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Agronomic Performance of Semi-dwarf and Dwarf Wheat Genotypes

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Abstract: Six bread wheat advanced genotypes (three semi-dwarfs and three dwarfs) developed through conventional and mutation breeding and two dwarf check varieties were evaluated for their agronomic performance. The experiment was conducted in RCBD with 3 replications. Agronomic parameters studied were grain yield, plant height, 1000-grain weight, spike length, number of spikelets/spike, number of grains/spike, main spike yield, days to heading, grain filling period and days to maturity. Results showed that the semi-dwarf genotypes produced higher grain yield as compared to dwarf genotypes, which confirms the significant impact of semi-dwarfing genes (Rht_1 and Rht_2) in wheat yield. Semi-dwarf genotypes NIA-8/7 and BWM-84 had significant increase in grain yield over other genotypes. However, different response for 1000-grain weight was recorded among both semi-dwarf and dwarf genotypes. The dwarf check variety T.D-1 produced the highest 1000-grain weight (48.6 g) followed by semi-dwarf genotype NIA-8/7 and dwarf mutant-72 (48.5 and 45.6 g respectively). Dwarf mutant-72 produced more grains per spike and main spike yield.

Key words: Wheat · Genotypes · Semi-dwarf · Dwarf · Plant height · Grain yield

INTRODUCTION

Wheat is cultivated in world over an area of 217.2 million hectares with annual production of 631.3 million tones and average yield of 2906 kg/ha [1]. It contributes 12.7 percent to the value added in agriculture and 2.6% to GDP [2]. FAO's latest forecast for world wheat out put in 2008 stands at a record 658 million tones, representing a significant (8.7 percent) increase from 2007 [3]. Wheat is the staple cereal food of about 35% of the world population and its demand will grow faster than for any other crop in the world. Asia produces more than the half of the total world production of wheat. The major sharer of which are South Asia and China. It is because it suits well in the cropping pattern of Asia. The forecasted global demand for wheat in the year 2020 varies between 840 and 1050 million tons [4].

Bread wheat (*Triticum aestivum* L.) accounts for 80% of the wheat consumption in the world. However, a tremendous success in wheat breeding was achieved in early 80s, with the introduction of semi-dwarf genes (*Rht1* and *Rht2*) and 1B/1R translocations [5-7]. Norman Borlaug began working with wheat in the Rockefeller-Mexico in 1945. He took advantage of the Mexican climate to accelerate his wheat breeding on disease resistance (the leaf and yellow rusts); later he sought to reduce lodging and began to work with Norin 10, Japanese wheat that was developed partly from Daruma and was sent to the US after the Second World War. Around 1900, the 'Daruma' wheat was grown in Japan and considered to be a semi-dwarf type having reduced height genes (Rht_1 *and* Rht_2). These semi-dwarf types yielded far better than the taller wheat grown in most parts of the world at that time and served as the framework for the "Green Revolution" in early 1960s [8-11]. Then in 1946, the Norin 10 was introduced and used to develop Norin 10/Brevor 14 by Vogel *et al.,* [12] and was then used by Norman Borlaug [13] and many other scientists as a primary source of semi-dwarf (Rht_1 and Rht_2 genes).

Heisey *et al.,* [14] estimated that more than 64 million hectares in developing countries representing more than 75% of total area were planted with modern wheat varieties developed by Cimmyt (Mexico) in 1997. Yield component such as kernel weight, plant height, number of tillers/plant, early seedling vigour and good stand establishment have been identified as good indicators of seedling vigour [9,15-17]. Dwarf wheat genotypes with short coleoptile length associated with poor seedling

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growth are supposed to low yielding as compared to semi-dwarf genotypes. The aim of this study was to evaluate the agronomic performance of newly evolved semi-dwarf wheat genotypes versus dwarf genotypes and to investigate the genetic impact of dwarfing genes (Rht_1 and Rht_2) in the improvement of wheat grain yield.

MATERIALS AND METHODS

Six newly evolved bread wheat (*Triticum aestivum* L.*)* genotypes along with two dwarf check varieties (Yecora and T.D-1) were evaluated for their agronomic performance (yield and yield associated traits). Among these six, three genotypes viz., BWS-77, BWM-84 and NIA-8/7 were semi dwarf type contains Rht_1 while other three mutant lines (MASR-07, MASR-70 and MASR72) had dwarf plant type contains Rht_1 and Rht_2 genes. The objectives of the present study were to compare the yield and yield component performance of dwarf and semi-dwarf genotypes. Each genotype was sown with 4 rows, 3m long in RCB design at Nuclear Institute of Agriculture (NIA), Tando Jam. Data on days to heading, days to maturity and grain filling period were recorded when crop was at field. At maturity, five randomly selected plants were studied from each replication. Morphological data on plant height, spike length, spikelets/spike, number of grains/spike, number of grains/spikelet, main spike yield, 1000-grain weight and grain yield (kg/ha) were recorded. Data was statistically analyzed by ANOVA as suggested by Gomez and Gomez, 1983 and the means were compared using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The results depicted the significant differences among different agronomic traits of dwarf and semi-dwarf wheat genotypes. Data on days to heading, days to maturity, grain filling period, 1000grain weight, grain yield, biological yield and harvest index is given in Table 1. Results about yield components such as spike length, number of grains/spike, main spike yield and plant height are given in Table 2. Genotypes showed different response for their time to ear emergence. Semi-dwarf genotype BWS-77 took more days to heading (87.7) followed by dwarf mutant lines MASR-70 and MASR-07 (82.3 and 81.7 days respectively). BWM-84 headed earlier (69.0 days) than other genotypes.

