

**Instructions for the Management and Reporting
of Results for the CIMMYT Wheat Program
International Nurseries**



The International Maize and Wheat Improvement Center (CIMMYT) is an internationally funded, nonprofit scientific research and training organization. Headquartered in Mexico, CIMMYT is engaged in a worldwide research program for maize, wheat and triticale, with emphasis on food production in developing countries. CIMMYT is one of 13 nonprofit international agricultural research and training centers supported by the Consultative Group for International Agricultural Research (CGIAR). The CGIAR is sponsored by the Food and Agriculture Organization (FAO) of the United Nations, the International Bank for Reconstruction and Development (World Bank), and the United Nations Development Programme (UNDP). The CGIAR consists of 40 donor countries, international and regional organizations, and private foundations.

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Introduction •

Over the last two decades, the international multilocation testing of experimental germplasm has become widely accepted as a viable approach to accelerating the germplasm improvement process. In the case of wheat and triticale, CIMMYT serves as the hub of one of the world's largest international testing networks; several hundred cooperating agricultural scientists, located in over 100 countries worldwide, participate in the evaluation of experimental materials contained in CIMMYT nurseries. These nurseries are grown under a wide range of environmental conditions, and are subjected to numerous diseases and other stresses.

Given the diversity of production conditions encountered worldwide, CIMMYT has standardized as much as possible the

recommended management practices, evaluation techniques and reporting procedures for its international nurseries. The purpose of this information bulletin is to provide cooperators and other interested parties with guidance in growing and evaluating CIMMYT nurseries.

International testing is done strictly on a voluntary basis; cooperating scientists and national programs must request nurseries from CIMMYT. These individuals and programs are free to use the experimental materials contained in each nursery in any way they desire. The only requests that CIMMYT makes are these: 1) the return of performance data to CIMMYT for subsequent compilation, analysis and publication, and 2) acknowledgement (when appropriate) of the source of

germplasm selected for use by national crop improvement programs. If a line from a CIMMYT nursery is released directly as a commercial variety, the originating institution (if other than CIMMYT) must be recognized, as well as the country of origin. Commercial varieties released directly from CIMMYT nurseries cannot be protected under patents or plant breeders' rights legislation.

Accuracy in recording performance data and its **timely return** to CIMMYT for analysis are critical to the success of the international testing network. Data from many researchers are fed into the system, and the pooled results form the basis of the international nursery reports published by CIMMYT. The quality of these nursery reports is totally dependent upon the quality of the experiments and the data reported by each cooperator. The reports help guide subsequent breeding efforts, both by CIMMYT and by cooperating wheat researchers around the world.

Suggestions as to how experimental results can be improved are welcome, and all correspondence should be directed to:

International Wheat Nurseries Coordinator
Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)
Londres 40, Apdo. Postal 6-641
Col. Juárez Deleg. Cuauhtémoc
06600 México, D.F.



Submitting Cultivars or Advanced Lines for Yield Testing •

National crop improvement programs wishing to obtain a comparative evaluation of their materials under a wide range of production conditions (i.e., a comparison of their germplasm with that of other countries) are encouraged to send seed samples to Mexico. These samples will be increased under optimum production conditions in northwest Mexico to produce the seed needed for nursery distribution. Samples should be no less than 500 grams each, and the seed should be of excellent quality and free of admixtures.

It is seldom possible to increase and distribute all varieties

submitted for trial, and the final composition of the nurseries is determined by CIMMYT staff. The origins of the entries included in the nurseries are indicated in the entry lists that accompany each nursery.

Seed samples, along with their **phytosanitary certificates**, should be sent to CIMMYT's International Wheat Nurseries Coordinator (the same address shown on page 2). Clearly state what kind of chemical treatment, if any, has been applied to the seed prior to shipment. Please label the package:

**Experimental Wheat Seed
No Commercial Value**

Sending the seed by air freight or air mail will help to preserve seed quality, due to the shorter shipping period. Samples must reach CIMMYT **no later than September 15**, to be increased during the winter season in northwest Mexico. **Please advise** the International Wheat Nursery Coordinator by a separate letter (sent airmail) as to when and how the seed was sent. This facilitates the clearing of the seed through Mexican customs and plant quarantine.

Main Types of Nurseries •

CIMMYT assembles and distributes four basic types of international nurseries:

- Yield trials
- Screening nurseries
- Disease monitoring nurseries
- Segregating populations

In addition, CIMMYT crossing block nurseries are available to a limited number of cooperators on a special request basis. Crossing blocks are composed of cultivars and advanced lines with well-

defined characteristics, and serve as progenitors in CIMMYT's crossing programs. As data from yield nurseries, screening nurseries and disease monitoring nurseries are returned to the Center and analyzed, outstanding materials become candidates for inclusion in the crossing blocks. For information about the availability of these special nurseries, contact either the Wheat Nurseries Coordinator or the respective crop program leaders.

Yield trials

These nurseries serve four primary objectives: (1) to provide wheat researchers with an opportunity to assess the yield performance of advanced breeding lines over a wide range of production conditions, (2) to provide needed information on adaptation, (3) to enable researchers in national crop improvement programs around the world to evaluate the performance of their new cultivars in many locations, as

well as the performance of materials from many other countries and from CIMMYT, and (4) to provide cooperators with a source of new genetic variability for use in their crossing programs.

International yield trials are composed of new commercial cultivars and experimental germplasm from the important wheat-growing regions/countries of the world, as well as new material coming from CIMMYT. In a given location, some entries may be too early or late, too tall or too short, too light-sensitive, or susceptible to prevalent diseases. Thus, yield trials may

be difficult to grow and evaluate in certain locations; even so, the data obtained are extremely valuable.

The principal international yield nurseries distributed by CIMMYT are:

- International Spring Wheat Yield Nursery (ISWYN)
- Elite Selection Wheat Yield Trial (ESWYT)
- International Durum Yield Nursery (IDYN)
- Elite Durum Yield Trial (EDYT)
- International Triticale Yield Nursery (ITYN)

In addition, the CIMMYT-based ICARDA barley program provides the:

- International Barley Yield Trial (IBYT)

Screening nurseries

These nurseries have three main objectives: (1) to provide cooperating researchers with the opportunity to evaluate the performance of new advanced lines from CIMMYT and, in special cases, from selected national programs, (2) to obtain information on the performance of experimental germplasm under a wide range of climatic and disease conditions, and (3) to provide a source of new genetic variability.

