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# Evaluation of Durum Wheat Promising Lines using on-Farm Research in Farmer's Fields

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## ABSTRACT

On-farm research method has been known as an effective non formal educational method. In order to transmit the new applied researches results into farmers' field, this study was conducted to compare grain yield of four durum promising lines along with two durum and one bread wheat varieties local checks using randomized complete block designed (RCBD) in two farmer fields during 2010-2011 cropping season. Agronomical practices such as preparing of seedbed, using of fertilizer and so on did basis on conventional local of trial sites. The results of the combined analysis of variance showed that there were significant differences ($p<0.05$) between two experimental locations for day to grain maturity, number of spike $m^{-2}$ and grain per spike. Also, there were highly significant differences ($p<0.01$) between different genotypes for all the studied traits. In addition, there was a highly significant difference for interaction of genotype × location on grain yield. The highest values of day to heading, day to maturity, grain filling period, number of spike $m^{-2}$ and grain yield were produced by Bahar bread wheat cultivar. However, there were no significant difference between Bahar and durum wheat genotypes of Arya, D-84-3 and D-86-6. The results of genotypic effect and genotype × location interaction on grain yield imply that D-84-3 promising durum wheat line among durum wheat genotypes was produced the highest grain yield in on-farm experimental sits and might be used as a stable breeding materials under farmer's field condition.

**Key words**: genotype, grain filling, grain maturity, grain yield, kernel weight, location

## INTRODUCTION

Mankind is totally dependent on crops for most of his food, as well as for many other important needs. Currently crops occupy nearly one fifth of the planet's vegetated surface, by far the biggest imprint of man upon the planet and its landscapes. Cropping is also the world's largest source of employment and livelihood, with well over 1 billion small farmers in developing countries [1, 2]. The dramatic increase in world food production over the past half century has been from increased crop yields. It is generally agreed that future increase in world food production will become even more dependent on increased yield as the amount of cultivated area in the world continues to decrease [3]. In the other hand, many farmers in rural areas do not have the most up-to-date information on how to grow food efficiently and economically. Improving their knowledge including new methods, techniques and educations can help to increase the farmers' level of productivity.

Now a day, there are different methods and tools for technology transfer to the farmer's field. On-farm research has been known as an essential implement and effective method for developing and transmitting the new applied researches results into farmers' field. It also has an indispensable duty for screening and substantiation of farming applied science under local farmer's conditions. Furthermore, on-farm research creates a suitable condition for participatory management of the researchers, extension agents and farmers for the finding of agricultural problems in the rural areas [4].

Amongst the crop plants, wheat is the dominant crop in temperate countries being used for human food and livestock feed. It is a widely adapted crop which is grown in temperate, irrigated to dry and high rain-fall areas and in warm, humid to dry and cold environments. Undoubtedly, this wide adaptation has been possible due to the complex nature of the plant's genome, which provides great adjustability to the crop [5, 6]. The most important modern wheat species now are the hexaploid bread wheat (*Triticum aestivum spp*) and the tetraploid durum wheat (*Triticum turgidum durum*), which are distinctive based on their genomic number, grain composition and food end-use quality attributes [7]. However, durum wheat is a crop adapted to marginal lands. Sowing area of durum wheat in the world is 13.7 million ha which constitutes 6% of the total wheat sowing area with production averaging about 30 million tons annually. Durum wheat has the hardest grain of all wheat and is used to make semolina. With its strong gluten properties and superior cooking characteristics, semolina is used in pasta products such as macaroni, and spaghetti [6, 8, 9].

Historically durum wheat has received insufficient attention from breeders and farmers. Even in areas with low rainfall, farmers prefer to cultivate bread wheat, which relegates durum wheat cultivation to more marginal areas. It can be due to insufficient suitable durum wheat seeds compared to bread wheat for planting in different environmental conditions. One of the best options for crop production, yield improvement, and yield stability is to

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develop and cultivate new high yielding durum varieties [10, 11, 12]. Yield is a complex trait and is the result of environmental factors as well as interaction of many minor-effect characteristics by low heritability especially under dry land condition [13]. Increasing of spikes per square meter has shown a negative direct effect on grains per spike and grain weight [14]. The objective of present study was to determine the yield and yield components of the different durum and bread wheat genotypes under farmers' field conditions.

