

**CIMMYT
BREAD WHEAT
BREEDING
PROGRAM
GERM PLASM
MOVEMENT
AND
PLANTING PLANS**



**CENTRO INTERNACIONAL DE MEJORAMIENTO DE MAIZ Y TRIGO
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INTENCION

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short

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Introduction

The following is a brief description of the major domestic and international breeding and testing nurseries of the CIMMYT Bread Wheat Program written for the purpose of acquainting visiting scientists and trainees with the role of each nursery in CIMMYT's breeding scheme, how it is planted and what relationships it might have to other CIMMYT nurseries, both domestic and international. This explanation is not an attempt to explain CIMMYT breeding philosophies and is not a complete listing of all nurseries or all locations with which CIMMYT works.

CIMMYT breeding nurseries generally have Spanish names. Consequently, their abbreviations do not exactly match their English translations. International nurseries are given English names.

The CIMMYT Bread Wheat Program operates primarily in three Mexican locations. Ciudad Obregon (elevation 40 meters, 29° latitude north, temperature range from 0°C to 40°C) is located in the State of Sonora and is utilized for the winter breeding

role = papel
scheme = plan
attempt = intentar
to match = emparejar

cycle. Cd. Obregon offers environmental conditions which are conducive to maximum expression of yield potential. The screening of breeding material for leaf rust resistance is facilitated by the annual leaf rust epidemic which occurs throughout the Yaqui Valley. Cd. Obregon is a desert location and therefore is irrigated throughout the cropping season.

Toluca (elevation 2,640 meters, 19° latitude north, temperature range from -15°C to 20°C) is located in the state of Mexico near Mexico City. Natural infections of stripe rust are always heavy. Toluca is the site of CIMMYT's main summer breeding nursery, planted in May and harvested in October. However, the cold winter temperatures facilitate vernalization of fall-planted winter wheat nurseries which are used in the spring x winter crossing program.

El Batan, the location of CIMMYT headquarters, is also used as a screening nursery for stripe and leaf rusts. Like Toluca, El Batan is a summer nursery, planted in May and harvested in October.

The rainy season in Toluca and El Batan begins in mid June so nurseries at both sites are irrigated to facilitate germination and early seedling growth. However, rainfall is generally sufficient beginning in late June to negate the need for subsequent irrigation.

Nurseries at all three sites are needle-inoculated with stem rust and oil- and talc-inoculated with leaf and stem rust to supplement natural inoculum and as an educational aid for trainees.

In addition to the three breeding locations listed above, CIMMYT wheat pathologists plant summer nurseries in Patzcuaro, Michoacan to evaluate materials for resistance to *Septoria tritici* and *Septoria nodorum*; Refugio, Guanajuato to screen for stem rust; and winter nurseries in Rio Bravo, Tamaulipas and Los Mochis, Sinaloa for analysis of leaf rust resistance and Poza Rica, Veracruz for *Helminthosporium* screening.

Pedigrees in the CIMMYT Bread Wheat Program begin with an alphabetic designation of cross origin (CM = Mexican Spring x Spring cross, ICM = Mexican interspecific cross and SWM = Mexican spring x winter cross). These letters are followed by a cross number, for example 33027 is the numeric designation given to the cross which produced the cultivar 'Veery'. Following the cross number is either a letter or a number-letter combination. A letter indicates a single plant selection in the F1 generation from the top and double cross nurseries. In the number-letter combination, the number is used to designate a single plant selection from the F2 Masa nursery and the letter indicates the location of the selection. These are followed by a series of number letter combinations which identify individual selections by plant number and location of selection. For example, CM 6841-A-2Y-6M-500Ptz-0Y indicates that the spring x spring cross number 6841 was made by the bread wheat program in Mexico as a top or double cross. It was the first single plant selection made within the cross from the F1 top and double nursery (A). It was then grown in Cd.

Obregon and was the second selection from the F2 row (2Y). From there it was seeded in Toluca where it was the sixth F3 selection (6M). The following season it was grown in Patzcuaro where it was the first selection from the F4 progeny row to be pulled and transferred to the TN nursery (500 Ptz). Finally, it was grown again in Cd. Obregon where it was harvested in bulk in the F5 generation (0Y).

The only deviation from this system of pedigree designation appears in crosses made prior to 1970 where all crosses made by CIMMYT-Mexico were given a II designation. Thus II-8156, the cross which produced 'Siete Cerros', was made prior to 1970 by the CIMMYT Bread Wheat Program.