In the past, screening nurseries were composed of widely adapted entries that were evaluated under a wide range of production conditions. Recently, lines selected for specific characteristics have been grouped and distributed to target areas where certain traits are needed. For example, lines selected for tolerance to high levels of free aluminum are assembled and distributed to cooperators working in areas where aluminum toxicity is a significant production constraint. Other categories are: early maturing germplasm, lines being screened for resistance to helminthosporium diseases, materials undergoing screening against septoria diseases, and germplasm with resistance to fusarium head scab.



The principal international screening nurseries distributed by CIMMYT are:

- International Bread Wheat Screening Nursery (IBWSN)
- International Durum Screening Nursery (IDSN)
- International Triticale Screening Nursery (ITSN)

The CIMMYT-based ICARDA barley program provides the:

- International Barley Observation Nursery (IBON)

Several smaller screening nurseries also are distributed by CIMMYT:

- International Septoria Observation Nursery (ISEPTON)
- Scab Resistance Screening Nursery (SRSN)
- Helminthosporium Resistance Screening Nursery (HRSN)
- Aluminum Tolerance Screening Nursery (ATSN)
- Drought Screening Nursery (DSN)
- Heat Tolerance Screening Nursery (HTSN)
- Germplasm Bank Disease Evaluation Nursery (GBEN-D)

The objectives of these smaller screening nurseries are the same as for the major screening nurseries, with the exception of the GBEN-D. The purpose of the GBEN-D is to assess the current disease resistance of the bread wheat, durum wheat, triticale and barley entries being

maintained in the germplasm bank. Many of the samples stored in the bank were resistant to particular diseases at the time of their distribution and release. However, with changes in virulence and disease spectra, the resistance of these entries may no longer be effective. To obtain more current disease data on this material, selected groups of germplasm have been prepared for evaluation in disease "hot spot" locations around the world. Those that continue to show acceptable levels of resistance, or that constitute unique sources of resistance, will be maintained in the bank, and samples made available (along with the new information) to interested breeders and pathologists.

Disease monitoring nurseries

These nurseries are distributed by CIMMYT on a regular basis. The primary monitoring nursery is the International Disease Trap Nursery (IDTN), though certain other trap nurseries are distributed on a more limited basis through CIMMYT's regional offices. The purpose of a trap nursery is basically three-fold: 1) to monitor disease development, 2) to provide some measure of the virulence of pathogens present wherever the nursery is grown, and 3) to help identify which genes (or combinations of genes) for resistance are most effective in each location.

The IDTN contains the principal commercial cultivars grown around the world, selected advanced lines and/or cultivars having resistance to specific diseases, and selected susceptible checks. These sources of resistance may or may not be effective in all locations, but they do provide cooperators with a good starting place in the search for resistant germplasm and/or effective genes for resistance, as well as a classification of the virulence of the pathogen population present.

Segregating populations

These nurseries usually are composed of F₂ materials, and the degree of genetic and phenotypic variation in each nursery is thus very large. For many years cooperators have been receiving CIMMYT wheat nurseries composed of already stabilized lines. Some cooperators have indicated that the selection process followed in Mexico may eliminate germplasm useful for certain climatic or disease conditions. Thus, to avoid the loss of potentially valuable germplasm, segregating populations are made available to interested cooperators, but **no return data are requested.**

Planting Plans (Experimental Design)

The experimental design of the CIMMYT international nurseries has been standardized to a large extent, and the planting plans and the general notes to be taken are quite similar for each type of nursery. The need for standardization, both in the execution of the experiments and in the reporting of results, must be emphasized; uniformity of testing across locations is essential to ensuring the accuracy of the pooled data generated by the international testing network, and for the usefulness of the analyses and conclusions drawn from this data base.

The seed boxes shipped to each cooperator contain envelopes filled with the required amounts of seed. These envelopes are arranged in each box in the order in which they should be planted, as indicated by the plan of the trial. The quantity of seed in

each envelope varies with the crop and nursery. This adjustment is made to allow for a uniform and optimum seeding rate. Precise information on seeding rates for each nursery is available from CIMMYT's International Wheat Nurseries Coordinator.

Below are the general guidelines for planting the major types of nurseries; guidelines for the recording of specific data begin on page 8.

Yield trials

CIMMYT yield trials are made up of commercial cultivars and advanced lines, replicated three times. Yield trials are the only replicated nurseries distributed by CIMMYT; all other CIMMYT nurseries are non-replicated.

Six-row plots, 3 meters in length, are recommended. Seed normally is packaged in

individual envelopes, one for each row of the plot. Some cooperators have requested that seed be packaged for machine planting; in these cases one large package for each plot, containing enough seed to plant six rows, is provided. In each replication, one envelope (one entry) is reserved for the cooperator's own local check cultivar (see page 7).

The cultivar or line number and the plot number are identical in the first replication, but the cultivars/lines have been assigned at random. Entries are then randomized in replications two and three, and are arranged according to a randomized, complete block design.

The seed contained in each envelope is sufficient to plant a 3-meter row (9.4 feet), and the distance between the 4 center rows should be about 30 cms (Figure 1). CIMMYT recognizes

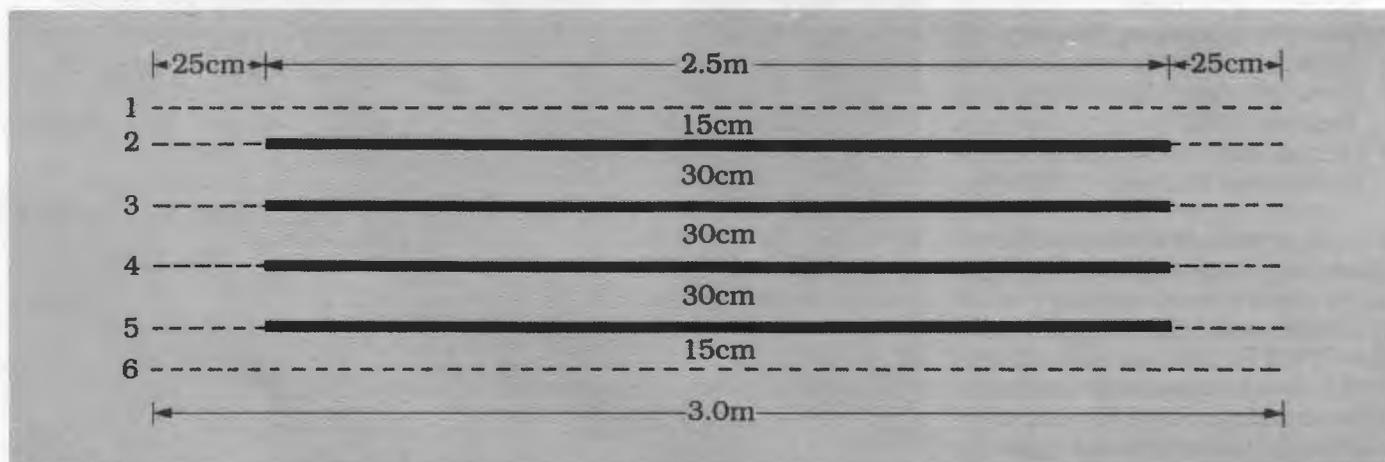


Figure 1. Recommended planting plan for international yield nurseries. Plant 6 rows, 3.0 meters long, with row spacing as shown. Harvest the 4 center rows only, after the border rows (1 and 6) and the row ends (of all rows) are removed and discarded.

that plot dimensions will differ according to the space available for planting the trials, so variations are expected.

