CIMMYT

Managing Trials and Reporting Data for CIMMYT's International Maize Testing Program

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Introduction

This bulletin contains information and guidelines on managing trials and collecting data for CIMMYT's International Maize Testing Program. The four types of trials that make up this program—International Progeny Testing Trials (IPTTs), Experimental Variety Trials (EVTs), and CIMMYT Hybrid Trials (CHTs)—are the principal means by which the Center and its cooperators in national research programs combine their efforts to evaluate maize germplasm over a wide range of growing conditions in some 80 countries.

The development and delivery of this technology begins with recombination and improvement, under fairly mild selection, of the Center's 33 maize gene pools, large reservoirs of genetic variability that are classified according to zone of adaptation, maturity period, and grain type and color. From the most promising materials in these pools, our scientists have derived 23 advanced populations that are superior in yield and other attributes. In a continuous, cyclical process (illustrated in Figure 1 on page 4), these populations are undergoing further improvement and being made available to cooperators in national programs through the IPTTs.

In each IPTT the full-sib or half-sib progenies of a particular population are tested at a minimum of six locations around the world. In a given year, about 15 populations are tested. The results of those trials are used for two purposes. First, based upon information provided by the trial cooperators, CIMMYT scientists select the best 50-60 families for within-family improvement, recombination, and regeneration of each population for the next cycle of improvement.

The second and more important use of IPTT results is for the development of experimental varieties (EVs), some of which are derived from the 10 best families at each location and others from the 10 best families across locations. These varieties are advanced to the F_2 stage and dispatched to cooperators in the form of EVTs, each of which is evaluated at 30-50 locations.

Information gathered from the IPTTs is extremely useful to us in continually improving the maize populations. But the primary beneficiaries of this and the other types of trials are the participants in the testing program. Each cooperator's data are analyzed at the Center and promptly returned to him or her, and the results for all trials are published and distributed to every cooperator in a preliminary and a final report. With this information maize breeders in national programs then decide whether to use superior germplasm as introductions in breeding nurseries or as potential varieties that could be tested in farmers fields and eventually released.

CIMMYT will send reasonable quantities of this germplasm to cooperators free of charge upon request. They are then free to use the seed in any way that suits the requirements of their programs. We ask only that cooperators acknowledge the origin of the seed, so that we can document the use of this germplasm in national programs. Every possible precaution is taken to ensure that the seed sent to cooperators is healthy and disease free (for details on seed health, refer to pages 18-20).

The value of the information generated by the International Testing Program, and ultimately the progress of the germplasm improvement work, depend to a large extent upon the care with which cooperators conduct the trials and the accuracy with which they record their data. For that reason please give close attention to the information and guidelines presented in the following pages.

In each IPTT, full-sib or half-sib progenies of a particular CIMMYT maize population are tested at up to five locations by cooperators in national programs and at one location in Mexico by our scientists. The information gathered on yield, adaptation and resistance to diseases and insects is used at CIMMYT to select progenies for recombination and to form experimental varieties.

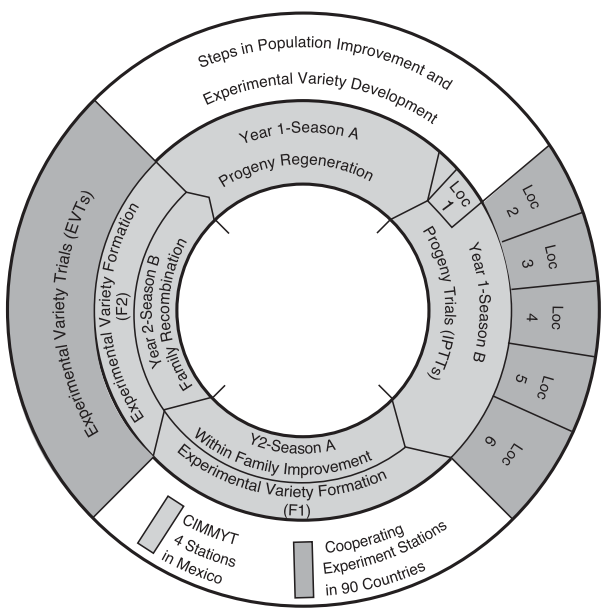

Figure 1. Flow of improved germplasm from population improvement through the international testing program.