Although this report specifically outlines nurseries in the bread wheat breeding program, nursery names and purposes are essentially the same for the CIMMYT durum wheat, barley and triticale breeding programs. Nevertheless, exceptions such as the high lysine crossing block of the barley program and the primary-triticale nursery do exist.



CIMMYT Base Nurseries

CB-Spring: (Crossing Block-Spring Wheat) contains four to five hundred advanced lines and named cultivars of spring wheat for use as parents in the crossing program. Entries are arranged in the crossing block according to their previously identified genetic superiority for one or more traits. Currently, cultivars and lines are separated into the following groups; (1) high yield and/or wide adaptation (2)

resistance to *P. recondita* in Mexico (3) resistance to *P. striiformis* (4) resistance to *P. graminis tritici* (5) resistance to *Septoria tritici* (6) tolerance to aluminum toxicity (7) large, fertile spikes (8) large grain (9) good industrial quality for both bread and pastry production.

CB-Winter: (Crossing Block-Winter Wheat) composed of advanced lines and named cultivars of winter wheat for use as parents in the spring x winter crossing program. Entries in the CB-Winter are organized according to origin. Currently, lines and varieties in the CB-Winter originate from Chile and Argentina in South America; Washington, Oregon, Montana, Nebraska, Kansas, Oklahoma, Texas, Indiana, and New York in the USA; England, France, Italy, East and West Germany, Holland, Switzerland, Yugoslavia, Romania, Czechoslovakia, Poland and the Soviet Union in Europe; Japan, South Korea and the People's Republic of China in Asia; and Turkey. The CB-Winter is transplanted in Cd. Obregon in November after 45 days of artificial vernalization. The same nursery is sown in Toluca in November without artificial vernalization.

Misc.: (Miscellaneous) varieties and advanced spring wheat lines which CIMMYT has received from wheat programs outside Mexico either through responses to seed requests or as entries from such international nurseries as RDISN, RDTN, VEOLA, ELAR, ACWYT, SNACWYT and ISWRN. Lines in the Misc. nursery have been evaluated for disease

resistance and general agronomic quality for at least one growing cycle in the L.O. or some similar nursery at one of CIMMYT's Mexico locations and continue to be examined as possible parents for the crossing program.

L.O.: (Observation Lines) cultivars and advanced spring wheat lines which are newly received from various national programs. Cultivars in the L.O. are evaluated for disease resistance and general agronomic value and, if identified as prospective parents for crossing, are graduated to the Misc. or CB-Spring.

P.C.: (Small Increase Plots) newly bulked F5 through F8 lines from Ciudad Obregon are grown as PC's in El Batán and Toluca where they are evaluated for disease resistance and general agronomic performance. PC entries from El Batán and Toluca which perform well and newly bulked F5 through F8 lines from Toluca are grown in the P.C. nursery the following season in Ciudad Obregon. All entries in the Obregon PC nursery are simultaneously evaluated in replicated yield trials. Lines which exhibit high yield, rust resistance, good grain quality and resistance to lodging and shattering are made available to cooperators through the International Bread Wheat Screening Nursery.

Experiments: (Yield Trials) consist of advanced lines from the PC's which are potential candidates for the International Bread Wheat Screening Nursery. The experiments are yield tests grown only in

Ciudad Obregon. Each nursery in the Experiments consists of 30 entries and 3 replications with 2 check varieties. In addition to yield testing, all lines are evaluated for disease resistance and industrial quality.

IBWSN: (International Bread Wheat Screening Nursery) comprised of advanced lines which have exhibited superior yield, disease resistance, acceptable industrial quality and excellent general agronomic value through evaluation in the Obregon experiments. The IBWSN consists of 300 to 600 entries which are selected from approximately 2000 PC's. The nursery is sent annually to about 250 locations throughout the world in an attempt to make available to cooperators the most recently developed material from the CIMMYT breeding program as well as to assess the performance of IBWSN entries over a wide range of environments. Cooperators may use the material directly in their breeding program for crossing, may reselect material for further testing and eventual release or may directly release any entry, provided the country of origin is acknowledged upon commercial release. Only seed from the PC's grown in Cd. Obregon is used to assemble the IBWSN.

PMI: (International Multiplication Plots) seed multiplication plots of named cultivars and advanced lines submitted by cooperators in national breeding programs worldwide for inclusion in the ISWYN.