Please record on the general information sheet to be returned to CIMMYT whatever dimensions are actually used. With this information, the Nursery Coordinator can compute yields and other variables in standardized units/area (e.g., kg/ha).

An empty envelope is provided with each replication for the packaging of a **local check cultivar**. The amount of seed needed for the local check will be the same as that provided for the other entries in the trial. The name of the local check cultivar is of interest to other cereal

scientists in the international network. The name should be recorded in the field books and on the general data sheets that are to be returned to CIMMYT. Please **do not** substitute local cultivars or lines for entries included in the experiment; this would spoil the uniformity of the trial and greatly complicate statistical analysis. If you wish to compare local materials (other than the local check cultivar) with the entries in a given yield trial, please place them at the end of each replication.

Before laying out the trials, study the recommended plot design shown in Figure 1. Again, if

these plot dimensions are not used, **please indicate** clearly the actual sizes of plots harvested.

Screening nurseries

These nurseries are distributed in non-replicated sets, and are composed of advanced lines selected from the CIMMYT crop programs. Individual envelopes containing the seed for each line to be screened are included in the seed boxes, and every 20th envelope contains seed of a control cultivar selected from the CIMMYT International Yield Nursery for the respective crop.

The envelopes contain enough seed to allow the use of any one of the following three non-replicated planting plans (see Figure 2):

- One row, 5 meters long
- Two rows, 2.5 meters long
- One 2.5-meter row at each of 2 locations

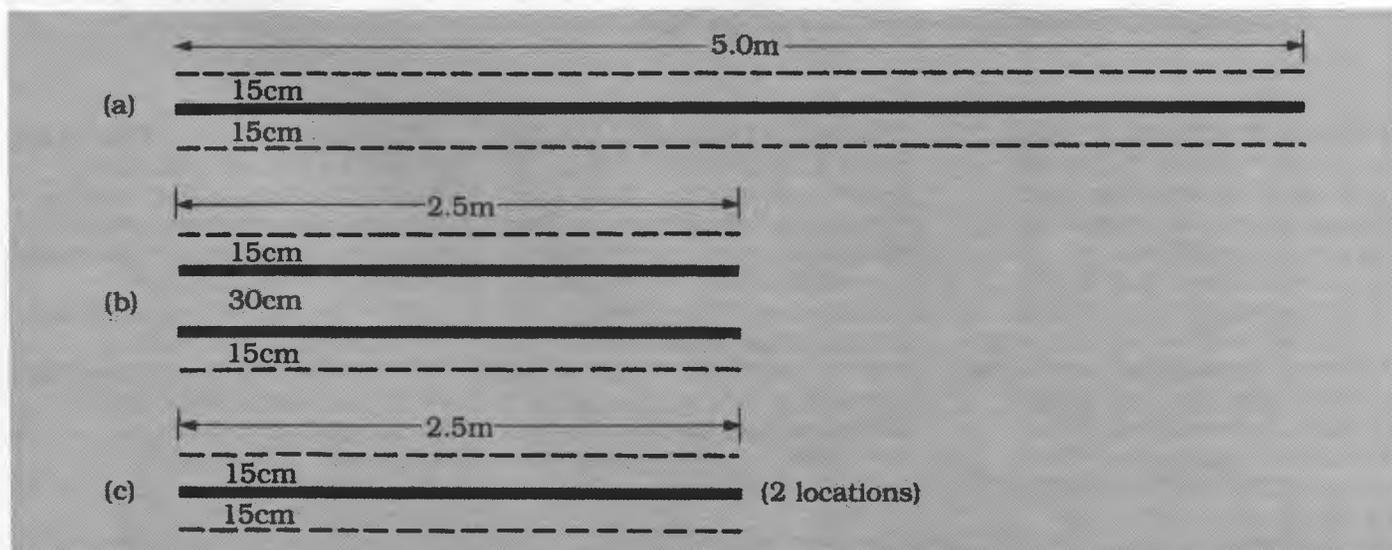


Figure 2. Planting plans for international screening nurseries. In (a) one row, 5.0 meters long, is used for each entry with 15 centimeters between rows. In (b) two rows, each 2.5 meters long, are used for each entry, with row spacing as shown. In (c), one row, 2.5 meters long, is used for each entry at two different locations.

These plots should be sown in accurate rows, since yield measurements may be requested. The spacing between rows and the shape and dimensions of the field layout are left to the discretion of the cooperator. It is **very important** that you indicate clearly on the general information sheet to be returned to CIMMYT **which** planting plan was used. If planting plan "c" is used, data from both locations should be reported.

Disease monitoring nurseries

Disease monitoring nurseries (such as the IDTN) are non-

replicated nurseries, but cooperators are encouraged to grow several of them, one in each of the important commercial small grain areas of the country, to monitor the diseases present.

Disease monitoring nurseries should be planted in two-row plots, each 1 to 2 meters in length, with the space between rows left to the discretion of the cooperator. However, it may be useful to increase the space between the two-row plots by leaving one row empty so as to reduce lodging. It would also be helpful to surround the nursery with four to six rows of the most

susceptible local cultivars available, and to plant one to two rows of susceptible local cultivars in the alleyways of the plot.

Segregating populations

The planting plans used for segregating population nurseries are left to the discretion of the cooperators. CIMMYT recommends that these nurseries either be space-planted (about 10-15 cm between seeds) to facilitate the selection of individual plants, or that they be planted as observation plots (using normal seeding rates) for the selection of the most promising populations.

