



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

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INTRODUCTION

Over the last five 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 wheat 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.

CIMMYT distributes from Mexico spring bread and durum wheat, and triticale nurseries. Winter and facultative bread wheat nurseries are distributed by the TURKEY/CIMMYT/ICARDA International Winter Wheat Improvement Program. Collaborative regional trials are also distributed from Central Asia, Siberia and the Eastern Gangetic Plains, and for specially targeted experimental probe experiments.

International testing is done on a voluntary basis; cooperators must request nurseries from CIMMYT. Cooperators, whether in the public or private sectors, are free to use the experimental materials contained in each nursery as defined by the Standard Material Transfer Agreement (SMTA).

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 data and reports made available 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.

MAIN TYPES OF NURSERIES

CIMMYT assembles and distributes four basic types of international nurseries:

- **Yield trials**
- **Screening nurseries**
- **Segregating populations**

In addition, CIMMYT user-defined “miscellaneous” nurseries are available upon special request basis.

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 from Mexico are:

- **Elite Selection Wheat Yield Trial (ESWYT)**
- **Semi-Arid Wheat Yield Trial (SAWYT)**
- **High-Rainfall Wheat Yield Trial (HRWYT)**
- **International Durum Yield Nursery (IDYN)**
- **International Triticale Yield Nursery (ITYN)**

Screening nurseries

These nurseries have three main objectives: (1) to provide an opportunity to evaluate the performance of new advanced lines from CIMMYT and 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 new sources of 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 rainfall environments are assembled and distributed to cooperators working in those particular environments. Other categories may include germplasm being developed and screened for high yield potential, warmer areas, semi-arid or cold environments, resistance to stem rust, leaf rust, stripe rust, helminthosporium, septoria, fusarium head scab, or soil-borne diseases and pests.

The principal international screening nurseries distributed by CIMMYT from Mexico are:

- **International Bread Wheat Screening Nursery (IBWSN)**
- **Semi-Arid Wheat Screening Nursery (SAWSN)**
- **High-Rainfall Wheat Screening Nursery (HRWSN)**
- **International Durum Screening Nursery (IDSN)**
- **International Triticale Screening Nursery (ITSN)**

Segregating populations

These nurseries usually are composed of F₂-derived 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 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 database.

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. 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.

Yield trials

CIMMYT yield trials are made up of commercial cultivars and advanced lines, replicated two times. Yield trials are the only replicated nurseries distributed by CIMMYT; all other CIMMYT nurseries are non-replicated. “Light” set versions of yield trials are distributed to those locations where the respective yield trial would not adapt well, but where the genetic diverse germplasm could be useful, or where nurseries first need to be multiplied in quarantine areas.

Six-row plots, 3 meters in length, are recommended. Seed is either packaged in individual 15g envelopes, one for each row of the plot (version *6) for hand planting, or packaged for machine planting, with one large envelop (version *1), 85g for each plot containing enough seed to plant six rows. In each replication, one envelope (one entry) is reserved for the cooperator's own local check cultivar.

The cultivar or line number and the plot number are identical in the first replication, but the cultivars and lines have been assigned at random.

Each cooperator should use their own local, experimental plot practices to sow these nurseries. **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.

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 (10g) 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 of the following three non-replicated planting plans:

- a) One row, 5 meters long
- b) Two rows, 2.5 meters long
- c) Two 2.5 meter rows at 2 locations
- d) Five 1 meter rows at 5 locations

The spacing between rows and the shape and dimensions of the field layout are left to the discretion of the cooperator. If planting plan “c” or “d” is used, data from all locations should be reported.

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 field books (in duplicate) for recording the disease data and general agronomic performance information described in the following pages. Electronic field books are available at:

<http://www.cimmyt.org/iwin/index.htm>

Attached to the front of the data field books is a sheet requesting general information about the experiment. The information requested includes plot size, latitude, longitude, elevation, planting dates, 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.

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

CIMMYT recommends that cooperators use the "Rust Scoring Guide" to facilitate the recording of uniform and accurate data on the cereal rusts:
http://www.cimmyt.org/english/docs/field_guides/rsg.pdf

Field notes on **leaf and stem 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, often referred to as a "trace" severity, should be denoted as 1% severity. The intervals used for recording severity are: 0%, 1%, 5%, 10%, 20%, 40%, 60% or 100%.

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

- 0** **No visible infection** on plants
- R** **Resistant** – Visible chlorosis or necrosis, *no uredia* are present
- MR** **Moderately Resistant** - *Small uredia* are present and surrounded by chlorotic or necrotic areas
- M** **Intermediate** - *Variable sized uredia* are present, some with chlorosis, necrosis, or both
- MS** **Moderately Susceptible** - *Medium sized uredia* are present and possibly surrounded by chlorotic areas
- S** **Susceptible** - *Large uredia* are present, generally with little or no chlorosis and no necrosis

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

- 1R** Trace severity with a resistant reaction
- 5MR** 5% severity with a moderately resistant reaction
- 60S** 60% severity with a susceptible reaction

Field notes on **yellow or stripe rust** use **only** severity (the percentage of rust infection on the plants or spikes) as severity changes rapidly and is difficult to score for this pathogen, or other foliar diseases may obscure the reaction type.

