# Evaluation of Genetic Variations and Breeding Values of Durum Wheat Lines in a Semi-Arid Environment of Tunisia

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Keywords : *Triticum* sp. - Durum wheat - Breeding - Selection.


## Summary

*Thirty one durum wheat lines introduced from the International Center of Agricultural Research in the Dry Areas (ICARDA) Durum Wheat Drought and Heat Tolerance Observation Nursery were investigated on main agronomic characters under the rainfed conditions of the Kef semi-arid region of Tunisia during the 1991/92 and 1992/93 growing seasons for evaluation of their genetic variations and breeding values.*

*All characters showed relatively large variations. Some lines performed better than the most commonly grown local cultivars included in the experiment as checks. Selection based on mean productivity defined as the average yield over the two growing seasons was applied in order to select the best genotypes. Eight elite lines were identified.*

## Résumé

*Trente et une lignées de blé dur provenant de la Pépinière d'Observation de la Tolérance à la Chaleur et à la Sécheresse du Centre International de la Recherche Agricole dans les Régions Arides (ICARDA) ont été étudiées sous les conditions pluviales de la région tunisienne semi-aride du Kef pendant les deux campagnes agricoles de 1991/92 et 1992/93. L'objectif était d'évaluer leurs variations génétiques pour les principaux caractères agronomiques et leur valeur d'amélioration ainsi que d'effectuer une sélection basée sur la productivité moyenne définie comme le rendement moyen pendant les deux campagnes agricoles.*

*Tous les caractères observés ont montré de larges variations. Quelques lignées se sont comportées mieux que les variétés locales les plus couramment cultivées incluses dans l'essai en tant que témoins. Huit lignées élites ont été identifiées.*


## Introduction

In Tunisia, durum wheat is an important cereal crop grown under rainfed conditions in about 58% of the acreage reserved to cereals (1.2 to 1.5 million hectares). Average yields are irregular and always depend on prevailing weather conditions. Demand for wheat continues to outpace supply and will not be met unless high-yielding cultivars are grown. Identification of such cultivars is the best and most economical method for increasing wheat production. Research on cereal improvement has developed a limited number of adapted cultivars. However, modern agricultural technology demands many cultivars with satisfactory mean yields. A strategy of selection based on mean yields across seasons and sites is efficient in accounting for variability in yield and hence lowers risk and raises profit to the growers (3, 4).

A wide wheat germplasm base is the foundation of any crop improvement process and must be available in order to enhance yielding ability (2, 5). Commercially acceptable cultivars may emerge from the manipulation of introduced genetic resources. Evaluation of them is of prime importance in selecting desirable types (1).

The purpose of this study was to determine major agronomic characters of durum wheat lines introduced from the International Center for Agricultural Research in the Dry Areas (ICARDA) to Tunisia and to compare their yield potential with that of commercial cultivars grown in the Kef semi-arid area of Tunisia.

## Material and Methods

Thirty one durum wheat lines (Table 1) selected from the ICARDA's Durum Wheat Drought and Heat Tolerance Observation Nursery were investigated on main agronomic characters under the rainfed conditions of the Kef semi-arid region of Tunisia during the 1991/92 and 1992/93 growing seasons for evaluation of their genetic variations and breeding potential. The lines included in the trials were initially selected at ICARDA in Aleppo, Syria, under low to moderate rainfall conditions. All entries are spring types. Before being brought to the trial, they were subjected to a seed increase process during the 1990/91 growing season at the Experiment Station of the «Ecole Supérieure d'Agriculture du Kef», Tunisia.

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**Table 1**
**Name or Cross / Pedigree of the durum wheat lines**

