced maize egg cell with a normally reduced sorghum gamete. This may be the only successful fertilization in the maize x sorghum crosses, as no classical hybrid has been identified (that is, a hybrid produced by the fertilization of normally reduced gametes and retaining the resultant chromosome number).

INCREASING CROSSABILITY

With both tripsacum and sorghum, there are two major barriers to hybrid production: (I) low seed set, and (2) embryo breakdown.

To increase the number of effective crosses made between maize and tripsacum, a garden was formed in 1976,

with replicate clones of each tripsacum genotype that had produced hybrids with maize. Subsequently, more crosses have been made with those successful genotypes. The crossability of most of these genotypes has been repeated in various cycles, whereas no hybrids have been produced with different genotypes. However, there was great variation in the production of hybrids with these successful tripsacums over different cycles, even when crossed with the same genotype of maize. Differences in environments between cycles and in the condition of the parents are known to affect crossability, and could account for the variations found.

Crosses will continue with different genotypic combinations to identify additional genotypes of superior crossability. When such genotypes are identified, they will be replicated and used more intensively in the new garden. Additional information on this work can be found in James, J., "New Maize x *Tripsacum* Hybrids for Maize Improvement," (Euphytica) 28, 239-247.

Too few hybrids have been produced between maize and sorghum, and results have been too variable to assess any degree of superior crossability. Those genotypes that have produced hybrids and new genotypic combinations are crossed each cycle in an attempt to establish their degree of crossability.

Increased efficiency in producing quantities of hybrids will require a greater understanding of the total system, and thus an input of basic research and specialist skills. CIMMYT restricts its direct involvement in these areas because it is felt that such work can be accomplished more effectively by collaboration with others who have the necessary expertise and facilities.

COLLABORATION WITH OTHER INSTITUTIONS

During 1978-79, CIMMYT's principal collaborative efforts were with:

(1) Dr. C.E. Green, University of Minnesota. A post-doctoral fellow was placed with Dr. Green to work on in-vitro culture techniques for use in the wide cross program. This research emphasized: (a) culturing very young embryos, to salvage as many viable embryos as possible (because more embryos die over time), and producing viable plants from such cultures, and (b) producing callus from plant explants, to be obtained with minimum damage to the plant (non-destructive sampling), for regenerating replicate plants of unique hybrid genotypes for experimentation.

(2) Dr. T.B. Rice, Pfizer Genetics, Groton, Connecticut. Pfizer's interest in obtaining drought tolerant materials led to their making of crosses between maize and sorghum. Two main areas of basic research related to this work are: (a) the improvement of tissue culture techniques to produce more hybrids. This work concentrates on the production of callus from embryos to

regenerate replicate plants directly from embryos, and (b) the biochemical identification of hybrids.

(3) Dr. B.J. Reger, United States Department of Agriculture, Athens, Georgia. Dr. Reger is interested primarily in producing hybrids between millet and sorghum, but maize is also included in her work. To increase the number of effective crosses, collaboration was begun on: (a) observation of alien pollen tube growth in millet, sorghum and maize, and investigating the effect of chemicals on this growth. (b) biochemical identification of inhibition, or lack of stimulation in stylar tissue before and after alien pollination, as compared with compatible pollinations.

MAIZE TRAINING

INTRODUCTION

During 1978 and 1979, 134 trainees from 33 countries gained new skills and experiences in CIMMYT's maize training program (table 1). They specialized in one of four areas: maize production research, maize improvement, experiment station operations, and maize quality laboratory techniques.