International Progeny Testing Trials

Experiment Design

Each trial contains a total of 196 entries, including 190 progenies and 6 checks. The entries should be tested in a 14 x 14 simple lattice design with two replications. We recommend the field layout shown in Figure 2, which is highly suitable for the experimental design. In this layout each replication is two blocks wide and four double ranges long. Each block contains 14 rows, and the double ranges are commonly separated from one another by narrow alleys. Border rows, having materials of the same plant height and maturity as the materials being tested in the IPTTs, are planted on both sides of the trial to eliminate border effects in the edge plots.

To facilitate planting, the packets in your seed shipment are arranged by plot number in the exact order in which the material should be grown in the field.

If it is not possible for you to plant the trial according to our recommended design, please send a detailed map showing how it was planted with the data you return to CIMMYT for analysis.

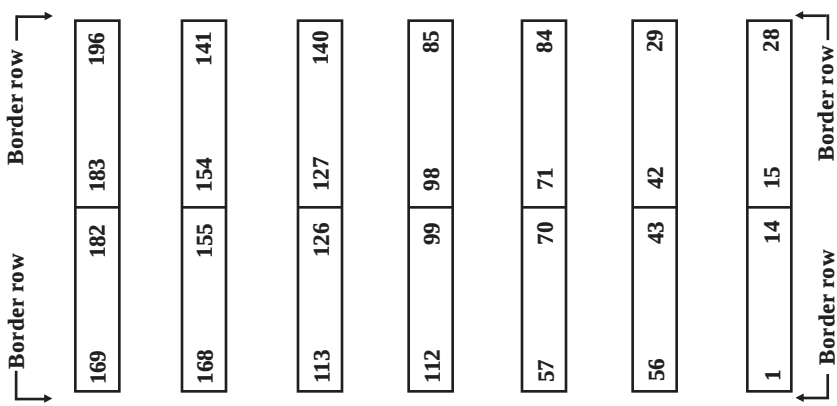

Figure 2. Recommended field layout for IPTTs. These trials have a 14 x 14 simple lattice design with two replications (only one replication is shown here). Each replication of the 196 entries is two blocks wide and seven ranges long. There are 14 rows in each block, and the seven ranges are separated by alleys. The border rows eliminate border effects in the edge plots.

Plot Size

To realize full expression of yield potential and other agronomic characters, the trial should be planted at optimum density. In trials at CIMMYT's test sites in Mexico, the density is 53,000 plants per hectare in a perfect stand. The materials are grown in one-row plots 5 m long at row-to-row spacing of 75 cm and hill-to-hill spacing within rows of 50 cm. These dimensions are considered appropriate with respect to maturity and plant height in Mexico.

Each seed packet in your shipment should contain 33 seeds for planting a one-row plot. We recommend that you plant three seeds per hill and **thin to two.** A perfect stand will have 11 hills, or 22 plants, per row.

If the row width at your research station differs from that at CIMMYT's test sites, retain your own row-to-row distance, but be sure to adjust the hill-to-hill spacing or row length to obtain a plant density of 53,000 per hectare. If you do so, enter the plot length and hill dimensions in the field too, so we can calculate the plant density and plot size correctly. Table 1 lists the row dimensions that will give an approximate density of 53,000 plants per hectare.

Please note: Maize materials can vary in height and maturity from one test location to another. Where there is such variation, adjust the plant density to the level you consider most appropriate. Again, be sure to record the plot dimensions, so we can calculate plot size accurately.

Table 1. Dimensions for obtaining a density of 53,000 plants per hectare.

Row-to-row distance (cm)	With 1 plant/hill		With 2 plants/hill	
	Hill-to-hill distance (cm)	Row length (m) (for 22 plants)	Hill-to-hill distance (cm)	Row length (m) (for 22 plants)
65	29	6.09	58	5.8
70	27	5.67	54	5.4
75	25	5.25	50	5.0
80	24	5.04	48	4.8
85	22	4.62	44	4.4
90	21	4.41	42	4.2
95	20	4.20	40	4.0
100	19	3.99	38	3.8

Local Check Varieties

The term “local checks” is used here to indicate leading maize varieties available in the national breeding program or from some other organization within the country. As mentioned previously, each IPTT tests two local checks, which are replicated twice. Four empty envelopes are provided in your shipment for seed of these varieties. Place 22 seeds of individual checks in each of two envelopes.