Table 1: Mean agronomic performance of semi-dwarf and dwarf genotypes

Genotypes	Days to heading	Days to maturity	Grain filling period	1000-grain weight (g)	Grain yield (kg/ha)	Biological yield (kg/ha)	Harvest Index
MASR-07	81.7b	138.3a	58bc	36.95e	2288 d	14500a	15.8
MASR-70	82.3b	137a	52d	36.02e	2377 d	11500ab	20.7
MASR-72	73.3cd	133.7b	58.3ab	45.60b	3047cd	11667ab	26.11
BWS-77	87.7a	138.3a	50.7d	36.24e	3547bc	13167ab	26.93
BWM-84	69e	131c	62a	43.91c	3957abc	13833a	28.6
NIA-8/7	74.3c	128.7c	54.3cd	48.47a	5007 a	14167a	35.34
T.D-1	72d	129.7c	58.3ab	48.59a	3193bcd	8667b	36.84
Yecora	72d	120.7d	37.33e	41.50d	3067cd	11833ab	25.91

Table 2: Mean agronomic performance of semi-dwarf and dwarf genotypes

Genotypes	Plant height (cm)	Spike length (cm)	No. Spikelets/spike	Grains/spike	Main spike yield (g)
MASR-07	80.3d	14.35a	19.87d	47.93c	1.62e
MASR-70	85.0c	13.97a	24.60a	67.20ab	2.07d
MASR-72	75.3e	14.85a	22.73b	79.60a	3.33ab
BWS-77	110a	12.17b	22.87b	65.60ab	2.62c
BWM-84	106b	11.61b	21.33c	74.47a	3.74a
NIA 8/7	109a	11.49b	20.93cd	58.33bc	2.93bc
T.D-1	71.3f	11.24b	17.3e	55bc	2.46cd
Yecora	83.3c	11.72b	20.80cd	57.13bc	2.54c

Semi-dwarf genotypes NIA-8/7, BWM-84 and both check varieties TD-1 and Yecora matured earlier (120.7-31.0 days) as compared to other genotypes. These results indicated that these genotypes could be best fitted in short duration planting system as they possessed early maturity so that could be more tolerant to high temperature stress. These findings provided the well-documented information regarding test entries that newly evolved semi-dwarf type high yielding genotypes NIA-8/7 and BWM-84 could planted in December after cotton, rice and sugarcane crops as a late sowing varieties. However, both genotypes were not significantly different for maturity period from both commercial famous wheat varieties (Yecora and T.D-1). There is an urgent need to develop early maturing genotypes in this region where high temperature is a major environmental constraint for wheat grain yields. Semi dwarf genotypes BWM-84 used 62 days to fill their grain whereas dwarf genotypes MASR-72 and MASR-07 took 58.3 and 58 days respectively to fill their grain which showed non significant difference with check variety TD.1 (58.3 days). The famous commercial variety TD-1 possessed the highest (48.59g) 1000-grain weight than all other genotypes. Semi-dwarf genotypes NIA-8/7 and BWM-84 produced higher 1000-grain weight (48.47 and 43.91g respectively) than dwarf entries. Dwarf genotype MASR-72 had also higher 1000-grain weight (45.60g). Grain yield results indicated that semi-dwarf genotypes produced overall maximum yield than dwarfs. NIA-8/7 (semi-dwarf) produced significantly higher grain yield (5007 kg/ha) followed by BWM-84 and BWS-77 (3957 and 3547 kg/ha respectively). Dwarf genotypes were inferior in yield as compared to semi dwarf. The possible reason for lower yield might be due to the presence of both Rht and Rht_2 genes; which may hinder expressions of other yield contributing genes.

Dwarf genotype MASR-07 produced higher (14500 kg/ha) biological yield followed by semi dwarf-genotypes NIA-8/7, BWM-84 and BWS-77. The dwarfs check TD-1 had higher harvest index (36.84) followed by semi-dwarf genotype NIA-8/7 (35.34). Other semi-dwarf genotype BWM-84 also showed good harvest index (28.6). Dwarf genotype MASR-07 and MASR-70 showed low harvest index (15.8 and 20.7 respectively). Significant difference in plant height was observed among genotypes. MASR-72, MASR-07 and MASR-70 had dwarf plant height (75-85 cm), whereas semi-dwarf genotypes BWM-77, NIA-8/7 and BWM-84 had semi-dwarf plant height (106-110 cm respectively).

Dwarf genotypes (MASR-72, MASR-7 and MASR-70) had significantly longer spikes than semi-dwarfs (13-14.85 cm). While, spike of semi-dwarf genotypes and check varieties ranged from 11-12.5 cm. Dwarf genotype MASR-70 could produce 24.60 spikelets per spike followed by semi dwarf genotype BWS77 (22.87) and dwarf genotype MASR-72 (22.73). All of the genotypes dwarf and semi dwarf had more number of spikelet per spike as compared to check varieties. Great variation was observed in number of grains per spike and it ranged from 47.93 to 79.60 grains per spike. Dwarf genotype MASR-72 produced (79.60) higher number of grains per spike followed by semi dwarf BWM-84 (74.84). Semi dwarf genotype BWM-84 gave higher main spike yield (3.74g) followed by MASR-72 and NIA-8/7 (3.33g, 2.93g respectively).

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