Collecting and Recording the Data •

The seed boxes sent to each cooperator contain forms (in duplicate) for recording the disease data and general agronomic performance information described in the following pages. Both forms should be filled in and one copy returned (**by airmail**) as soon as possible after harvest to the CIMMYT International Wheat Nurseries Coordinator. The cooperator's copy and the one to be returned to CIMMYT are marked clearly.

Attached to the front of the data forms is a sheet requesting general information about the experiment (see Figure 3). The information requested includes plot size, latitude, longitude, elevation, planting date(s), rainfall, irrigation applied, fertilizer used, etc. Please provide as much of the requested information as possible, for it is very useful in interpreting the results of the trial.

With replicated yield trials, notes should be recorded for each replication (if possible) because this will allow a more adequate statistical treatment of the data. The data forms contain unlabelled (blank) columns for recording any additional information that cooperators feel is useful. Cooperators are encouraged to include all additional data in which differential reactions are observed.

INTERNATIONAL WHEAT NURSERIES				CIMMYT					
GENERAL NOTES TO BE TAKEN				Nursery Name: _____					
				Year: _____					
COUNTRY : _____				Location: _____					
State or Province : _____				Identification: _____					
STATION NAME: _____				Nurs. Year Perm. Loc.					
COOPERATOR(S): _____						ELEVATION			
						[] [] [] []			
LATITUDE			LONGITUDE			Meters or Feet			
Degrees Minutes N or S			Degrees Minutes E or W						
[] [] [] []			[] [] [] []			[] []			
PLEASE CHECK (<input checked="" type="checkbox"/>) EACH APPROPRIATE BOX									
DATE PLANTED: _____				DATE HARVESTED: _____					
Month Day Year				Month Day Year					
APPLIED NOT APP		SOWING DATE		SOIL CONDITION		GERMINATION			
		8		9		10			
FERTILIZER		EARLY		AT SOWING		POOR			
N [] []		1 [] []		4 [] []		6 [] []			
P [] []		2 [] []		5 [] []		7 [] []			
K [] []		3 [] []		MOIST		GOOD			
		LATE							
SCALES USED AND DATES ON WHICH THE AGRONOMIC AND DISEASE NOTES WERE TAKEN.				39 LOCAL CHECK					
VARIABLE SCALE USED DATE				34 Chemical Control of Insects.					
Month Day Year				35 Chemical Control of Weeds.					
				36 Chemical Control of Insects and Weeds.					
				37 Mechanical Control of Weeds.					
				38 Hand Weeding.					
DISEASE DEVELOPMENT		INSECT DAMAGE		WEED PROBLEM		BIRD DAMAGE			
19		27		28		29			
17 [] []		20 [] []		21 [] []		22 [] []			
NEGLIGIBLE		NEGLIGIBLE		NEGLIGIBLE		NEGLIGIBLE			
18 [] []		44 [] []		49 [] []		52 [] []			
SLIGHT		SLIGHT		SLIGHT		SLIGHT			
41 [] []		45 [] []		50 [] []		53 [] []			
MODERATE		MODERATE		MODERATE		MODERATE			
42 [] []		46 [] []		51 [] []		54 [] []			
HEAVY		HEAVY		HEAVY		HEAVY			
OTHER OBSERVATIONS: _____						COPIA PARA EL COOPERADOR COPY FOR THE COOPERATOR COPIE POUR LE COOPERATEUR			
No. OF RAINS DURING THE CYCLE: _____				TOTAL PRECIPITATION: _____ mm					
NUMBER OF IRRIGATIONS: _____				TOTAL WATER APPLIED: _____ mm					
YIELD GIVEN IN: kg/ha [] []		bu/acre [] []		grams/plot [] []				kg/plot. [] []	
PLANT HEIGHT: cm [] []		inches [] []		m [] []		OTHER MEASURE: _____			
TEST WEIGHT: kg/hl [] []		lbs/bu [] []		OTHER MEASURE: _____					
WEATHER IF ABNORMAL, PLEASE SPECIFY: _____									
15 [] [] NORMAL									
PLOT SIZE		A NO. OF ROWS HARVESTED PER ENTRY [] []		B LENGTH OF EACH ROW [] []		C DISTANCE BETWEEN ROWS [] []			
				★ A A B A C					

Figure 3. General information sheet for the CIMMYT international wheat nurseries.

CIMMYT asks that data be reported using the metric system, except in the case of disease reactions. In any case, please **indicate clearly** the units in which data are taken.

Cereal rusts

The method outlined here for taking notes on stem, leaf, and stripe rust infections was recommended by Dr. W.Q. Loegering (USDA International Spring Wheat Rust Nursery, 1959) for use with the International Rust Nursery. This method has been adopted for the sake of uniformity. If another method is used, an explanation should accompany the data. CIMMYT recommends that cooperators use the "Rust Scoring Guide" (published jointly by CIMMYT and IPO, Wageningen, The Netherlands) to facilitate the recording of uniform and accurate data on the cereal rusts.

Field notes on the rusts describe **severity** (the percentage of rust infection on the plants) and **field response** (the type of disease reaction). Severity is recorded as the percent of infection according to the modified Cobb scale. Since severity is determined by observation (visual estimates), readings will not be absolutely accurate. A less than 5% severity is referred to as a "trace" severity (denoted "t"). Beyond that, the intervals used for recording severity are 5%, 10%, 20%, 40%, 60% and 100%, as shown in the rust severity scale in Figure 4.

The field response of a variety or line refers to the type of disease reaction and is recorded by using the following letters:

- O** No visible infection on plants.
- R** **Resistant**—Necrotic areas with or without minute uredia present.
- MR** **Moderately Resistant**—Small uredia are present and surrounded by chlorotic or necrotic areas.
- M** **Intermediate**—Variable sized uredia, some with necrosis and/or chlorosis.
- MS** **Moderately Susceptible**—Medium sized uredia are present with no necrosis; possibly some distinct chlorosis.
- S** **Susceptible**—Large uredia are present, with no necrosis and little or no chlorosis.

Under special circumstances it may be desirable to distinguish VR (Very Resistant) or VS (Very Susceptible) field responses. Usually, however, distinctions between VR and R, or VS and S are difficult to make and therefore of little value.

Severity and field response readings are recorded at the same time and are combined in the following way:

- tR** Trace severity with a resistant reaction;
- 5MR** 5% severity with a moderately resistant reaction;
- 60S** 60% severity with a susceptible reaction.

These severity and response readings are converted by CIMMYT to **coefficients of infection (CIs)**, which allow us to compare and report to our cooperators the relative disease resistance of nursery entries.