Since check varieties are grown in one-row plots, their maturity and plant height should be similar to that of the progenies, and they should have good seed quality. The progenies are treated at CIMMYT with a combination of a systemic insecticide (Furadan) and protective fungicide (Thiram), details of which are given on pages 19-20. If possible, apply a similar seed treatment to the check varieties to ensure that they are evaluated reliably.

Be sure to record the name of the local checks in the field book you send to CIMMYT for data processing.

Experimental Variety Trials and CIMMYT Hybrid Trials

Experimental varieties formed on the basis of IPTT results are tested for the first time in EVTs. These trials are organized according to their adaptation (tropical, subtropical, or highland), maturity (early, intermediate, or late), and grain color (white or yellow).

CIMMYT hybrid trials (CHTs) were introduced in the International Testing System in 1994. These trials are grouped according to adaptation and grain color.

Experimental Design

Each EVT includes 15-20 experimental varieties plus 2 reference checks and 2 local checks. Each CHT includes up to 16 CIMMYT experimental hybrids, 1 common check hybrid, 1 EV check, and 2 local check hybrids. For the three types of trials, we use a randomized complete block design (RCB) with four replications.

To facilitate planting, the seed packets are arranged by plot number in the exact order in which the materials should be grown in the field.

Please send a detailed map showing the layout of your trial with the data you return to CIMMYT for analysis.

Plot Size

EVTs and CHTs should be grown in two-row plots. At CIMMYT the rows are 5 meters long with row-to-row spacing of 75 cm and hill-to-hill spacing within rows of 50 cm, giving 11 hills per row. Each seed packet contains 66 seeds for one plot. We plant three seeds per hill and later thin to two plants per hill. A perfect stand should therefore have 22 plants per row, or 44 plants per plot, and a density of 53,000 plants per hectare.

Should this arrangement prove unsuitable at your research station or site, adjust the row width, row length, hill spacing, and plant density as you consider appropriate for the material being tested. Please record these dimensions in the field book, so we can calculate the yields accurately.

Local Checks

In EVTs and CHTs, elite varieties or hybrids are compared with superior maize varieties or hybrids available in the national breeding program or from some other organization in the country. For that purpose eight empty envelopes are included for two local checks, which should be replicated four times. Place 66 seeds of individual check varieties in each of four envelopes.

Seed of these varieties should be of the highest quality to ensure that their performance in the trial truly reflects their genetic potential. As a further guarantee of accurate germplasm assessment, a combined seed treatment of a systemic insecticide (Furadan) and a protective fungicide (Thiram) is applied at CIMMYT to the EVs and reference checks (details of which are given on pages 19-20). We encourage you to treat seed of local checks with the same or a comparable insecticide and fungicide.

Be sure to enter the names of the local check varieties in the field book you return to CIMMYT.

Managing Trials

The best results are obtained from trials planted on fields that have uniform soil and are far away from trees. Well-chosen fields are particularly important for large trials like the IPTTs, though the effect of soil variation on the results of these trials can be much reduced through good field layout and the use of a lattice design (see the suggested field layout for IPTTs in Figure 2 on page 5).

EVTs and CHTs are tested in a randomized complete block design. The layout of the blocks, or replications, will depend on obvious fertility trends or other gradients and on your experience with the plot.

At this stage of testing, it is a good idea to apply appropriate fertilizers to bring out the full genetic potential of the varieties. Generally, nitrogen should be applied at a rate of 100-200 kg / ha; the rates for other nutrients will vary according to location. At a later stage, the materials can be tested under less ideal management that may resemble more closely the practices of the average farmer around the test location. If you prefer, however, you can conduct the EVTs and CHTs under local management conditions to make the trial results more immediately relevant to farmers. In either case, protect the trial from birds and animals since variable damage by these pests can ruin the experiment.