| Entry | Name or Cross / Pedrigree[1] |
|---|---|
| **Introduced germplasm** | |
| 01 | Om rabi 5 |
| 02 | Ru/Wascana<br>ICD84-0665-6AP-TR-22AP-0TR |
| 03 | Ru/Wascana<br>ICD84-0665-6AP-TR-26AP-0TR |
| 04 | Rufom-9<br>ICD84-1257-7AP-TR-2AP-0TR |
| 05 | Rufom-10<br>ICD84-1257-7AP-TR-3AP-0TR |
| 06 | Rufom-6<br>ICD84-1257-7AP-TR-5AP-0TR |
| 07 | Ru/Mrb15<br>ICD84-1257-7AP-TR-11AP-0TR |
| 08 | Omguer-4<br>ICD85-0988-6AP-TR-2AP-0TR |
| 09 | Belikh 2<br>L92-6AP-1AP-1AP-0AP |
| 10 | Guerou 1<br>ICD79-1463-1AP-2AP-4AP-0AP |
| 11 | GdoVZ 512/Cit/Ruff/Fg/3/Nile<br>ICD86-0615-ABL-0TR-2AP-0TR |
| 12 | GdoVZ 512/Cit//Ruff/Fg/3/DWL 5023<br>ICD86-0838-ABL-0TR-4AP-0TR |
| 13 | Mrb3/Chen<br>ICD85-0642-ABL-5AP-0TR-7AP-0TR |
| 14 | Mrb3/Chen<br>ICD85-0642-ABL-28AP-0TR-2AP-0TR |
| 15 | Mrb SH/Heider<br>ICD85-0910-ABL-2AP-0TR-12AP-0TR |
| 16 | Omtel-2<br>ICD-BM-ABL-405-0AP |
| 17 | Om rabi 5 |
| 18 | Rusomar-1<br>ICD-BM-ABL-406-0AP |
| 19 | Stk/4/Jo/3/Cr//Cit 71<br>ICD83-0050-3AP-6AP-0TR |
| 20 | Om rabi 3<br>L 0589-4L-2AP-3AP-0AP |
| 21 | Stk/4/Jo/3/Jo/Cr//Cit71<br>ICD-BM-ABL-306-0AP |
| 22 | Chahba 88/Khb2<br>ICD85-0666-ABL-TR-5AP-0TR |
| 23 | Korifla |
| 24 | Khb1//BD2014/Rabi<br>ICD85-0305-ABL-2AP-0TR |
| 25 | GdoVZ 2512/Cit//Ruff/Fg/3/Nile<br>ICD86-0615-ABL-0TR-1AP-0TR |
| 26 | GdoVZ512/Cit//Ruff/Fg/3/GgoVZ449<br>ICD85-1517-ABL-1AP-0TR-4AP-0TR |
| 27 | Krf/Baladia Hamra//Krf<br>ICD86-1753-ABL-2AP-0TR-1AP-0TR |
| 28 | Aw12/Bit<br>ICD84-0322-ABL-5AP-TR-AP-6AP-0TR |
| 29 | Carzio (Italy) |
| 30 | Acsad 71/4/Plc/Ibis//Gta/Bit/3/Gd<br>ACSAD 88 9-42-0AP |
| 31 | Gta/Tc60//Stk/3/Chahba 88<br>ICD86-1031-ABL-3AP-0TR |
| **Local checks** | |
| 32 | Chili |
| 33 | INRAT 69 |
| 34 | Karim |
| 35 | Ben Bechir |
| 36 | Razzek |

[1] All crosses are made in ICARDA, Aleppo, Syria

Annual precipitation at the experimental site has historically fluctuated between 300 mm and 500 mm with most rainfall occurring during the period 1 October to 30 April. Monthly precipitation (mm) during the two growing seasons, respectively for 1991/92 and 1992/93, was 56.5 and 19.5 in September, 52.6 and 48.7 in October, 32.6 and 59.7 in November, 16.1 and 56.4 in December, 28.4 and 21.3 in January, 62.3 and 24.9 in February, 31.1 and 45.1 in March, 95.8 and 7.3 in April, 82.1 and 44.5 in May, and 27.7 and 14.8 mm in June (a total of 485.2 and 338.2 mm). The soil at the test site is an sandy clay loam, not well developped, deep, and a fine textured vertisol. On a volume basis, it has a field capacity of 27% and a wilting point of 12%. Prior to each trial the site was a fallow. Field tillage consisted of a deep fall plowing followed by a good seed bed preparation. Fertilizers were applied at the recommended rates (based on soil test results) for optimum wheat yield. Plots were kept weed free by a periodic hand weeding.

The experimental design was a randomized complete block design with four replications. Plots were 5 m long with 6 rows spaced 20 cm apart. Seeds were drilled at a rate of 250 grains/$m^2$. At maturity, the four center rows of each plot were harvested with a Hege plot combine and yield corrected to 13% moisture.

