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YIELD AND YIELD COMPONENTS WITH RELATION TO PLANT HEIGHT IN SEMI-DWARF WHEAT

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Abstract

Eighteen genotypes including two check varieties were compared for yield and yield components. In this yield comparison lines 04 and 08 had the highest grain yield per plot. The subsequent line which had higher grain yield was 06. The possible reasons for the highest grain yield in line 04 could be due to the longest spike length, the highest number of spikelets per spike, higher number of grains per spike, higher grain yield of main spike and higher grain weight. Correlations were calculated for pooled yield and yield components data of various genotypes. Plant height showed positive and highly significant correlation with spike length, number of spikelets per spike, number of grains per spike and main spike grain yield but no correlation with number of grains per spikelet. Main spike grain yield exhibited positive and highly significant correlation with plant height, spike length, number of spikelets per spike, number of grains per main spike and number of grains per spikelet.

Introduction

A semi-dwarf stature of wheat (*Triticum aestivum* L. 2n=6x=42) has been shown to induce increased yields through more efficient utilization of available assimilates associated with crop lodging (Dalrymple, 1986). A considerable amount of information regarding the effects of the Rht_1 and Rht_2 genes on various agronomic, physiologic, morphologic, and biochemical traits has been elucidated. The Norin 10 derived GA-insensitive alleles, *Rht-B1b* (Rht_1) and *Rht-D1b* (Rht_2), reduce plant height by 15% and increase yield by 24% (Gale & Youssefian, 1985; Flintham *et al.*, 1997). According to Borlaug (1968) these genes carried by about 90% of the semi-dwarf cultivars worldwide and represent one of the major factors of the “Green Revolution”. Their distribution is restricted to geographical areas that are not subject to heat stress during ear emergence as this has been demonstrated to reduce plant fertility (Worland & Law 1985). The effect on yield and yield components has been singled out to be of the most interest to wheat workers. Incorporation of Rht_1 and Rht_2 has led to the selection of spring wheat cultivars with higher yield potential in low latitude environments characterized by early winter sowing eg. India, Pakistan and northwestern Mexico (Jain & Kulshrestha 1976; Fischer *et al.*, 1981). The study is to determine the effect of plant height and, in particular, the effect of major dwarfing genes Rht_1 and Rht_2 on agronomic characteristics of spring wheat.

Materials and Methods

Sixteen F_6 best genotypes derived from a range of different crosses and two check varieties viz. Sarsabz and Kiran-95 were evaluated for yield and yield components. The

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genotypes were grown into four rows each with row length of 03 meters in a randomized complete block design with three replicates. Analysis of variance was calculated on the basis of individual plant selection. The character days to heading and plot grain yield (Kg/plot) were calculated on the basis of replicates. The statistical data were analyzed according to Steel & Torrie (1981).

Results and Discussion

Comparative performance: In this yield comparison, line 04 and 08 had the highest grain yield than all the lines and check varieties (Table 1). The possible reasons for high grain yield in line 04 could presumably be due to medium type heading dates, longest spike length, increased number of spikelets per spike, higher number of grains per spike and increased main spike grain yield. Numerous studies (Allan, 1989, 1997, Borrell *et al.*, 1991, Miralles & Slafer, 1995) have shown that the presence of GA-insensitive *Rht-B1b* and *Rht-D1b* genes is associated with greater kernel number per spike to increase the kernel number per unit area. Because ear and stem growth coincides in wheat, genetic reductions in height reduce stem growth, and thereby reducing competition for assimilate between the elongating stem and developing ear (Youssefian *et al.*, 1992). The high grain yield in line 08 could be due to early heading dates, which escapes from biotic and abiotic stresses. The line 08 had the highest number of grains per spike and also the boldest grain weight than the remaining lines and check varieties. The subsequent lines, which had higher grain yield, were lines 06, 01 and 11. The high grain yield in line 06 could be due to bolder grain weight. The high grain yield in line 01 could be due to earliness, double dwarf plant height and also bolder grains. The high grain yield in line 11 could be due to optimum plant height and increased number of grains per spikelet. Fischer & Quail (1990) and Richards (1992) have reported that there is an optimum plant height (70-100 cm) at which maximum grain yield could be achieved by the use of semi-