Collecting Data from Trials

General instructions

A duplicated field book containing forms for recording observations and data is included in your seed shipment. The characters or traits to be recorded are described on pages 12-17. You need not record data for every character; select the ones that are most important for your purposes and that relate to obvious differences among entries.

Please **take notes on each entry in each replication.** If no data are recorded for a plot, it will be assumed that these are missing values. At present CIMMYT does not have computer programs that can account for missing values.

To help us avoid delays and errors, record data directly in the field book, not in a second notebook, from which the data would later have to be copied into the field book. As a further safeguard against errors in entering and analyzing your data on the computer, please write the information as clearly and neatly as possible.

As soon as the final harvest data are recorded, the green copy of the form, marked "TO BE RETURNED," should be airmailed to CIMMYT. Keep the yellow original, marked "FOR COOPERATOR," for your own records and analysis.

In addition to the green copy of your field book, please return to CIMMYT the three items listed below, all of which are included with your seed shipment:

1. The trial summary sheet, which includes the trial number, test location, check names, cooperator name, and address to which we should mail completed trial analysis. Data analysis should take 1 to 2 weeks, or possibly longer, depending on our workload.

2. The three-page form headed "General Notes to Be Taken," which gives detailed information about the research station's location, the planting date, fertilizer applied, weather, and plot sizes and other observations on the crop cycle. This information will help us interpret your results and will provide a basis for grouping tests environments in across-site analysis.

3. The form headed "Daily Rainfall and Temperature Record During the Growth of the Crop." This information is essential in calculating growing degree days and available moisture during critical stages of maize growth.

Variables to be Recorded

The following sections give instructions for collecting data on various characteristics of maize being tested in the international trials (the subheading for each trait is accompanied by the exact trait designation that appears in the

field book). For IPTTs, which are grown in one-row plots, record data on the **whole row**. For EVTs and CHTs record data for **both rows** of each plot.

Plant stand (PT ST)—In IPTTs this is the number of plants per one-row plot and for EVTs and CHTs the number in the two center rows of each four-row plot. Plant stand count is particularly useful at locations where certain viral diseases or downy mildew are present. Determine plant stand approximately 3 weeks after planting, and enter this data in the column designated "PT ST". Plant stand should be recorded after thinning.

Days to flowering (DAYS TO FLOWER)—Record the number of days from planting until the date on which 50% of the plants in a plot have silks 2-3 cm long. You may, in addition, record the days to 50% pollen shed. If you do so, write "days to pollen" either in the "days to flower" column or in a blank column, so we will code the information.

Plant height (HEIGHT PLANT)—For 5-10 plants selected at random, measure the distance from the plant base to the point where the tassel starts to branch. Alternatively, you may estimate this distance for each plot using a measuring rod. Record the plant height in centimeters.

Table 2. Diseases causing local lesions on maize leaves.

Code	Common name	Pathogen
a.	Anthracnose	*Colletotrichum graminicola*
b.	Gray leaf spot	*Cercospora zeae-maydis*
c.	Curvularia leaf spot	*Curvularia* spp.
d.	Maydis leaf blight	*Helminthosporium maydis*
e.	Turcicum leaf blight	*H. turcicum*
f.	Helminthosporium leaf spot	*H. carbonum*
g.	Leaf blight	*Helminthosporium* spp.
h.	Banded leaf and sheath blight	*Hypochnus sasakii*
i.	Yellow leaf blight	*Mycosphaerella/Phyllosticta*
j.	Eyespot	*Kabatiella zeae*
k.	Tarspot	*Phyllachora maydis*
l.	Brownspot	*Physoderma maydis*
m.	Tropical rust	*Physoderma maidis*
n.	Common rust	*Puccinia sorghi*
o.	Southern rust	*P. polysora*
p.	Rust	*Puccinia* spp.
q.	Leaf disease	Unknown

Ear height (HEIGHT EAR)—For the same 5-10 plants whose height you have measured, also determine the distance in centimeters from the plant base to the node bearing the uppermost ear. Again, you may estimate this distance for each plot. Plant height and ear height can be measured any time between 2 and 3 weeks after flowering until just prior to harvest, depending on your work schedule.