Measurements were taken on grain yield, 1,000-kernel weight, days to heading, plant height, and leaf rust and septoria infections. The data collected for each trait was subjected to an analysis of variance. The least significant difference (LSD) value appropriate for comparing two cultivar means was computed.

Since in Tunisia moisture stress is unpredictable from year to year, selection based on mean productivity defined as the average yield over the two growing seasons was applied.

## Results and Discussion

Grain yield differences among the entries were highly significant during every growing season. All entries produced more yield during the 1991/92 than during the 1992/93 growing season. The mean grain yield ranged from 2946 to 7298 kg/ha in 1991/92 and from 1502 to 3441 kg/ha in 1992/93 (Table 2). During the 1992/93 growing season, none of the introduced cultivars performed better than the cultivars Karim, Ben Bechir and Razzek (checks), the most widely grown cultivars in Tunisia (Table 2). However, during this same year, some introduced cultivars out yielded the other two checks, Chili and INRAT 69 which are grown in an important acreage in the semi-arid region of Tunisia because they are more drought tolerant than the remaining checks used in this experiment. The mean yield (pooled over the 2 years) of the introduced lines was compared to that of the checks. The lines which out yielded the mean of the checks by more than 10% were identified as high yielding lines. These lines were decreasing, yielding : No. 28, No. 08, No. 26, No. 27, No. 01, No. 22. No. 03, and No. 09. They were associated with 137%, 123%, 122%, 118%, 116%, 116%, 113%, and 112% of the overall mean seed yield of the checks, respectively. Thus, they

might have the potential of becoming varieties used in the semi-arid conditions of Tunisia or may be utilized as parents in future crosses. Despite the favorable environmental conditions, Om rabi 3 (entry No. 20), compared to the remaining introduced lines, was associated with the minimum grain yield value in 1991/92 (Table 2). This cultivar is going to be released in Tunisia as a registered variety but from the results of this experiment it does not seem to be a desirable type in Le Kef semi-arid region of Tunisia.