Out of more than 100 candidate cultivars, 49 are selected for the ISWYN. The PMI nursery is grown only in Cd. Obregon.

ISWYN: (International Spring Wheat Yield Nursery) contains forty-nine named cultivars and advanced lines (not all of which have been developed by CIMMYT) plus one local check variety (3 replications) sent annually to 120 locations throughout the world. Plot size, standardized at all locations, is 6 rows of 2.5 meters with the central 4 rows harvested for yield evaluation. Data is also collected on agronomic and pathologic characteristics and is returned to CIMMYT for analysis and subsequent publication. The ISWYN, started in 1964, was one of the first international yield nurseries. Its success has helped to provide the impetus necessary for the establishment of international nurseries in every major crop species by various international agricultural centers and national institutions. To date, the ISWYN has been one of the greatest driving forces in the dissemination of spring wheat germ plasm to all major wheat-producing regions of the world. It has assisted in the identification of widely adapted cultivars. This information has substantial significance in selection of parents in the CIMMYT crossing program.

P.M.: (Multiplication Plots) seed multiplication plots of the best lines from the CIMMYT breeding program which have proven potential for use as varieties in Mexico or other major wheat producing

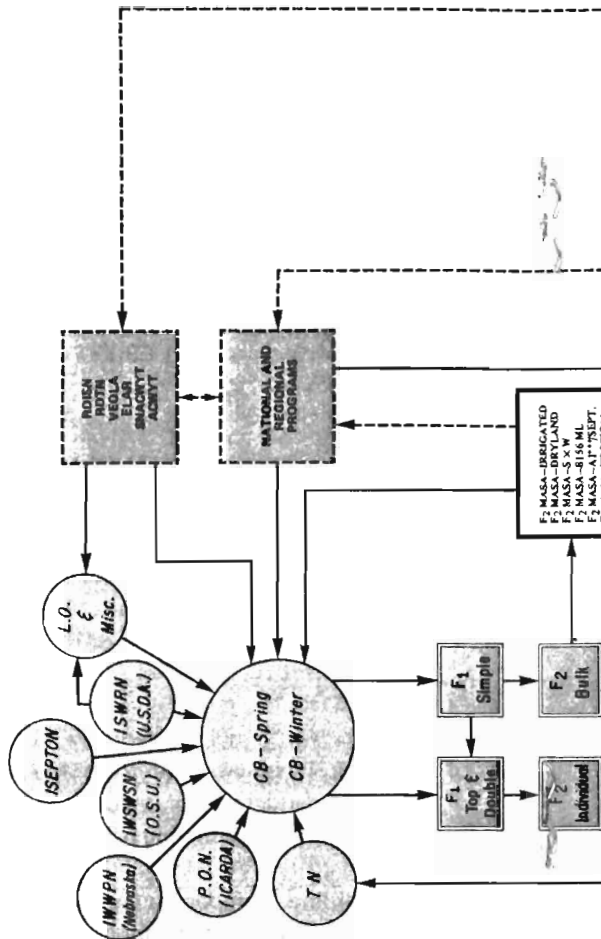
regions of the world. Lines in the PM nursery may be included in the ISWYN. More than 100 PM's are grown annually in Obregon. Seed stocks of all PM entries are maintained for 4 years.

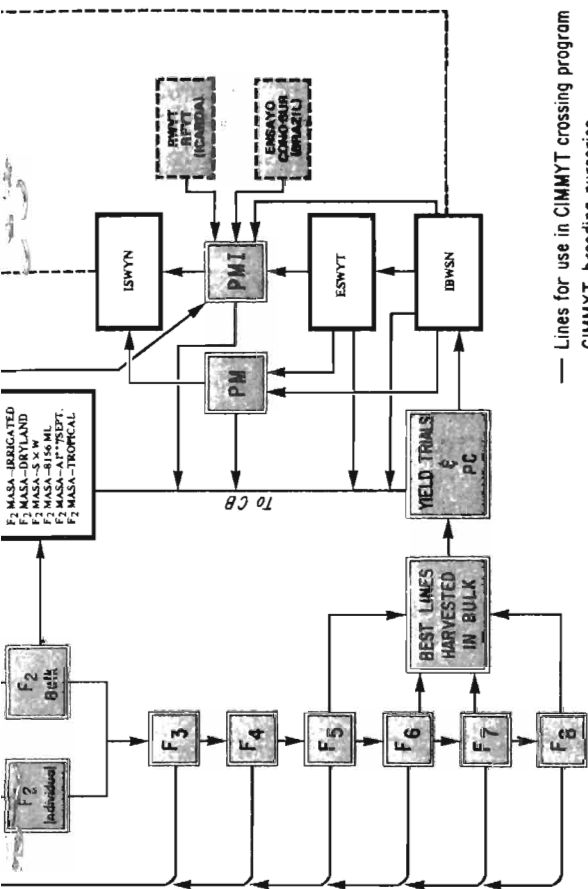
ESWYT: (Elite Spring Wheat Yield Trial) comprised of twenty-nine entries of the most advanced material from the CIMMYT breeding program which has exhibited high yield potential for two years in Obregon. Each entry is replicated 3 times and space is reserved for the inclusion of 1 national check variety. Seed for the ESWYT comes from the Obregon PM nursery. The ESWYT is sent annually to 30 select cooperators whose data help to identify suitable varieties for testing in the ISWYN.