## MATERIALS AND METHODS

Field experiments were done during the 2010-2011 growing season in Neyshabur and Mashhad farmer's fields at the Khorasan-e-Razavi province, Iran. The study was conducted to compare grain yield of four durum promising lines (D-83-10, D-84-3, D-86-5 and D-86-6) along with two durum wheat varieties checks (Dena and Arya ) and one bread wheat variety (Bahar). At each experimental location, all genotypes were sown according to completely randomized block design with three replications. Agronomical practices of trial sites such as preparing of seedbed, using of fertilizer and so on were conducted basis on local conventional condition. The soil texture at the experimental fields was clay loam. Before sowing, 50, 90 and 50kg NPK were added to all the fields. Additionally, 70 kg N was top-dressed. Wheat was sown in the autumn at a sowing density of 500 seed m-1 based on 1000-kernel weight. Each experimental plot consisted of 12 rows, 10 meters in length and spaced 20 cm apart. Based on this, the plot size was 24 $m^2$ (12 × 10 × 0.2). Collected data were subjected to the analysis of variance (ANOVA) using MSTATC software upon combining the locations. Before doing an ANOVA, the data were analyzed for homogeneity of variances using a Bartlett test. Finally, comparative analyses of the means were performed using the Duncan's Multiple Range Test (P < 0.05 and P < 0.01).

## RESULTS AND DISCUSSION

The result of Bartlett test for homogeneity of variances revealed that combined analysis of variance in two experimental locations are practicable on day to heading, day to maturity, maturity duration, number of spikes $m^{-2}$, number of grain $spike^{-1}$, 1000-grain weight, and grain yield. The results of the combined analysis of variance (Table 1) showed a strong influence of the genotypes in all the traits, which demonstrate the presence of genetic variability among studied durum and bread wheat genotypes. Location mean squares were also highly significant (P<0.01) for day to heading, day to maturity and also significant (P<0.05) for 1000-grain weight. It can be concluded that differences among genotypes for those three traits were mainly controlled by environmental variance. Instead, genotype and location (G × L) interaction was no significant for all the traits studied except for grain yield at P<0.01. Askarinia et al. [15] reported that interaction of genotype × environment on wheat had the most shares in justifying grain performance variation. This may lead breeder for desirable selecting of the traits studied, along with yield and its components in different conditions.

**Table 1.** Combined analysis of variance for agronomical parameters (DHE: days to heading; DMA: days to physiological maturity; MD: maturity duration; S/m²: number of spike per square meter; K/S: kernel number per spike; TKW: thousand kernel weight GY: grain yield) in studied wheat genotypes

| Mean square (MS) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **S.O.V** | **df** | **DHE** | **DMA** | **MD** | **S/m²** | **K/S** | **TKW** | **GY** |
| **Location (L)** | 1 | 277** | 133** | 25.9 | 4100 ns | 0.03 ns | 107* | **0.1 ns** |
| **Genotype (G)** | 6 | 72.5** | 174.4** | 35.5** | 4279** | 70.4** | 49* | **0.4**** |
| **L×G** | 6 | 0.49 ns | 3.32 ns | 3.1 ns | 884 ns | 0.8 ns | 10 ns | **0.3**** |
| **Error** | 24 | 0.92 | 3.49 | 4.9 | 604 | 0.5 | 16 | **0.4** |
| **CV %** | - | **0.76** | **1.12** | **5.06** | **7.47** | **1.44** | **9.67** | **4.4** |

*Significant difference at $P < 0.05$  **significant difference at $P < 0.01$  ns: no significant

### *Day to heading, maturity and maturity duration*

Analysis of the combined data revealed that location and genotype had highly significant effect on both number of day to heading and maturity, while their interaction showed non-significant variation. In addition, genotype showed highly significant effect on maturity duration (Table 1). The combined data (mean values) exhibit that maximum (132.2) day to heading, (178.8) day to maturity, and (46.6) maturity duration were recorded in Bahar bread wheat cultivar, while the minimum (122.7) day to heading and (162.7) day to maturity were noted in Dena durum wheat cultivar. Moreover, D-84-3 promising durum wheat line exhibited the lowest maturity duration amongst all the studied genotypes (Table 2). Early maturity has been known as a major drought escaping mechanism and superior characteristic particularly under terminal drought stresses in dry region (16, 17). Therefore, Dena and D-84-3 durum wheat genotypes had better performance related to early maturity in comparison to Bahar bread wheat cultivar. The results are in agreement with those of Moayedi et al. [11] who reported early maturity and better performance of durum wheat compared to bread wheat genotype.