Table 1. In-Service Maize Trainees, 1978-1979

COUNTRY	Cycle			
	1978 A	1978 B	1979 A	1979 B
Afghanistan	2	2	2	
Bangladesh		2	2	1
Bolivia	1		1	1
Botswana		1		
Colombia	1	1		1
Costa Rica	1	1	2	2
Dominican Rep.				2
Ecuador	2		2	1
Egypt	2		1	
El Salvador		1		1
Ghana			1	1
Guatemala			1	
Haiti	1	1	1	1
Honduras			1	
India	4		1	
Indonesia		3		
Korea	1			
Malaysia			1	
Mexico		1	2	5
Nepal		5		
Nicaragua	3		1	4
Pakistan	1	1		1
Panama	1	2	3	
Peru	3	1	2	3
Philippines		1		1
Rwanda		1		
Syria		1		
Tanzania	3	6		4
Thailand			4	2
Turkey	2	1		2
Venezuela	1		1	
Zaire		3	3	3
Zambia	1	1		
	30	36	32	36

Almost all of the maize trainees come from jobs in some branch of their governments' agricultural organizations, usually research, extension, or credit institutions. Most have reached at least the Bachelor degree level in their studies, usually in an agricultural subject. They normally spend 3 to 6 months at CIMMYT.

This report provides a brief description of the training categories, plus a detailed outline of some of their activities in 1978 and 1979.

BASIC OBJECTIVES OF TRAINEE AREAS OF SPECIALIZATION

Ten years ago, the majority of trainees came to study maize improvement. Over the years, however, the number of trainees has greatly expanded, and today about 8 out of every 10 trainees specialize in maize production research.

All trainees have the same basic characteristics as maize production research trainees. However, because the other categories are fewer in number, they spend much of their time at CIMMYT working alongside selected members of CIMMYT's research staff. Most also spend a portion of their time with the maize production research trainees.

Maize Production Research

The main thrust of the production research training focuses on the strategy and development of a production research program. The aim is to provide experiences in planning and organization, plus considerable field experience in the implementation of such a program. Agronomic research is designed to identify and then investigate the factors most likely to pay off in farmers' fields. Maize production research trainees also participate in on-station research activities and obtain first hand experience in field operations used in the CIMMYT breeding programs, including seed preparation and treatment, as well as insect infestation. Trainees also play a part in selection of maize families that will continue in CIMMYT maize pools, or populations, or for the generation of experimental varieties.

Maize Improvement

Maize improvement trainees spend field time with CIMMYT maize breeders on CIMMYT's experiment stations. They obtain experience in all of the breeding techniques and materials used at CIMMYT headquarters and in the

The in-service training courses for production specialists are central to CIMMYT's efforts to assist national programs to strenghthen their production research activities. Trainees are exposed to a research methodology which first seeks to identify the agronomic and economic factors limiting maize production in a particular agroclimatic area and then, on a priority basis, to determine more profitable technological alternatives for maize production.

global maize improvement network coordinated by CIMMYT. The genetic background of these breeding techniques also is provided.

Usually there are about five maize improvement trainees per cycle, so that they can be accommodated within the regular activities of the CIMMYT maize breeding program. This field activity in the breeding program is interspersed with participation in the production research experiments and classwork more appropriate to their specialization in maize improvement. They become fully acquainted with the range of genetic materials and breeding procedures used in CIMMYT's maize improvement program. They also become conversant with the goals and methods of CIMMYT's global testing program. On their return home, most improvement trainees form a part of this global network.

Generally, the maize improvement trainees originate from and return to their national maize breeding programs. Their experience at CIMMYT exposes them to a greater variety of germ plasm and procedures than is possible in most national programs. Their awareness of the international fraternity of maize breeders is greatly enhanced while at CIMMYT. Their national programs should benefit from greater cooperative efforts on a regional and global basis.

Experiment Station Operations

Trainees in experiment station operations spend about 4 months at CIMMYT; they are frequently station

managers in their own countries. As they spend most of their time with CIMMYT's experiment station staff, they deal constantly with the requirements of the research program. They consider the design and development of experiment stations, land leveling, irrigation systems development, and all of the day-to-day operations of the experiment station that serves a vigorous research program. This work involves considerable hands-on experience with machinery for seed-bed preparation, seeding, weed control, cultivation, harvesting, etc. Most trainees do not come from monocrop stations in their own countries; thus, they are exposed to experiment station operations related to all crops grown on CIMMYT stations, including maize, wheat, sorghum, barley, triticale, and potatoes.