ISEPTON: (International *Septoria* Observation Nursery) consists of advanced lines including entries in the PC, IBWSN and CB-spring which are tested annually in Patzcuaro, Michoacan by CIMMYT wheat pathologists for resistance to *Septoria tritici* and *Septoria nodorum*. The resistant lines with acceptable plant type are included in the ISEPTON. The ISEPTON is distributed internationally to cooperators who regularly report a high incidence of *Septoria* infection. The most highly resistant lines with adequate agronomic characteristics are recycled through the crossing program.

ML. : (Multiline Component Nursery) an evaluation nursery of prospective components for the 8156 multiline. Analysis is based on plant type and disease

FIGURE 1. MOVEMENT OF GERmplasm IN CIMMYT BREAD WHEAT BREEDING PROGRAM





- Lines for use in CIMMYT crossing program
- == CIMMYT breeding nurseries
- CIMMYT international nurseries
- National and CIMMYT regional programs

resistance. The ML nursery is distributed internationally to 30 locations where Siete Cerros is well adapted in order to stabilize resistance to leaf rust.

T.N. : (New Bulls) progeny of F3 through F8 single plant selections made on the basis of exceptional plant type and disease resistance. New bulls are used as pollen parents in the CIMMYT crossing program.

F1 Simple : First generation progeny of simple crosses (variety or advanced line x variety or advanced line). The crosses are arranged both in the books and in the field according to the characteristic or region for which the cross was made. For example, if one of the sisters of the advanced line 'Bobwhite' had been identified as being resistant to *Septoria tritici* in Algeria and it was crossed the previous breeding cycle to the advanced line 'Veery', the F1 seed would be planted in the North Africa section of the F1 Simple Nursery.

F1 simple crosses are advanced to the F2 bulk nursery if they exhibit resistance to diseases in the location in which they are being grown. They also serve as parents for top and double crosses.

F1 Top and Double: First generation progeny of top crosses (F1 x variety or advanced line) and double crosses (F1 x F1). Individual plant selections are advanced to the F2 Individual Nursery.

F2 Bulk : Progeny of selected, bulk-harvested entries

in the F1 Simple nursery. Entries in the F2 bulk nursery are categorized according to known or suspected agronomic or pathologic characteristics. Lines in each category comprise a single international nursery which is distributed to cooperators in appropriate locations. Present F2 bulk categories include irrigated, dryland, spring x winter, 8156 multiline, aluminum/*Septoria* resistant and tropical.

F2 Individual : Progeny of single plant selections from the F1 Top and Double nurseries. Selections are made on the basis of plant type and disease resistance, single plant selections are advanced to the F3.

F3-F8 : Breeding nurseries in which evaluations are made on plant type and disease resistance. Single plant selections are made in the F3 through F7 generations whereas bulk selections are made in the F5 through F8 generations. Exceptional single plants may be selected in the F2 through F8 nurseries and advanced to the T.N. Nursery. Bulk selections are yield tested in the experiments and seed is concurrently increased in the PC's.

CIMMYT REGIONAL NURSERIES

RDISN : (Regional Disease and Insect Screening Nursery) comprised of approximately 2400 advanced lines of bread wheat, durum wheat, barley and triticale which originate from national breeding programs and international research centers. The



nursery is distributed through ICARDA by CIMMYT's regional wheat pathologists in the Eastern Hemisphere. Disease resistant selections are used by CIMMYT either directly as parents for crossing or are advanced to the L.O. or Misc. nurseries for further observation.