***Grain yield***

The analysis of the combined data showed that differences among the genotypes and also genotype × location interaction were significant statistically (P<0.01) while the location showed non-significant variation. As it seen in Table 2, Grain yield of the genotypes ranged from 3767 to 5067 kg $ha^{-1}$ with a mean value of 4519 kg $ha^{-1}$ (Table 2). The highest grain yield was obtained from the Bahar bread wheat cultivar. It followed by D-84-3 (4917 kg $ha^{-1}$) and Arya (4850 kg $ha^{-1}$) durum wheat genotypes. Although, those genotypes produced different grain yield, nonetheless there were no significant difference among the noted genotypes. In the other hand, the lowest grain yield was obtained from D-83-10 durum wheat line. It had significant difference to all the studied genotypes except the D-86-5 durum wheat line. As it seen in Fig.1, for interaction of genotypes with location, the highest grain yield (5133 kg $ha^{-1}$) was produced by D-84-3 durum wheat line in Neyshabur location (L1 G4). It followed by L2G7, L1G1, L2G2, L2G4 and L1G7 treatments which was observed statistically similar results. The results also observed that minimum grain yield (3500 kg $ha^{-1}$) was produced by D-83-10 durum wheat genotype in the Neyshabur location (L1G3).

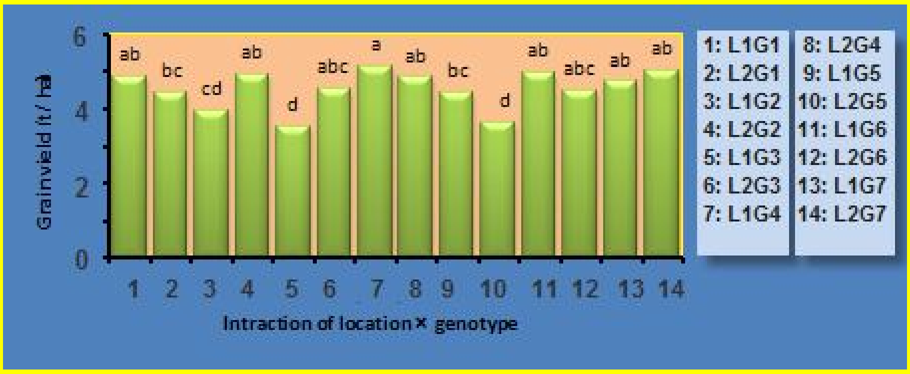


**Figure 1**. Interaction of genotypes × location on grain yield

***Number of spike $m^{-2}$***

Perusal of the combined data revealed significant effect of genotype on number of spike $m^{-2}$, while the location and their interaction showed non-significant variation, which has explained equal reaction of the studied genotypes in two experiment locations (Table 1). The data exhibit that maximum (402) spikes $m^{-2}$ were obtained to Bahar bread wheat cultivar, while the minimum (302) spikes $m^{-2}$ were recorded in D-86-6 durum wheat genotype. Although, there were non-significant differences amongst all the studied wheat genotype except Bahar bread wheat cultivar (Table 2). The results agreed with moayedi et al. [11] who reported higher spike $m^{-2}$ in bread wheat compared to durum genotypes. Protić et al. [18] also showed strong correlation between grain yield and number of spikes per m². Thus, variations in grain yield of the studied genotypes might be predominantly associated with variations in spikes per square meter. For breeders, the spike number through direct effect on grain yield and via 1000-grain weight can be defined as an indirect selection criterion in new high-yielding durum wheat varieties.