Maize Quality Laboratory Technology

Trainees in maize quality laboratory technology usually spend 3 months at CIMMYT; they either come from an established laboratory in their country, or they will return home to establish such a laboratory. The major interest in maize grain quality is in the development of varieties with improved nutritional quality. Such a breeding program requires a support laboratory to give the required amino acid readings quickly and accurately. CIMMYT has a very efficient laboratory serving an extensive breeding program for improved quality protein maize. Thus, these trainees spend most of their time working through all phases of the laboratory routines. They also spend some

132

time in the field with the breeders who are developing the maize varieties with improved nutritional quality.

TRAINING PATTERN FOR MAIZE PRODUCTION RESEARCH

Two groups each of 30 maize production research trainees arrive during the year. They spend 5 to 6 months at CIMMYT in one of the two training cycles that correspond with the maize growing seasons in Mexico. Each group contains representatives from 15 to 20 developing countries of Africa, Asia, and Central and South America.

Production research trainees work within the practical framework of a strategy applicable at their national program level—a strategy built around production research experiments conducted in farmers' fields. The research program is organized into a multi-staged production research system, which requires cooperation among several inter-related institutions (see the *Maize Improvement Report, 1976-77,* for an organizational chart of this production research system).

The system first seeks to identify the agronomic and socio-economic factors limiting maize production in a particular agroclimatic area; then, on a priority basis, it determines the technology for profitable maize production. This process involves both agronomic and socio-economic decision making.

Sample Trainee Schedule (1978-1979)

On arrival at CIMMYT, production research and improvement trainees spent one week in orientation at CIMMYT headquarters. They were briefed on the production research program that they would carry to the farmers' fields. They then moved directly to such fields in the Poza Rica-Tuxpan area of the Gulf Coast of Mexico.

The Poza Rica-Tuxpan area was selected for this training program because it typifies the home areas of many trainees from tropical lowlands. The major constraints to production in this area are similar to those faced by the trainees in their local environments.

The trainees were divided into 6 sub-groups, or teams, all members of any one group spoke either English or Spanish. The entire group was transported by bus to the sites of the on-farm experiments. At each individual site, each team laid out and planted one experiment.

The total group of production research trainees also participated in one or two further experiments, plus an experimental production plot of about 0.5 to 1 ha (which also serves as a seed multiplication plot). The preparation and marking of the experiments, as well as planting, fertilizing, and spraying of one site, usually required a full day. Excluding the experimental production plot, the area of the experiments at a site was about 3/4 to 1 ha. Six sites could normally be planted in a two-week period, weather permitting, with each team planting a different experiment at each of the six sites. Table 2 lists the titles of the experiments conducted during a typical cycle in 1978 and 1979.

Table 2. Experiments Conducted by Maize Production Trainees at CIMMYT in 1979.

Experimental Variety Trial
Quality Protein Maize Variety Trial
Variety x Production Inputs Experiment (Variety x Nitrogen x Insect Control x Density)
Basic Fertilizer Experiment (N x P x S x Zn)
Fertilizer Experiment (N x P)
Systems of Application of Fertilizer Experiment
Weed Control Experiment
Nitrogen x Weed Control Experiment
Insect Control Experiment
Variety x Density Experiment
Nitrogen x Density Experiment
Density x Spatial Distribution Experiment
Verification Trial
Experimental Production Plot

Many of the above experiments were conducted using zero tillage, as well as conventional tillage, to further broaden the experience of the trainees.