RDTN : (Regional Disease Trap Nursery) consists primarily of commercial varieties, susceptible check varieties, important sources of disease resistance, promising new varieties and disease differentials. In addition to providing cooperators the opportunity of testing material over a wide array of environments and under a variety of pathogen race-regimes, commercial varieties, which act as the selective forces on disease organisms, facilitate the surveillance of pathogen race changes throughout the region. This "early warning" system may serve to apprise countries of the appearance of pathogens virulent on their major commercial varieties before it reaches their country.

The RDTN is sent annually to 150 locations in 50 countries primarily in the Middle East, North Africa and the Indian Subcontinent. As with the RDISN, the RDTN is a joint CIMMYT/ICARDA regional nursery distributed by CIMMYT's regional wheat pathologists for the Eastern Hemisphere. RDTN disease resistant selections enter the CIMMYT breeding program in the same manner as RDISN selections.

VEOLA : (Latin American Wheat Disease and Observation Nursery) consists of approximately

1000 varieties and advanced lines of bread wheat, barley and triticale which originate in Latin American national programs and CIMMYT. The VEOLA is the Western Hemisphere equivalent of the RDISN and is assembled by the cooperative CIMMYT/INIAP Andean Region Program in Quito, Ecuador. In addition to supplying regional disease information the VEOLA facilitates germ plasm exchange between cooperating countries. Disease resistant selections are used by CIMMYT either directly as parents or are transferred to the L.O. or Misc. nurseries for further observation.

In both the RDISN and VEOLA the outstanding lines or varieties of the respective nurseries are, in the following year; grown in the other nursery to provide worldwide exchange of materials.

ELAR : (Latin American Rust Nursery) contains commercial varieties, advanced lines, rust differentials and near-isogenic lines which originate from breeding programs throughout the Western Hemisphere. The ELAR is assembled and distributed by CIMMYT's regional wheat program in the Andean Region, Quito, Ecuador as the Western Hemisphere equivalent of the RDTN. The objective of the ELAR is to survey virulence patterns of wheat pathogens which are known to be of international significance, to identify disease "hot spots", to identify race origins of pathogens and to serve as an early warning system for new mutations of pathogens.

ACWYT : (African Cooperative Wheat Yield Trial)

advanced lines selected by CIMMYT's East Africa Regional Program; the Kenyan national wheat research program in Njoro, Kenya and by country programs of the East African region. CIMMYT has grown only representative cultivars for the evaluation of disease resistance in Mexico.

SNACWYT : (East African Screening Nursery) advanced lines from East African national programs assembled by CIMMYT's East Africa Regional Program and the Kenya national wheat research program in Njoro, Kenya. CIMMYT grows the SNACWYT in Toluca and El Batan and advances the top-performing lines to the CB-spring for crossing or to the Miscellaneous for further observation.



OTHER INTERNATIONAL NURSERIES:

ISWRN : (International Spring Wheat Rust Nursery) the ISWRN, the first international crop nursery, was initiated as a result of the 1950 stem rust epidemic in the United States. It is assembled by the U.S.D.A. and distributed to more than 70 locations throughout the world. Advanced lines and released varieties from all areas of the world are included. CIMMYT, an ISWRN cooperator since the inception of the nursery, relies heavily on nursery results to help strengthen rust resistance, particularly stem rust resistance, in bread wheat. CIMMYT wheat pathologists are also cooperators with the IWWRN; the International Winter Rust Nursery.

IWWPN : (International Winter Wheat Performance Nursery) consists of thirty commercial varieties and advanced lines of winter wheat which originate from winter wheat breeding programs worldwide. The IWWPN is administered by the University of Nebraska. Widely adapted varieties from the IWWPN are used by CIMMYT in the winter x spring crossing program.

IWSWSN : (International Winter x Spring Wheat Screening Nursery) a cooperative nursery between Oregon State University and CIMMYT which is intended for the distribution of winter x spring derived lines to major winter wheat regions of the world. O.S.U. has the mandate to produce advanced lines of winter wheat derived from winter x spring, (winter x spring) x winter and (winter x spring) x (winter x spring) crosses. O.S.U. uses three nursery locations (Hyslop, Moro and Pendleton, Oregon) to evaluate lines for wide adaptation. CIMMYT is responsible for synthesizing all the winter x spring simple crosses which are used by O.S.U. as top and double components. Currently, the IWSWSN is distributed to more than 70 locations throughout the world. O.S.U. collects, analyses and distributes all data received from cooperators. CIMMYT uses this data to assist in the planning of spring x winter simple crosses.