Usually, a single severity and response reading gives an adequate description of the disease reaction of a line or variety; occasionally there is obvious variability in the disease reaction within a line. This variability may appear in several forms:

- 1) A clear-cut separation of plants into two or three classes.
- 2) Two or more reactions, with a clear-cut separation into classes.
- 3) A range of reaction on each plant, without separation into classes.

The first form of variability may result from either segregation or seed mixture. The second indicates the presence of two or more races of rust. The third may result either from race mixtures in the field or an intermediate (M) response by the cultivar/line. It is usually not practical to determine what causes the variability, but it is

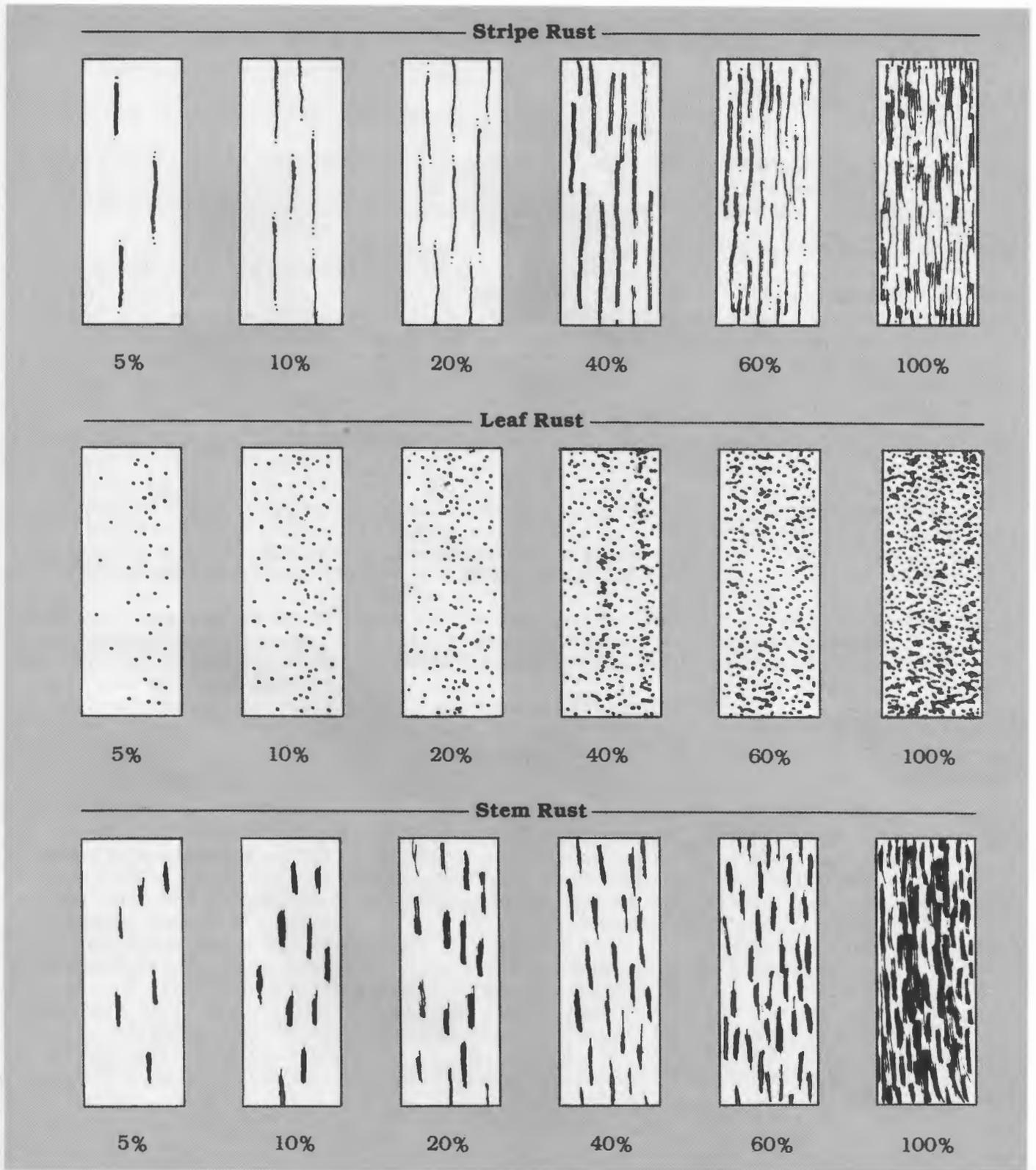


Figure 4. Rust severity scale.

quite simple to record whether the variability is represented by a clear-cut separation of plants into classes or by a range in the reaction, as follows:

“—” A dash separating two readings indicates a range in severity and response of the plants in the row. For example, 15R—5S means that there was a range of severity and response to rust from 15R to 5S. When using these combinations, the first reading represents the predominant class or reaction. Segregation is indicated in the following manner:

5R, 50S Severity and response readings ranged between 5R and 50S.

Readings that are difficult to make are indicated in the following ways:

“e” An “e” is used to indicate that an entry may have escaped infection. Often a cultivar or line will have little or no rust, but there is doubt that it is truly resistant, either because it matured early or for other reasons. Thus “Oe” indicates that there was no rust on the entry, but there is a doubt that the variety was as resistant as the “0” reading would indicate.

“n” Often one disease, such as stripe rust or a leaf spot, is so severe that taking notes on other diseases is impossible. This situation is indicated by using the letter “n”. For example, if stripe rust kills the leaves before leaf rust can develop, then the note for leaf rust will be “n”.

“—” When data cannot be recorded on an entry for any other reasons, such as missing entries or the premature death of plants due to other reasons, the space for the note should be marked with a dash.

Only scores recorded in the way described here are used in the computations done at CIMMYT.

Other foliar diseases

Internationally standardized scoring scales for septoria, helminthosporium, powdery mildew, scald and other diseases have not been developed. However, CIMMYT pathologists have developed an easy, simple scale for estimating (evaluating) the development of various foliar diseases.¹

With this method, disease development is evaluated using a 0 to 9 scale: 0 (zero) indicates no infection and 9 (nine) indicates

^{1/} Saari, E.E. and J.M. Prescott, 1975. “A Scale for Appraising the Foliar Intensity of Wheat Diseases.” *Plant Diseases Reporter*, 59:377-380.

the most severe infection. The mid-point of the plant provides the starting place for taking a measurement.

To use this scale, first grasp the plant at its mid-point. If lesions are noted at this point, but not above it, the intensity of the disease reaction should be given a 5. Lesions on leaves below the mid-point result in scores of 1 to 4, depending on how far up the plant they have progressed. As the lesions progress up the plant from the mid-point, the score increases, up to a severity of 9. A more detailed description and a diagrammatic representation of this scale are given in Figure 5.