**Table 2**
**Mean of the major agronomic characters of the germplasm during the 1991/92 and 1992/93 growing seasons**

| | Agronomic character* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1991/92 | | | | 1992/93 | | | |
| | SY | KW | DH | PH | SY | KW | DH | PH |
| Entry No. | | | | | | | | |
| 01 | 5747 | 52.4 | 137 | 103 | 2396 | 44.9 | 139 | 92 |
| 02 | 4647 | 53.8 | 148 | 123 | 1809 | 46.8 | 151 | 110 |
| 03 | 5680 | 51.7 | 140 | 96 | 2211 | 50.0 | 141 | 87 |
| 04 | 4995 | 46.9 | 140 | 116 | 1502 | 43.8 | 144 | 101 |
| 05 | 4318 | 42.8 | 148 | 126 | 2322 | 39.5 | 149 | 108 |
| 06 | 5160 | 49.7 | 141 | 125 | 1858 | 43.7 | 143 | 103 |
| 07 | 4682 | 51.2 | 141 | 128 | 1598 | 41.8 | 140 | 105 |
| 08 | 6180 | 52.4 | 137 | 118 | 2415 | 46.9 | 140 | 93 |
| 09 | 6032 | 53.4 | 146 | 97 | 1794 | 44.4 | 144 | 82 |
| 10 | 4336 | 54.5 | 137 | 94 | 2020 | 50.1 | 141 | 85 |
| 11 | 5544 | 56.7 | 138 | 93 | 1940 | 48.6 | 141 | 79 |
| 12 | 5384 | 48.7 | 135 | 104 | 2183 | 44.0 | 133 | 87 |
| 13 | 5322 | 49.5 | 138 | 121 | 1901 | 44.4 | 140 | 102 |
| 14 | 5325 | 49.1 | 148 | 122 | 2246 | 42.8 | 151 | 107 |
| 15 | 4237 | 49.0 | 136 | 130 | 2159 | 43.0 | 135 | 112 |
| 16 | 4703 | 51.2 | 138 | 135 | 2489 | 43.9 | 142 | 115 |
| 17 | 5085 | 52.3 | 134 | 101 | 2166 | 47.4 | 139 | 86 |
| 18 | 4862 | 53.4 | 136 | 123 | 1955 | 46.0 | 139 | 104 |
| 19 | 5396 | 54.1 | 147 | 96 | 1694 | 47.1 | 146 | 83 |
| 20 | 4073 | 50.2 | 134 | 107 | 2135 | 43.3 | 132 | 94 |
| 21 | 5801 | 50.0 | 133 | 110 | 1820 | 43.7 | 130 | 90 |
| 22 | 5448 | 55.1 | 137 | 110 | 2662 | 49.6 | 140 | 90 |
| 23 | 5152 | 52.2 | 140 | 93 | 1680 | 47.1 | 144 | 81 |
| 24 | 4635 | 54.2 | 141 | 100 | 2042 | 50.4 | 146 | 88 |
| 25 | 5033 | 54.2 | 142 | 95 | 1746 | 50.0 | 148 | 85 |
| 26 | 6405 | 52.3 | 146 | 87 | 2179 | 46.1 | 149 | 79 |
| 27 | 6477 | 50.8 | 148 | 100 | 1824 | 46.9 | 150 | 85 |
| 28 | 7298 | 50.1 | 147 | 108 | 2276 | 44.0 | 144 | 89 |
| 29 | 4516 | 53.4 | 146 | 90 | 2046 | 49.2 | 145 | 81 |
| 30 | 5097 | 45.2 | 134 | 88 | 2064 | 39.7 | 131 | 80 |
| 31 | 4177 | 49.4 | 141 | 102 | 2349 | 43.2 | 137 | 94 |
| 32 | 2946 | 58.4 | 167 | 135 | 1850 | 54.6 | 165 | 130 |
| 33 | 3462 | 56.7 | 157 | 110 | 2356 | 53.8 | 155 | 100 |
| 34 | 5359 | 49.8 | 140 | 90 | 3284 | 51.2 | 142 | 85 |
| 35 | 4614 | 48.1 | 138 | 82 | 3441 | 43.8 | 138 | 78 |
| 36 | 4572 | 52.3 | 140 | 83 | 3156 | 54.7 | 141 | 81 |
| Mean | 5075 | 51.5 | 142 | 107 | 2155 | 46.5 | 143 | 93 |
| LSD (0.05) | 560 | 5.2 | 07 | 15 | 230 | 3.9 | 05 | 13 |

* SY = seed yield (kg/ha), KW = 1,000-kernel weight (g), DH = days to heading, PH = plant height (cm), LR = leaf rust score (0 = no visible infection, Tr = traces), SP = septoria score.

Although high grain yield is the main selection criterion for variety adaptation, 1,000 kernel weight, heading dates, plant height, and disease resistance are important agronomic traits. Cultivars with plump seeds are generally more appreciated by farmers. Early maturing cultivars escape late season moisture stress. Semi-dwarf types are resistant to lodging and very responsive to the addition of water and fertilizers. Resistance to diseases is the cheapest and most efficient way to plant protection. Genetic variability for these traits was present (Table 2). Most introduced lines performed better than the local checks with regard to all these traits except for 1,000-kernel weight.

## Conclusion

The superiority of some introduced lines was confirmed. The selected lines in this preliminary screening may be possibly adapted to Le Kef semi-arid region of Tunisia and could be used as cultivars there. They may also be utilized in a breeding program designed to improve the yield and other major agronomic traits of the local cultivars.

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COMMUNIQUE DE PRESSE

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Le deuxième séminaire international sur le Safoutier et autres oléagineux non conventionnels s'est tenu à Ngaoundéré du 3 au 5 Décembre 1997 dans les locaux de l'Ecole Nationale Supérieure de Sciences Agro Industrielles (ENSAI) de l'Université de Ngaoundéré (Cameroun) avec le financement de l'Institut Africain-Américain (AAI), USA, de La Coopération Technique Allemande (GTZ), du Centre Technique de Coopération Agricole et Rurale (CTA), Convention de Lomé ACP-UE, de la Commission Internationale de Génie Rural (CIGR) Belgique.

Le programme comportait une cérémonie d'ouverture, une exposition des oléagineux non conventionnels et des publications, des sessions scientifiques, des conférences débats, une visite d'usine et d'un jardin de safoutiers, une cérémonie de clôture.

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