During a single cycle, any one team could not conduct all 14 experiments. However, each team was assigned a set of about 6 experiments that would provide experience with as many variables as possible. For example, in 1979, one team of trainees (including a representative each from Afghanistan, Ghana, Haiti, Thailand, and Zaire) participated in the following experiments: a Variety x Production Inputs Experiment; an Insect Control Experiment; a Basic Fertilizer Experiment; a Systems of Fertilizer Application Experiment; a Variety x Density Experiment; a Nitrogen x Weed Control Experiment; and a Verification Trial. In addition, this team worked with the entire group of trainees in conducting an Experimental Variety Trial (of the type CIMMYT distributes internationally) and planted a number of seed multiplication plots, both on and off station.

After the planting phase, the trainees continued to manage the field experiments, applying all further treatments, taking notes, and finally harvesting and obtaining yield data. This process involved frequent visits to the on-farm locations. Interspersed with the on-farm work were visits to CIMMYT's experiment stations to familiarize the trainees with all facets of CIMMYT's core program and its interaction with national programs around the world—including, of course, their own country.

Thus, in conducting this wide range of experiments, the trainees were exposed to various problems and variables that might be encountered in their own countries. Each trainee was responsible for every trial conducted by his team, and each was expected to be completely familiar with every experiment conducted during the season. They frequently had opportunities to explain all phases of the field program to visitors, including research administrators and policy makers from their own countries.

In the interval between flowering and harvest, trainees used data from previous training cycles in the statistical analysis, economic analysis, and agronomic interpretation of experiments similar to their experiments.

Following the harvest of the field experiments, the maize production research trainees spent their final weeks in analyzing the agronomic and economic data. When completed, the entire group met with the maize training agronomists and other CIMMYT staff for further agronomic and economic interpretation of the data.

As an exercise, recommendations for farmers of the zone were drawn up and the trainees developed plans for the production research experiments to be conducted in the next crop cycle. This interpretation of the data and the subsequent formulation of future plans was the final comprehensive step of the production research training process.

In addition to the contact with farmers whose land was used in the experiments, the trainees obtained further insight into the agriculture of the area by interviewing other farmers in the zone. These interviews were guided by CIMMYT's agricultural economists to demonstrate that a knowledge of farmers' circumstances is essential to the planning, execution, and interpretation of a program of on-farm experiments.

Although little machinery is employed in the field training, production trainees received a short course in mechanization provided in cooperation with a tractor manufacturer.

Additional Learning Experiences

Although field work is the core of the training program, the training has been designed to cover areas that complement the field operations. CIMMYT seeks to develop trainees with an ability to consider a gamut of appropriate plans and strategies for their countries in the realm of production research. Thus, building on the trainees' previous agronomic training, CIMMYT provided learning experiences in a number of areas, including agronomy, breeding, pathology, entomology, physiology, statistics and economics.

Because of the short duration of the production course, and because all subjects must be taught in both English and Spanish, the material cannot be too complicated or all-encompassing. Teaching is restricted to background material useful to the successful operation and interpretation of a field production research program. In most training cycles, this task is complicated by the fact that the trainees come from widely varied backgrounds of training and experience.

Training Trainers

The maize production research training program attempts to train "trainers" who can make production research decisions and train others in their own country. CIMMYT does not presume, however, to train all the maize production agronomists needed in the developing world.

The training effort is designed to be multiplied by the efforts of the trainee alumni in their own countries, and help supply the world-wide needs for maize production agronomists. In achieving this goal, CIMMYT training staff have traveled to the home countries of a few former trainees to assist them in the establishment of production training programs for research and extension staff within their own agricultural system. CIMMYT outreach staff also are involved in these activities in their country or region.

This strategy for maize production research developed by the CIMMYT maize training program has been adopted by a number of countries for crops other than maize—even for animal production research.

Contributions of Former Trainees

Most former trainees are involved in some facet of their national maize research, production, or extension programs. Many have risen to senior positions in their organizations. A small but steadily increasing number are working as production agronomist/trainers in their countries. CIMMYT hopes to see this trend continue. The development of production training programs is encouraged at the national level by commitment of a proportion of CIMMYT's headquarters training staff time (as well as that of its staff in national and regional programs) to active participation in such programs. CIMMYT training staff have participated in such programs in Ecuador, Panama, Costa Rica, Tanzania, Pakistan, India, Nepal, Dominican Republic, Nicaragua, Haiti, and Honduras.