Diseases (DISEASES)—To get an accurate rating of disease severity, take notes on damage late in the growing season but before the leaves begin turning brown. Rate the damage in each plot, concentrating on the diseases that are important in your region. If possible, give the scientific name of the disease pathogen. For assistance in disease identification, consult the CIMMYT publication entitled *Maize Diseases: A Guide for Field Identification*, copies of which are available upon request.

Infection by the foliar diseases listed in Table 2 should be rated on a scale of 1 to 5, where 1 indicates no diseases and 5 very heavy infection. Record the score in whole numbers or in halves. The standard rating scale for most major foliar diseases, such as the blights and the rusts, is shown in Figure 3.

To indicate the extent of damage caused by the diseases listed in Table 3 (page 14), record the number of plants affected per plot.

Insect damage (INSECTS)—If the trial has been treated with an insecticide to control a particular pest, do not record data on damage by that insect. Nor is it worthwhile to take data on insect damage that is not very evenly distributed among entries in a trial, as is frequently the case. If there are large differences

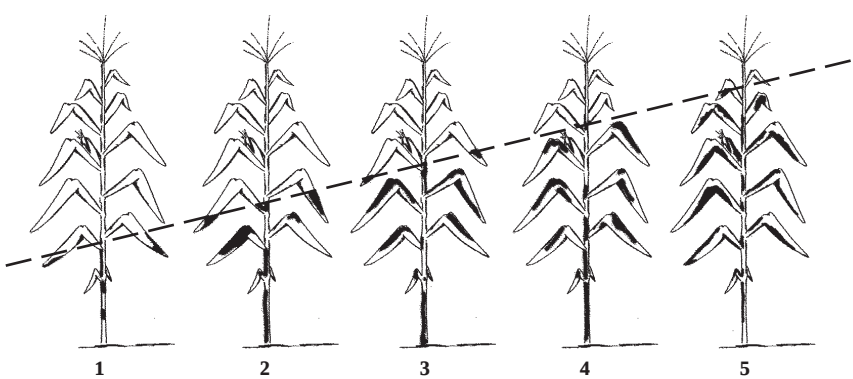

Figure 3. Rating scale for foliar diseases.

in insect damage between entries, rate the damage on a scale of 1 to 5, where 1 indicates no damage and 5 very heavy infestation. Record the score only in whole numbers, and list the pest's scientific name on the form "General Notes to be Taken."

Plant aspect (PT ASP)—Data on this trait should be taken at the brown husk stage, when plants are still green and the ears are fully developed. For each plot, rate characteristics such as plant and ear height, uniformity of plants, disease and insect damage, and lodging on a scale of 1 to 5, where 1 is excellent and 5 poor. Record these scores only in whole numbers in the column headed "PT ASP."

Root lodging (LODGING ROOT)—Data on root and stalk lodging should be taken late in the season just before harvest. Record the number of plants that are leaning 30º or more from the perpendicular at the base of the plant where the root zone starts.

Stalk lodging (LODGING STALK)—Record the number of plants with stalks broken below the ears but not above the ears. There may be some weak plants that have poor stalk quality, but which have not yet lodged. To identify these push the stalks gently. Plants which then fall over should be counted

Table 3. Diseases to be recorded by plant count.

Code	Common name	Pathogen
aa.	Corn stunt disease	Spiroplasma
bb.	Maize bushy stunt disease	Mycoplasma
cc.	Maize dwarf mosaic virus	Virus
dd.	Fine stripe	Virus
ee.	Maize streak	Virus
ff.	Maize mosaic virus	Virus
gg.	Virus disease	Unknown
hh.	Late wilt	*Cephalosporium maydis*
ii.	Anthracnose	*Colletotrichum graminicola*
jj.	Charcoal rot	*Macrophomina phaseoli*
kk.	Fusarium stalk rot	*Fusarium (Gibberella)* spp.
ll.	Pythium stalk rot	*Pythium* spp.
mm.	Diplodia stalk rot	*Diplodia maydis*
nn.	Black bundle disease	*Cephalosporium acremonium*
oo.	Bacterial stalk rot	*Erwinia chrysanthemi*
pp.	Stalk rot	Unknown
qq.	Downy mildew	*Peronosclerospora* spp.
rr.	Downy mildew	*Sclerophthora* spp.
ss.	Unknown (downy mildew)	Unknown
tt.	Commot smut	*Ustilago maydis*
uu.	Head smut	*sphacelotheca reiliana*

as stalk-lodged plants. Enter data on stalk lodging separately from that on root lodging, since a particular plant might be both root lodged (leaning more than 30^{o}) and stalk lodged (broken below the ear).