Other foliar diseases

A field guide for the identification of wheat diseases and pests can be obtained at: http://www.cimmyt.org/english/docs/field_guides/wdp.pdf. 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.

After anthesis, disease severity in the field is best evaluated using the double-digit scale (00-99). The first digit (D_1) indicates disease progress in the canopy height from the ground level; the second digit (D_2) refers to measured severity based on diseased leaf area. Both D_1 and D_2 are scored on a scale of 1 to 9. For each score, percentage disease severity is estimated based on the following formula: $\text{Severity (\%)} = (D_1/9) \times (D_2/9) \times 100$

Other diseases and pests

The data field books 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. 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.

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. To enhance the uniformity of reporting, CIMMYT asks that whenever possible the following types of data (in the units specified) be recorded.

- **Maturity:** Two measurements of maturity are requested:

- 1) The number of days between germination and **heading**. 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 spikes are ripe.

- **Straw:** Two notes on straw characteristics should be recorded:

- 1) The average **plant height** of the plants in a row (in centimeters) 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).

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

- **Grain yield:** Each cooperator should use their own local, experimental plot management practices to harvest these nurseries. To reduce errors due to bird damage and shattering, the nursery should be cut as soon after physiological maturity as possible. Data should be recorded in grams (g) per plot. Please clearly indicate on the data sheets any modifications made in plot sizes or shapes, and the area actually harvested.

For screening nurseries, yield data is requested **only** for the lines selected for harvest. These data give an indication of the yield potential and are therefore useful (but not vital) in subsequent breeding efforts.

- **1000 grain weight:** The 1000 grain weight is expressed in grams (g) per 1000 kernels. Smaller units (e.g. 100 kernels) can be weighed with the resulting 1000 grain weight calculated.

- **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.

- **Agronomic Score and Check Mark:** Throughout the growing season, cooperators usually evaluate periodically the phenotypic development of nursery entries. CIMMYT recommends the following **agronomic score** and **check mark** (√) scales for recording these observations:

| | |
|--------------------------------|---|
| 0 Poor, unacceptable phenotype | 5 Outstanding phenotype |
| 3 Good phenotype | √ The entry has been selected to be harvested |

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 factors: A 0-9 or percentage (%) scale should be used for any other agronomic factors for which differential data can be taken, e.g., cold tolerance, sterility, shattering, rat, bird or hail damage, etc., as shown below:

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

RETURNING DATA TO CIMMYT

Please return data to CIMMYT as soon after harvest as possible. It is important that data be returned quickly, so that preliminary reports can be prepared and made available to other cooperators. Data return reminders may be sent to increase the return rate.

We prefer that data be returned to CIMMYT, by email attachments, in the electronic field book format available at:

<http://www.cimmyt.org/iwin/index.htm>.

Return electronic files to: Efren Rodriguez (E.Rodriguez@cgiar.org) or Tom Payne (T.Payne@cgiar.org)

Alternately, data may be returned to CIMMYT by airmail on one of the two paper field books supplied with each nursery sets.

The second copy of the data sheets should be kept for the cooperators' records. When data is received and processed, summarized analyses can be found at: <http://www.cimmyt.org/wpgd/index.htm>

Data and suggestions of how to improve IWIN trials should be returned to:

International Wheat Nurseries Coordinator

Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)

Apdo. Postal 6-641

Col. Juarez Deleg. Cuauhtemoc

06600 Mexico, D.F.

Or to: T.Payne@cgiar.org and E.Rodriguez@cgiar.org

REFERENCES

International Nurseries and Genebank seed requests can be placed at:
http://www.cimmyt.org/english/wps/obtain_seed/sidu.htm

International nursery electronic field books are available at:
<http://www.cimmyt.org/iwin/index.htm>

International nursery phenotypic data summaries can be found at:
<http://www.cimmyt.org/wpgd/index.htm>

The "Rust Scoring Guide" is available at:
http://www.cimmyt.org/english/docs/field_guides/rsg.pdf

“Wheat Diseases and Pests: A guide to field identification” is available at:
http://www.cimmyt.org/english/docs/field_guides/wdp.pdf

Other CIMMYT publications can be found at:
<http://www.cimmyt.org/english/wps/publs/Catalogdb/index.cfm>

CIMMYT Wheat Doctor. Wheat Doctor provides a simple, stepwise method for identifying wheat production problems and pests, and suggests ways you can overcome these problems.
<http://wheatdoctor.cimmyt.org/>