RWYT : (Regional Wheat Yield Trial) twenty-four commercial varieties and advanced lines (4 replications) selected on the basis of superior

performance in the Mideast and North African region. The RWYT is an ICARDA regional nursery. RWYT top-performing entries are entered in CIMMYT's CB-spring nursery and are also included in the ISWYN to test their broad adaptation.

RFWYT : (Rainfed Wheat Yield Trial) twenty-four commercial varieties and advanced lines (4 replications) selected by ICARDA from its rainfed PON as well as the best adapted commercial cultivars from rainfed areas of the region. Selections enter the CIMMYT bread wheat program in the same manner as RWYT selections.

PON : (Preliminary Observation Nursery) advanced lines selected in countries of the Mideast, Asia and Africa. Many PON entries originate from CIMMYT's IBWSN and ISWYN. The PON is an international nursery which is assembled and distributed by ICARDA. The best performing lines from the PON enter the CIMMYT breeding program through the C.B.-Spring or Miscellaneous nurseries.

Ensayo Conosur : (Southern Cone Trial) thirty commercial varieties and advanced lines replicated three times. The Ensayo Conosur is assembled and distributed by EMBRAPA, the Brazilian Agricultural Research Organization, and consists of entries adapted to the southern cone region of South America. Selections from Ensayo Conosur are used directly in the CB-spring.

**PLANTING PLAN OF CIMMYT BREAD WHEAT NURSERIES
CD. OBREGON, TOLUCA AND EL BATAN^{1/}**

Nursery ^{2/}	LOCATION ^{3/}			Comments
	Cd. Obregon	Toluca	El Batan	
CB-spring	4R2M	4R2M	4R2M	Planted on 3 dates 10 days in succession.
CB-winter	4R2M	4R2M	-	Planted on 2 dates 10 days in succession.
Misc.	2R2M	2R2M	2R2M	Solid seeded
L.O.	2R2M	2R2M	2R2M	Solid seeded
P.C.	4R11M	2R2M	2R2M	Solid seeded
Experiments	4R5M	-	-	Solid seeded
IBWSN	2R2M	2R2M	2R2M	Solid seeded
PMI	20R11M	-	-	Solid seeded
ISWYN	6R2M	6R2M	6R2M	Solid seeded
PM	60R11M	-	-	Solid seeded
ESWYT	6R3M	6R3M	6R3M	Solid seeded
ISEPTON	2R2M	2R2M	2R2M	Solid seeded
ML	2R2M	2R2M	2R2M	Solid seeded
TN	2R2M	2R2M	2R2M	Solid seeded
F ₁ Simple (PS + B)	2R3M	2R3M	-	Space planted
F ₁ Top & Double (PS)	4R5M	4R5M	-	Space planted
F ₂ Bulk (PS)	2R11M	2R11M	-	Space planted
F ₂ Individual (PS)	2R2M	2R2M	-	Space planted
F ₃ & F ₄ (PS)	2R2M	2R2M	-	Space planted
F ₅ (PS + B)	3R3M	2R2M	-	Space planted
F ₈ (B)	3R3M	2R2M	-	Space planted
RDISN	1R1M	1R1M	1R1M	Solid seeded
RDTN	2R2M	-	-	Solid seeded
VEOLA	1R1M	1R1M	1R1M	Solid seeded
ELAR	2R2M	-	-	Solid seeded
ACWYT	-	2R2M	2R2M	Solid seeded
SNACWT	-	2R2M	2R2M	Solid seeded
ISWRN	2R1M	2R1M	2R1M	Solid seeded
RWPN	-	6R2M	-	Solid seeded
RWSN	2R2M	2R2M	-	Solid seeded
RWYT	6R2M	-	-	Solid seeded
RFWYT	6R2M	-	-	Solid seeded
PON	6R2M	-	-	Solid seeded
Enoyo Conocer	6R2M	-	-	Solid seeded

^{1/} May vary according to land availability. Reserve seed of all lines and varieties maintained for 2 years. All reserve seed is planted for all selected F₁'s for use in top and double crosses.

^{2/} Letters in parentheses indicate method of harvesting.
PS = Individual plant selection; B = Bulk.

^{3/} Planting designations give the number of rows first and row length second.
For example: 2R2M = 2 rows of 2 meters.

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