Husk cover (HK COVER)—Before harvest record the number of ears in each plot that have any portion of the ear exposed. At CIMMYT we will convert this figure into a percentage of poor husk cover by dividing it by the total number of ears harvested. Also, for each plot rate materials for husk cover on the 1-to-5 scale described below and illustrated in Figure 4. Score entries on this trait when ears are fully developed and the husk is drying down. The best time is 1-3 weeks before harvest.

Rating scale		Husk cover
1	Excellent	Husk tightly covers ear tip and extends beyond it.
2	Fair	Covers ear tip tightly.
3	Exposed tip	Loosely covers ear up to its tip.
4	Grain exposed	Husk leaves do not cover the ear adequately, leaving its tip somewhat exposed.
5	Completely unacceptable	Poor husk cover, tips clearly exposed.

Number of plants at harvest (PLANT HARVESTED)—Count the number of plants in each plot at harvest, regardless whether plants bear one ear, two, or are barren. Keep in mind that the plot size for IPPTs is one row and for EVTs and CHTs is two rows.

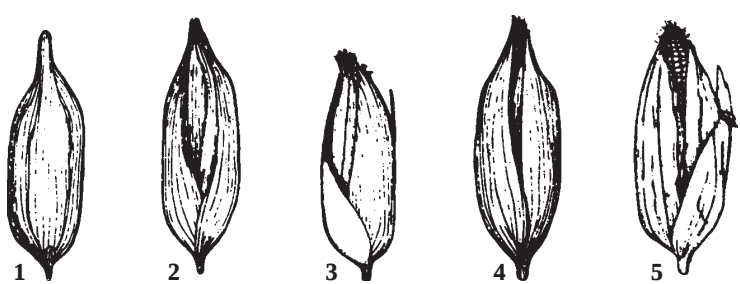

Figure 4. Rating scale for husk cover.

Field weight (FIELD WT.)—After harvesting all plants in the single row of an IPTT or the two rows of an EVT or CHT, record the field weight of ears with cobs in kilograms to one decimal place. If at all possible, delay harvest of maize until its moisture content is low (15-25%). This will permit full expression of stalk and root lodging and of differences among families in ear rots. In addition, the grain is much easier to shell for moisture content determination and most moisture meters are more accurate at low moisture.

Total number of ears (NO. OF EARS TOTAL)—Record the total number of ears harvested, excluding secondary ears that are extremely small.

Rotten ears (NO. OF EAR ROTTEN)—For every plot rate the incidence of ear and kernel rots caused by *Diplodia* spp., *Fusarium* spp., or *Gibberella* spp. on a scale of 1 to 5, as follows:

1 = 0% infected kernels
2 = 10% infected kernels
3 = 0% infected kernels
4 = 30% infected kernels
5 = 40% or more infected kernels

This rating scale is illustrated in Figures 5 and 6.

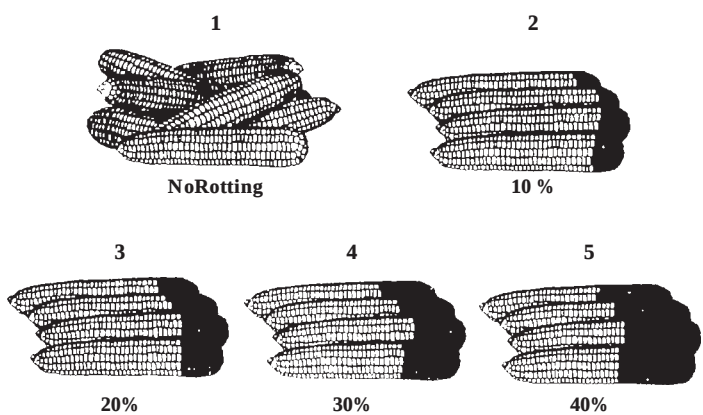

Figure 5. Rating scale for ear rots arising from the ear butt, as when caused by *Diplodia* and gray ear rots. Infection may also begin from the ear tip, as with the *Gibberella (Fusarium)* ear rots.