When it is desirable to record the degree of infection on the spike, draw a slash mark after the leaf infection score and record the percentage of the spike that is affected. For example, 6/50 would mean a leaf infection just above the mid-point of the plant with 50 percent of the spike affected.

Other diseases and pests

Disease damage to the spikes, roots and crowns, to the plant as a whole, and insect damage should be recorded as the percentage of the area infected or damaged. If scored in some other way, a key to the method used should accompany the information sheet returned to CIMMYT.

0 **Free from infection.**

Oe **Free from infection**, but probably represents an **escape**.

1 **Resistant:** A few isolated lesions on lowest leaves only.

2 **Resistant:** Scattered lesions on the second set of leaves; light infection on the first leaves.

3 **Resistant:** Light infection of lower third of plant; lowest leaves infected at moderate to severe levels.

4 **Moderately Resistant:** Moderate infection of lower leaves; scattered light infection extending to the leaf immediately below the mid-point of the plant.

5 **Moderately Susceptible:** Severe infection of lower leaves; moderate to light infections extending to mid-point of the plant; infection does not extend beyond mid-point of plant.

6 **Moderately Susceptible:** Severe infection of the lower third of the plant; moderate infection on the middle leaves; scattered lesions beyond the mid-point of the plant.

7 **Susceptible:** Severe infection on lower and middle leaves; infections extending to the leaf below the flag leaf, or trace infections on the flag leaf.

8 **Susceptible:** Severe infection on lower and middle leaves; moderate to severe infection of upper third of plant; flag leaf infected by more than a trace amount.

9 **Very Susceptible:** Severe infection on all leaves; the spike is infected to some degree. Spike infections are scored as to the percentage of the total area covered. The percent infection of the spike is recorded following the numerical leaf infection score and is separated from it by a slash, e.g. 6/10.

n **No scoring possible** due to necrosis as a result of other diseases or factors.



Figure 5. The 0-9 scale for appraising the foliar intensity of wheat, triticale, and barley diseases

Agronomic and quality data

The type of agronomic and quality data collected will depend upon which nursery is being evaluated and the degree of differentiation among the entries (see Table 1). To enhance the uniformity of reporting, CIMMYT asks that whenever possible the following types of data (in the units specified) be recorded and returned to the International Wheat Nurseries Coordinator; this information is necessary for accurate analyses, and much of it will be included in the nursery summary reports published by CIMMYT.

- **Planting date:** Because most nurseries are prepared and airfreighted from Mexico only once each year, some cooperators receive their set(s) out of season. Nurseries should **not** be grown out of season unless there is a very good reason for doing so (e.g., disease development). Please always indicate the planting date on the data sheets.
- **Stand establishment:** Even though CIMMYT tries to send high quality, viable seed to its cooperators, once the seed has been shipped we no longer have control over how it is handled or under what conditions it is stored prior to planting. Poor stand establishment can be due to many factors and can adversely affect yield. It is therefore important for cooperators to report any

Table 1. Agronomic data requested for each major type of nursery

Data and Units	Yield Nurseries	Screening Nurseries	Disease Monitoring	Segregating Populations
Planting Date (day/month)	X	X	X	n.a.
Stand Establishment	X	X		n.a.
Grain Yield (kg/ha)	X	X ¹		n.a.
Test Weight (kg/hl)	X	X ²		n.a.
1000 Grain Weight (grams)	X			n.a.
Days to Flowering (number of days)	X	X		n.a.
Days to Maturity (number of days)	X	X		n.a.
Plant Height (cm)	X	X		n.a.
Lodging (%)	X			n.a.
Shattering (%)	X			n.a.
Neck Break (%)	X ³	X ³		n.a.
Frost Damage (0-9)	X ³	X ³		n.a.
Rat, Bird or Hail Damage (%)	X ³	X ³		n.a.
Yellow Berry (%)		X ⁴		n.a.
Check Marks (Stars)		X	X	n.a.
Other Agronomic Factors (0-9)	X	X		n.a.
1 Yields are requested only for lines selected (check marked)		3 Use blank columns to record data		
2 Only for the ITSN		4 Only for the IDSN		

serious stand establishment problems. However, since small grains are able to "fill in" many of the gaps in the stand resulting from poor germination or emergence, please report only those entries (by entry number) having such a low plant density that they should be excluded from any analysis.

- **Grain yield:** In the yield trials, grain yield is measured using only the four center rows (row ends trimmed) of each six-row plot in all replicates (see Figure 1). To reduce errors due to bird damage and shattering, each variety should be cut no later than a week after its physiological maturity. The grain may be either dried to a uniform moisture content (12%) in bundles before threshing or, if samples having a high moisture content are threshed, the grain should be dried to a uniform moisture content (12%) before grain weights are recorded. If moist grain samples are weighed, the moisture content should be determined for each sample using an electric conductivity moisture meter, and sample weights corrected to a uniform 12% moisture basis.

Regardless of the method used, a description of the procedure employed should be returned with the data sheets. In all cases, grain weights should be determined using samples that have been

previously cleaned and corrected for moisture as described above. Data should be recorded in grams (g). Please clearly indicate on the data sheets any modifications made in plot sizes or shapes, and the area actually harvested.

As to the screening nurseries, yield data is requested **only** for the lines selected. These data give an indication of the yield potential of resistant lines, and are therefore useful (but not vital) in subsequent breeding efforts. If possible, please report this information.

- **Test weight:** Grain densities of the cleaned grain samples used to determine yields are referred to as the "test weights" of the samples, and commonly are measured in kilograms per hectoliter. Depending on the equipment available for making the measurements, however, test weights can be expressed either as kilograms per hectoliter (kg/hl) or as pounds per bushel (lbs/bu). Either is acceptable to CIMMYT, as long as the units of measurement are indicated clearly on the data sheets.

If possible, please report the test weights of the entries selected from each screening nursery. However, because of the special effort to improve triticale seed, CIMMYT asks that the test weights of all entries in the ITSN be

provided. If this cannot be done, please record the test weight of each entry selected from the ITSN.