Table 1: Comparative performance of wheat genotypes for agronomic characters

Genotypes	Days to heading	Plant height (cm)	Spike length (cm)	Spikelets spike^{-1}	No: of grains spike^{-1}	Grain yield of spike (g)	Grains spikelet^{-1}	Plot yield (g)	1000-Grain weight (g)
CIM-04-09	73gh	64.5h	11.25bcd	17.3cde	51.8abc	1.83abcd	2.99abcdef	475abc	40.11ab
CIM-04-10	73gh	70.3f	10.65de	15.5de	48bcd	1.76bcd	3.07abcde	413bcdef	36.81bcdef
CIM-04-11	77ef	60.8j	10.5de	15.9de	51.1abc	1.83abcd	3.24abc	363cdef	38.55abcd
CIM-04-14	75fg	80.8d	13.8a	19.5ab	53.3ab	2.05abc	2.72f	563a	36.99bcdef
CIM-04-16	78e	58.5k	10.95cde	15.8de	51.8abc	1.75cd	3.28ab	413bcdef	33.96ef
CIM-04-17	78e	53.5l	10.15ef	15.2e	47.4bcd	1.88abcd	3.12abcd	525ab	39.4abc
CIM-04-18	81c	62ij	12.1b	17.3cde	53.8ab	2.11a	3.13abcd	313f	39.3abc
CIM-04-19	71h	83.1c	11.2bcde	17.6bcd	55.8a	2.04ab	3.16abcd	563a	41.48a
CIM-04-20	74gh	54.5l	10.7de	16de	46.5bcd	1.87abcd	2.51cdef	438bcde	39.56abc
CIM-03-04	75fg	68g	10.7de	16.1de	51.1abc	2.03abc	3.18abcd	363cdef	36.65cdef
CIM-03-06	78de	69.9f	10.95cde	17.5bcd	50.4abc	2.01abc	2.86def	463abcd	35.4def
CIM-03-09	79cde	71.8f	10.95cde	16.4de	48.4abc	1.79bcd	2.96bcdef	325ef	37.07bcdef
CIM-03-17	71h	74.7e	10.9cde	15.8de	52.1abc	1.8bcd	3.3a	400cdef	35.5ef
CIM-03-19	84b	63.2hi	9.4f	19.4ab	45cd	1.71d	2.3g	325ef	38.14bcd
CIM-15	81cd	48.5m	9.3f	15.2e	41.2d	1.41e	2.71f	313f	34.25ef
CIM-23	88a	79.4d	11.3bcd	21.1a	49.6abc	1.67d	2.34g	438bcde	33.81f
Sarsabz	73gh	85b	12b	18.1bc	53.6ab	1.84abcd	2.86def	350def	34.31ef
Kiran-95	79cde	91.6a	11.9bc	18.6bc	51.7abc	2.04ab	2.77ef	400cdef	37.19bcde

Note: The significance level was at 0.05.

Table 2: Correlation coefficients for pooled data of yield and yield components.

Characters	Spike length	No. of spikelets	No. of grains per spike	Main spike grain yield	No. of grains per spikelet
Plant height	0.432***	0.384***	0.257***	0.211**	0.115 ns
Spike length		0.623***	0.665***	0.588***	0.038 ns
No. of spikelets			0.518***	0.397***	0.49 ns
No. of grains per spike				0.819***	0.482***
Main spike grain yield					0.411***

Note: *=0.05, **=0.01, ***=0.001 significance level, ns = non-significant

dwarf genes. In this yield comparison the lines 15 had the lowest grain yields. The possible reason for the lowest grain yield in line 15 could be due to late heading dates, which might have been subjected to high temperatures during grain filling period. The line 15 had also double dwarf plant height with reduced spike length, the lowest number of spikelets per spike, the lowest grain yield of main spike, reduced number of grains per main spike and lower grain weight.

Correlation studies: The results of correlation analysis of pooled data for experimental genotypes are presented in Table 2. Plant height had highly positive and significant correlation with spike length, number of spikelets per spike, number of grains per main spike and main spike grain yield. Law *et al.,* (1978) and Aycicek & Yildirim (2006) reported the positive association of plant height with grain yield within the major dwarfing gene group. Contrasting results were reported by Villareal *et al.,* (1992) wherein plant height had a strong negative correlation with grain yield in single-gene dwarfing group. Belay *et al.,* (1993) reported that plant height had a weak association with most of the characters except tiller number, grain yield per plot and harvest index where it showed significant negative association in Ethiopian durum wheat. Plant height had non significant negative correlation with number of grains per spikelet. Spike length had positive but highly significant correlation with number of spikelets per spike, number of grains per main spike and grain yield of main spike. However, spike length had negative and non significant correlation with number of grains per spikelet. The character of number of spikelets per spike had positive and significant correlation for number of grains per spike and main spike grain yield. However, number of spikelets per spike had negative and non significant correlation with number of grains per spikelet. Jamali *et al.,* (2003) reported the similar findings in which number of spikelets had positive and highly significant association with the number of grains per spike and main spike grain yield, and non-significant and negative correlation with number of grains\spikelet.

Number of grains per main spike had positive and highly significant correlation with main spike grain yield and number of grains per spikelet. Li *et al*. (2006) reported that both the *Rht-B1b* and *Rht-D1b* semi-dwarfing genes had significantly positive effects on kernel number and grain weight per spike. Main spike grain yield had positive and highly significant correlation with number of grains per spikelet.

It is concluded that selection based on number of grains per main spike and increased main spike grain yield could result new high yielding varieties under our environmental conditions.

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