Ear aspect (ER ASP)—After harvest, but before taking a sample for moisture determination, spread out the pile of ears in front of the plot and rate them for characteristics such as disease and insect damage, ear size, grain filling, and uniformity of ears on a scale of 1 to 5, where 1 is the best and 5 the poorest. Record these ratings in whole numbers in the column headed "ER ASP."

Percent moisture (MOISTURE %)—Take 10 ears from each plot, remove 2 central kernel rows on each one, mix the grain, and with this sample bulk determine the moisture percentage in the grain at harvest. Portable moisture testers are very handy for this purpose. The moisture percentage should be recorded at the time of harvest and only to one decimal place.

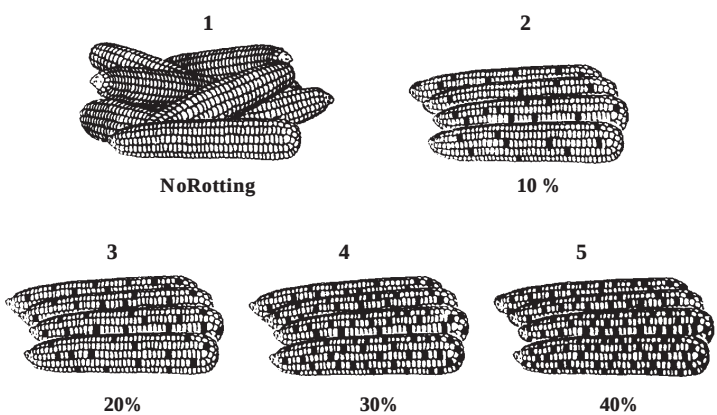

Figure 6. Rating scale for ear rots (such as that caused by *Fusarium moniliforme)* which result from husk injury and affect widely scattered kernels.

Seed Health

CIMMYT receives seed of new maize germplasm from cooperating programs and collections for its germplasm bank and every year responds to several thousand requests for seed from countries around the world. Every precaution is taken to ensure that both the incoming and outgoing seed is entirely disease free. Details about these safeguards are provided in the following sections.

Seed Imported by CIMMYT

Seed imported into Mexico by the Center falls into three categories: experimental varieties, introductions, and collections for the germplasm bank. These categories are defined below, and information is given about the precautions we take to ensure that seed-borne diseases from imported seed are not transmitted to crops at CIMMYT's experiment stations in Mexico.

Experimental varieties—Basic seed of these varieties is received from our regional programs, in which the Center's maize populations are improved for specific characters. These crops are grown under the supervision of CIMMYT regional staff members, and the plants and seeds are subject to the same procedures carried out at our experiment stations in Mexico. In that way CIMMYT ensures that only disease-free lines and seeds are shipped into the country. In addition, before planting seed at our experiment stations in Mexico, we treat it with a combination of insecticide and fungicides, including ridomil.

Introductions—These are improved germplasm materials that are developed by various national programs and have characters of importance to our Maize Improvement Program. These materials are treated with a combination of insecticide and fungicides, including ridomil, and are always grown in an isolated introduction nursery, never in the experimental plots of CIMMYT's maize nurseries. The introduction nursery is kept under constant surveillance for any seed-borne diseases and is evaluated for various agronomic characters. Plants suspected of having seed-borne diseases, including viruses, are immediately rogued. Seed harvested from healthy plants in the introduction nursery is grown in breeding plots the next year.

Collections for the germplasm bank—All germplasm collections are treated with insecticide and fungicides and stored for at least one year. Afterwards, we grow these materials for observation in a separate block from other materials, taking the same precautions as for introductions.