- **1000 grain weight:** Some cooperators do not have the equipment necessary to determine test weights, and sometimes there is not enough seed to do so. In these instances, the weight of a 1000 grain sample will suffice. The 1000 grain weight is usually expressed in grams (g); if any other unit of measurement is used, please indicate it clearly on the data sheets.
- **Maturity:** Two measurements of maturity are requested:
 - 1) The number of days between germination and flowering. A nursery entry has reached flowering when 50% of the culms are fully headed (spikes fully exerted).
 - 2) The number of days between germination and physiological maturity. Physiological maturity is achieved when 50% of the peduncles are ripe.
- **Straw:** Two notes on straw characteristics should be recorded:
 - 1) The average height of the plants in a row (in centimeters or inches) should be measured when the grain is beginning to

form. The distance to be measured is from the ground to the tip of the terminal spikelets of the spike (excluding awns). This distance is the plant height. Please record plant height in whole numbers (do not use decimals or fractions) and indicate clearly the units used.

2) The degree of lodging should be recorded using a percentage scale when the plants are physiologically mature. The 0% value indicates fully upright plants and 100% indicates completely lodged plants.

- **Shattering:** This variable should be recorded using a percentage scale, with 0% indicating no shattering and 100% indicating complete shattering.
- **Neck break:** In some nursery entries there may be a weakness of the rachis at the "neck," near the base of the spike. In such cases, the entire spike frequently breaks off and falls to the ground. Notes should be taken on the percentage of plants having this flaw.
- **Frost damage:** The damage to the seedlings caused by frost should be noted, as should the damage caused by frost during flowering (or later). Seedling damage should be indicated in one of the

unlabelled columns on the data sheets using the following 0-9 scale:

- 0 No frost damage
- 1 Trace damage
- 3 Slight damage
- 5 Moderate damage
- 7 Severe damage
- 9 Very severe damage

Frost damage occurring during flowering (or later) should be recorded as the percent sterility or percent of grain that was severely frozen. The dates on which the frosts occurred should also be recorded.

- **Rat, bird and hail damage:** Please record losses due to rats, birds or hail using a percentage scale, with 0% indicating no damage to the plots and 100% indicating a complete loss.
- **Yellow berry:** Durum wheat grain often shows differing degrees of mottling (whitish to pale yellow blotches in crystalline or vitreous kernels), which is referred to as yellow berry. This is scored as an average percentage of the area affected in the kernels, combined with the number of kernels in the seed lot.
- **Check marks and stars:** Throughout the growing season, cooperators usually evaluate periodically the

phenotypic development of nursery entries. CIMMYT recommends the following check mark (✓) and star (*) scale for recording these observations:

- ✓ The entry has an above average phenotype and is to be harvested
- ✓* Good phenotype
- ✓** Excellent phenotype
- ✓*** Outstanding phenotype

If an entry receives no check marks or stars, it is assumed to have a phenotype no better than the check cultivar.

At the end of the season, these notes help cooperators select the best phenotypes based on their appearance throughout the season. This manner of selection has been very helpful in eliminating less desirable entries, particularly in screening and disease nurseries.

- **Other agronomic factors:** A 0-9 scale should be used for any other agronomic factors for which differential data can be taken, e.g., cold tolerance, sterility, etc., as shown below:

- 0 No damage
- 1 Trace damage
- 3 Slight damage
- 5 Moderate damage
- 7 Severe damage
- 9 Very severe damage

Returning the Data to CIMMYT•

As indicated earlier, data should be recorded on the forms supplied with the nursery sets and one copy should be airtailed to CIMMYT as soon as possible after harvest. It is important that data be returned quickly, so that preliminary reports can be prepared and made available to other cooperators.

The second copy of the data sheets should be kept for the cooperators' records. When all cooperators have reported, a final summary is published for general distribution.

As noted earlier, data should be returned to:

International Wheat Nurseries Coordinator
Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)
Londres 40, Apdo. Postal 6-641
Col. Juárez Deleg. Cuauhtémoc
06600 México, D.F.

Processing and Returning Data to Cooperators•

The tables and analyses of variance for yield nurseries and screening nurseries are produced by a computer program called "NAP". Anyone wanting more information about this program please inquire to the Head of Data Processing Services (DPS); same address as the International Wheat Nurseries Coordinator.

In Table 2, a list of abbreviations is given as used by CIMMYT's data processing services. Names of diseases, quality parameters, agronomic conditions and other observations are indicated in various languages.

Table 2. Abbreviations used by the CIMMYT Data Processing Services, in English, Spanish and French.