***Number of kernel spike $^{-1}$***(k/s)

The results of combined analysis of variance showed that genotype had highly significant effect on Number of kernel spike $^{-1}$, while the location and their interaction showed non-significant variation in this study. Maximum number of kernel spike$^{-1}$ were produced by D-86-6 (51.6 k/s), D-83- 10 (50.6 k/s) and D-84-3 (50.4 k/s) promising durum wheat lines, while minimum number of kernel spike$^{-1}$ was produced by Bahar bread wheat cultivar (43.1 k/s). Although, it has been previously reported (19) that high yield in the new bread and durum wheat varieties are associated with the increasing number of grain per spike. The results of the present study showed the adverse outcome. In addition, Moustafa [20] also noted that the number of kernel spike$^{-1}$ is determined during the floral initiation to anthesis. Therefore, this stage period might be considered as the most crucial growth and developmental stage for the final grain yield.

***1000-kernel weight***

The analysis of the combined data revealed that differences among the location and genotypes were significant statistically (P<0.05) on 1000-kernel weight, while their interaction showed non-significant variation (Table 1). The data (Table 2) exhibit that maximum (44.6 g) 1000-kernel weight was obtained to Dena durum wheat cultivar, while the minimum (36.3 g) 1000-kernel weight was recorded by D-86-6 durum wheat line. There were no significant differences among all the studied genotypes related to 1000-kernel weight, except D-86-6 durum wheat line**.** The kernel spike$^{-1}$ has a predominant importance over the kernel weight in grain yield. Nonetheless, grain weight is well documented to be a major yield component determining final yield in Mediterranean environments (21). Most of reports has noted on positive correlation between grain yield and 1000-kernel weight. [11, 22]. In contrast, Ehdaei et al. [23] reported negative correlation between 1000-kernel weight and grain yield.

**Table 2.** Mean values of agronomical parameters (DHE: days to heading; DMA: days to physiological maturity; MD: maturity duration; S/m²: number of spike per square meter; K/S: kernel number per spike; TKW: thousand kernel weight GY: grain yield) in different durum and bread wheat genotypes

| Traits | DHE | DMA | MD | $S/m^{-2}$ | K/S | TKW (g) | GY (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|
| Genotype | | | | | | | |
| ARYA | 123.8 c | 166 bcd | 42.7 ab | 322 b | 44.3 cd | 42.4 a | 4850 abc |
| DENA | 122.7 c | 162.7 d | 40.1 b | 304 b | 46.7 b | 44.6 a | 4433 c |
| D-83-10 | 126.1 b | 168.7 b | 42.7 ab | 307 b | 50.6 a | 42.3 a | 3767 d |
| D-84-3 | 127.8 b | 167.1 b | 39.2 b | 330 b | 50.4 a | 42.9 a | 4917 ab |
| D-86-5 | 123.2 c | 163.8 cd | 40.3 b | 335 b | 45.1 c | 43.1 a | 4000 d |
| D-86-6 | 123.5 c | 166 bcd | 42.3 ab | 302 b | 51.6 a | 36.3 b | 4600 bc |
| BAHAR | 132.2 a | 178.8 a | 46.5 a | 402 a | 43.1d | 38.7 ab | 5067 a |
| LSD | 2.05 | 3.99 | 4.53 | 52.6 | 1.46 | 5.66 | 0.4227 |
| Sx | 0.39 | 0.76 | 0.86 | 10.03 | 0.27 | 1.63 | 0.0706 |

Column sharing the same letters indicates no significant differences at $p < 0.01$

## Conclusions

However durum wheat has the superior crop traits, farmers prefer durum wheat cultivation to more marginal areas. It can be due to insufficient attention from breeders, insufficient recognition and information from farmers and lack of suitable durum wheat seeds for planting in different environmental conditions. Wheat breeders should try to select the new cultivars and lines responsive to the environmental changes for improving grain yield and yield components. Most of new high yielding varieties have been selected under on-station research condition. However on-farm research can help the research and development process. The results of the combined analysis of variance under on-farm condition showed that there were significant differences between two experimental locations for day to grain maturity, number of spike $m^{-2}$ and kernel per spike. Also, there were highly significant differences amongst different genotypes for all the studied traits. In addition, there was a highly significant difference for interaction of genotype × location on grain yield. The results of genotypic effect and genotype × location interaction on grain yield imply that D-84-3 promising durum wheat line among durum wheat genotypes was produced the highest grain yield in on-farm experimental sits and might be used as a stable breeding materials under farmer's field condition.

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