Ears of all types of germplasm are dried to a moisture content of less than 12% (usually 10%) before shelling. Randomly selected seed samples are checked in our seed health laboratory for efficiency of seed treatment and for seed-transmitted pathogens. This is done at the time the seed is imported and again after it has been multiplied in Mexico.

Seed Distributed by CIMMYT

Listed below are procedures and requirements for ensuring the health of seed that the Center's Maize Program distributes for testing to its cooperators around the world. This information may be of interest not only to cooperators, but to plant quarantine authorities and any other persons concerned with seed health and the prevention of seed-borne disease spread.

- CIMMYT supplies maize seed only in response to specific requests received from national programs.

- All maize seed supplied by the Maize Program, whether as entries in international trials or nurseries (IPTTs, EVTs, or CHTs) or as breeding materials (pools, populations, and experimental varieties), is always produced at CIMMYT's maize experiment stations in Mexico.

- All of our experimental maize plots are grown under the supervision of CIMMYT maize scientists, including pathologists and entomologists, who monitor the plots from planting to harvest. Any plants suspected of having seed-borne diseases are removed immediately.

- To qualify for shipment, seed must come from maize plots that are free from seed-borne diseases of maize (such as *Xanthomonas stewartii, Pewronosclerospora* spp., and *Helminthosporium carbonum* as well as virus diseases known or suspected of being seed borne). This seed is harvested only from healthy plants, and the ears are individually selected by CIMMYT scientists.

- Harvested ears are artificially dried to reduce the moisture level of the grain to less than 12% (usually 10%).

- The seed is carefully examined after shelling, and apparently unhealthy seeds are discarded. All chaff and other debris is removed prior to shipment.

- All seed to be shipped is treated with a fungicide and systemic insecticide, details of which are given below. Randomly selected seed samples are checked in CIMMYT's seed health laboratory for efficiency of seed treatment and seed-transmitted pathogens.

- Male sterile materials with T cytoplasm are not included in our program.

These measures ensure that seed distributed by CIMMYT is produced under insect-and disease-free conditions and that it is of the highest quality possible. Treatment of the seed with a mixture of carbofuran and thiram further guarantees that it will remain pathogen and insect free and promotes better stand establishment. Here are some details about the chemicals used in the seed treatment.

Furadan (2,3-Dihydro-2, 2-Dimethyl-7-Benzofuranyl N- Methylcarbamate)— The common names or synonyms for this broad-spectrum systemic insecticide / nematicide are Carbofuran and 2,2-Dimethyl-7-Coumaranyl.

Symptoms of poisoning by Furadan are those of cholinesterase inhibition. The antidote for *mild intoxication* is 2 mg of atropine sulfate administrated intramuscularly or sublingually, and for *severe intoxication* 4 mg of atropina sulfate, preferably administered intravenously as soon as cyanosis disappears.

For *acute oral toxicity*, the LD 50 of Furadan in mammals is 8-14 mg / kg of body weight, and for *dermal toxicity* 3,400 mg / kg of body weight.

THIRAM (Tetramethylthiuram Disulfate)—The common names of this protective fungicide are Arasan, Tersan, Pomarsol, and Nomersan.

This chemical has low mammalian toxicity; for *acute oral toxicity* its LD 50 in mammals is 780 mg / kg of body weight. Since it may cause skin irritation, we suggest that you wash your hands after handling treated seed. Do not put the seed in your mouth or use it for food or feed.

CIMMYT's seed treatment includes 50 ml of Furadan 30% (seed treater), 2 g of Arasan 75% (wettable powder), and 12 ml of water per kilogram of seed.

CIMMYT (www.cimmyt.mx or www.cimmyt.cgiar.org) is an internationally funded, nonprofit scientific research and training organization. Headquartered in Mexico, the Center works with agricultural research institutions worldwide to improve the productivity, profitability, and sustainability of maize and wheat systems for poor farmers in developing countries. It is one of 16 similar centers supported by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR comprises over 55 partner countries, international and regional organizations, and private foundations. It is co-sponsored by the Food and Agriculture Organization (FAO) of the United Nations, the International Bank for Reconstruction and Development (World Bank), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP). Financial support for CIMMYT's research agenda also comes from many other sources, including foundations, development banks, and public and private agencies.

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