Abbreviation	Scientific Name(s)	Variable name/scale	Nombre de la Variable/escala	Nom de la Variable/échelle
AL TOL	-	Aluminum tolerance (0-9 Scale)	Tolerancia a aluminio(escala 0-9)	Tolérance à l'aluminium (échelle 0-9)
ALT B	<i>Alternaria triticea</i>	Alternaria leaf blight (0-9 scale)	Tizón por alternaria (escala 0-9)	Alternaria (échelle 0-9)
ANT DMGE	-	Ant damage (percentage)	Porcentaje de daño de hormigas	Dégat du aux fourmis en pourcentage
APHD DMGE	-	Aphid damage (percentage)	Porcentaje de daño por áfidos	Dégat du aux pucerons en pourcentage
ARMY WORM	-	Army worm (percentage)	Porcentaje de gusano cogollero	Noctuelle en pourcentage
BAC S	<i>Xanthomonas campestris</i>	Bacterial stripe (0-9 scale)	Rayado bacteriano y pajilla negra (escala 0-9)	Rayure bactérienne (échelle 0-9)
BAC B	<i>Pseudomonas syringae</i>	Bacterial blight (0-9 scale)	Tizón bacteriano de la hoja (escala 0-9)	Brulure bactérienne des feuilles (échelle 0-9)
BAR S	<i>Pyrenophora graminea</i> (syn. <i>Drechslera gramineum</i> syn. <i>Helminthosporium gramineum</i>)	Barley stripe (0-9 scale)	Mancha estriada de la cebada (escala 0-9)	Taches brunes de l'orge (<i>Helminthosporium gramineum</i>) (échelle 0-9)
BIRD DMGE	--	Bird damage (percentage)	Porcentaje de daño por pájaros	Dégat du aux oiseaux en pourcentage
BYDV	--	Barley Yellow Dwarf Virus (0-9 scale)	Virus del enanismo amarillo de la cebada (escala 0-9)	Jaunisse nanisante de l'orge (échelle 0-9)
CHECK MARK	--	Check Mark (selected entries)	Entradas seleccionadas	Lignées ou variétés sélectionnées
COVD SMUT	<i>[Ustilago hordei (U.Kollen)]</i>	Covered smut (percentage)	Porcentaje de carbón cubierto	Cherbon couvert en pourcentage
EARS/M2	--	Ears per meter square	Espigas por metro cuadrado	Epis par M2
FALL NO	--	Falling number (seconds)	Actividad alfa amilasa (segundos)	Activité de l'alpha amylase (en secondes)
FERT %	--	Fertility (percentage)	Porcentaje de fertilidad	Fertilité en pourcentage
FRST DMGE	--	Frost damage (percentage)	Porcentaje de daño por heladas	Dégat du au gel en pourcentage
FUS N	<i>Fusarium nivale</i> (syn. <i>Monographellanivalis</i>)	Fusarium leaf blotch (0-9 scale)	Mancha de la hoja y moho niveo (moho blanco) (escala 0-9)	Tache de la feuille (<i>Fusarium nivale</i>)(échelle 0-9)
GERM %	--	Germination (percentage)	Porcentaje de germinación	Germination en pourcentage
HAIL DMGE	--	Hail damage (percentage)	Porcentaje de daño por granizo	Dégat du a la grêle en pourcentage
HEAD DAYS	--	Number of days to heading	Número de días al espigamiento	Nombre de jours a l'épiaison
HEL SP	<i>Helminthosporium spp.</i>	<i>Helminthosporium</i> , spp. (0-9 scale)	<i>Helminthosporium</i> sp. (escala 0-9)	<i>Helminthosporium</i> sp. (échelle 0-9)
L FIRE	--	Leaf fire (0-9 scale)	Tizón foliar (escala 0-9)	Sécheresse des feuilles (échelle 0-9)
LEAF RUST	<i>Puccinia recondita</i>	Wheat leaf rust (Cobb scale)	Roya de la hoja-trigo (escala de Cobb)	Rouille brune du blé (échelle de Cobb)
LEAF RUST	<i>Puccinia hordei</i>	Barley leaf rust (Cobb scale)	Roya de la hoja- cebada(escala de Cobb)	Rouille brune de l'orge (échelle de Cobb)
LODG %	--	Lodging (percentage)	Porcentaje de acame (vuelco)	Verse en pourcentage
LSE SMUT	<i>[Ustilago Nuda(U. tritici)]</i>	Loose smut (percentage)	Porcentaje de carbón volador	Charbon nu en pourcentage
MAT DAYS	--	Number of days to maturity	Número de días a la madurez	Nombre de jours à la maturation
MOIST %	--	Moisture (percentage)	Porcentaje de humedad	Humidité en pourcentage
NECK BRK	--	Neck breakage (percentage)	Porcentaje de rotura de cuello	Cassure du pèdoncule en pourcentage
NET B	<i>Pyrenophora teres</i> (syn. <i>Drechslera teres</i> , syn. <i>Helminthosporium teres</i>)	Net blotch (0-9 scale)	Mancha reticulada (escala 0-9)	Helminthosporium de l'orge (échelle 0-9)
NOBS	--	Number of observations	Número de observaciones	Nombre d'observations
PLNT DENS	--	Plant density (stems/m2)	Densidad de plantas (tallos/metro cuadrado)	Population de plantes (tiges/M2)
PLNT HT	--	Plant height (cm)	Altura de planta (cm)	Hauteur (cm)
POW M	<i>Erysiphe graminis</i>	Powdery mildew (0-9 scale)	Oidio o cenicilla polvorienta (escala 0-9)	Oïdium (échelle 0-9)
PROT %	--	Protein (percentage)	Porcentaje de proteína	Protéine en pourcentage
SCAB %	<i>Fusarium spp.</i>	Head scab (percentage)	Porcentaje de roña	Fusarium de l'épi en pourcentage
SCLD	<i>Rhynchosporium secalis</i>	Scald (0-9 scale)	Escaldadura (escala 0-9)	Rhynchosporium (échelle 0-9)
SDMT INDX	--	Sedimentation index (cc)	Indice de sedimentación (cc)	Indice de sédimentation (cc)
SEP N	<i>Leptosphaeria nodorum</i> (syn. <i>Septoria nodorum</i>)	Septoria glume blotch (0-9 scale)	Tizón de la gluma (escala 0-9)	<i>Septoria nodorum</i> (échelle 0-9)
SEP S	<i>Septoria spp.</i>	Septoria glume/leaf blotch (0-9 scale)	Septoria sp. (escala 0-9)	<i>Septoria</i> spp. (échelle 0-9)
SEP T	<i>Mycosphaerella graminicola</i> (syn. <i>Septoria tritici</i>)	Septoria leaf blotch (0-9 scale)	Mancha foliar ó tizón foliar (escala 0-9)	<i>Septoria tritici</i> (échelle 0-9)
SHTR %	--	Shattering, head (percentage)	Porcentaje de desgrane (espiga)	Egrenage en pourcentage
SPT B	<i>Cochliobolus sativus</i> (syn. <i>Bipolaria sorokiniana</i> , syn. <i>Helminthosporium sativum</i>)	Spot blotch (0-9 scale)	Tizón foliar (escala 0-9)	Tache de la feuille (<i>Helminthosporium sativum</i>) (échelle 0-9)
STEM RUST	<i>Puccinia graminis</i>	Stem rust (Cobb scale)	Roya del tallo (escala de Cobb)	Rouille noire (échelle de Cobb)
STRP RT.H	<i>Puccinia striiformis</i>	Stripe rust, head (percentage)	Porcentaje de roya amarilla (espiga)	Rouille jaune sur épi en pourcentage
STRP RT.L	<i>Puccinia striiformis</i>	Stripe rust, leaf (Cobb scale)	Roya amarilla-hoja (escala de Cobb)	Rouille jaune sur feuilles (échelle de Cobb)
STRP V	--	Barley stripe mosaic virus (scale 0-9)	Virus del mosaico lineal de la cebada (escala 0-9)	Mosaïque striée de l'orge (échelle 0-9)
TAN S	<i>Pyrenophora tritici-repentis</i> (syn. <i>Helminthosporium-tritici-repentis</i>)	Tan spot (0-9 scale)	Mancha foliar amarilla (escala 0-9)	<i>Helminthosporium tritici</i> (échelle 0-9)
TEST WT	--	Test weight (kg/hl)	Peso hectolítrico (kg/hl)	Poids spécifique (kg/hl)
1000 G.W.	--	1000 grain weight (gm)	Peso de 1000 granos (gramos)	Poids de 1000 grains (grammes)
YELL BERR	--	Yellow berry (percentage)	Porcentaje de panza blanca	Mitadinage en pourcentage
YIELD KG/HA	--	Yield (kg/ha)	Rendimiento kg/ha	Rendement kg/ha





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INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER
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