Follow-up activities are sought with trainees in the other areas as well. Continuing work with former trainees in experiment station operations and maize quality laboratory technology is frequently crucial to successful establishment of a functioning experiment station or laboratory.

The trainees' continuing links with CIMMYT and other national programs are one of the major benefits of the overall training program.

MAIZE COOPERATIVE PROJECTS OUTSIDE MEXICO

More than 80 maize-growing countries participated in 1978-79 in a worldwide network which conducts maize trials and exchanges data. Several individual countries in the network have asked for staff assistance and CIMMYT has received special funds to provide this collaboration. Within this network, CIMMYT has established regional programs and assigned staff to serve collaborating countries in the major maize-producing areas of the developing world. Fifteen staff members were assigned to these cooperative projects during 1978-79, as described below.

NATIONAL PROGRAMS

A national maize program typically fulfills the following purposes: (1) to conduct research in local experiment stations, including participation in international trials; (2) to test improved varieties on local farmers' fields; (3) to multiply seed; (4) to provide additional training for maize scientists; and (5) to formulate national agricultural policies which encourage greater food production. In certain cases, at the request of collaborating countries and with special project funding, CIMMYT will assign staff to a national program to share in these purposes, including the testing of germplasm received from neighboring countries and from Mexico, and in the feedback of information to the network of scientists.

The following countries participated in cooperative arrangements with CIMMYT during 1978-79: Pakistan, Egypt, Nepal, Zaire, Tanzania, Ghana, and Guatemala (see table 1). Eight maize scientists were assigned to these seven programs. In late 1979, the CIMMYT scientist formerly assigned to the Egypt National Program was reassigned to the newly-created Mideast Regional Program, serving Egypt and other countries, with headquarters in Turkey.

REGIONAL PROGRAMS

CIMMYT's regional maize programs serve as a major link between regional groups of collaborators and CIMMYT. In several parts of the world, on an informal basis, a great deal of regional cooperation takes place among maize-growing countries. These arrangements help improve maize production through the open exchange of genetic material and research information.

Regional maize programs generally comprise neighboring countries in which maize is a major crop, grown under similar climatic conditions, exposed to similar diseases and insects, and therefore benefiting from continuous exchange of germ plasm and technology within the region.

Typically, a regional program will sponsor: (1) periodic workshops among maize scientists to review one year's research and plan the following year; (2) maize trials for the region; (3) visits of local scientists to neighboring countries; (4) training within the region; and (5) consultation by CIMMYT scientists.

In 1978-79, CIMMYT scientists shared in maize improvement in the following regions: Central America and Caribbean, South and Southeast Asia, and the Andean countries of South America. In late 1979, the Mideast Maize Regional Program was started, with one scientist assigned to the area.

Table 1. Cooperative projects with national programs, 1978-79.

Country	Start of CIMMYT arrangement	1979 Population (millions)	CIMMYT assigned staff	Approximate maize crop(tons)
Egypt	1968	40	1	2,938,000
Pakistan	1968	80	1	846,000
Zaire	1972	28	2	350,000
Nepal	1972	13	1	800,000
Tanzania	1973	17	2	900,000
Guatemala	1976	7	2	850,000
Ghana	1979	11	1	380,000

Source: FAO, 1979 Production Yearbook

Table 2. Regional maize programs, 1978-79.

Region and home base	Number of cooperating countries	1979 population (millions)	CIMMYT assigned staff	Approximate maize crop(tons)	Start of CIMMYT arrangement
Central America and Caribbean (Mexico)	13	37	2	2,450,000	1976-77 1977
South and Southeast Asia (India)	11	1,250	1	16,633,000	1976
Andean (Colombia and Ecuador)	5	81	3	2,866,000	1976

Source: FAO, 1979 Production Yearbook

135