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RESPONSE OF WHEAT GENOTYPES ON YIELD AND YIELD COMPONENTS WITH CHANGING PLANT POPULATION DENSITIES

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Abstract

The response of wheat (*Triticum aestivum* L.) genotypes on yield and yield components under different plant population densities were examined under field conditions for two years. The population densities were managed through row spacing of 15 and 30 cm at seeding rates of 100, 150 and 200 $kgha^{-1}$. There were large treatment and cultivar x treatment (seeding rate and row spacing) interactions for plant height, spike length, number of spikelets/spike, number of grains/spike and spike yield. The narrow row spacing with higher seeding rate treatments averaged 13.8% more grain yield than the standard spacing (30 cm) and seeding rate (100 $kgha^{-1}$) over two successive cropping seasons. The grain yield increased at narrow row spacing (15cm) in combination with higher seeding rates (150 and 200 $kgha^{-1}$) and was averaged to be 16.2% and 18.8% in 1994-95 and 8.9% and 12% in year 1995-96 respectively. Non significant cultivar x treatment x year interactions existed for all the measured traits. Spike yield, number of grains/spike and spikelet, number of spikelets/spike and spike length were reduced at higher seeding rates (200 $kgha^{-1}$) and narrow row spacing (15 cm), while enhanced at lower seeding rates (100 $kgha^{-1}$) with wider row spacing (30cm). The studies revealed that the average grain yield of spring wheat may be increased with combination of higher seeding rates (150 $kgha^{-1}$) and narrow (15 cm) row spacing.

Introduction

Wheat (*Triticum aestivum* L.) is a major food grain crop of Pakistan grown over 8.1 million hectares. The average yield of the wheat varieties grown in the country is much lower than their potential yield. This yield gap is either due to environmental factors such as problem soils, biotic and abiotic stresses or due to management deficiencies. Plant population in a unit area is regarded as an important input to have a bumper crop stand ending in a plentiful harvest. There are two common ways of manipulating plant population i) by increasing seed rate and ii) by changing row spacing. In many cases where narrow row spacing have been practiced, higher grain yields are reported (Johnson *et al.,* 1988, Marshall and Ohm, 1987). Holliday (1963) estimated that the use of row spacing narrower than the conventional (18-23cm) spacing increased grain yield by 5 to 7% on the average. On the other hand low seeding rates as compared to high seeding rates resulted in increased spike length, more number of grains per spike and higher grain weight (Hutchinson, 1936, Hussain and Butt, 1965). Similarly, wider row spacing had increased the number of grains per spike (Bajwa *et al.,* 1977) and decreased the number of tillers per unit area (Cholick, 1978, Johnson *et al.,* 1988), while optimum row spacing produced the highest yield (Barthakur *et al.,* 1979). Roth *et al.,* (1984) suggested a cumulative response of narrow row spacing and increased plant density. Shaheena *et al.,* (1987) studied the effect of population density on yield and yield components of wheat. They found that the plant population increased at 25 cm row spacing as compared to 30 cm, but the yield performance of various row spacing was partly due to the contribution of yield components, such as increased number of grains per spike and 1000 grain weight. The present study was aimed to determine the effects and interactions of row spacing and seeding rate on grain yield and yield components of spring wheat genotypes in our environment.

Materials and methods

Two years (1994-95 and 1995-96) field study was conducted to analyze the implication of row spacing and seeding rate effects on the performance of three spring wheat cultivars, viz. SI88123, SI88231 and Sarsabz. Four combinations of seeding rates and row spacing were used as 100 $kgha^{-1}$ + 30cm, 150 $kgha^{-1}$ + 30cm, 150 $kgha^{-1}$ + 15cm, and 200 $kgha^{-1}$ + 15cm respectively. It was a factorial experiment in a randomized complete block design (RCBD) with four replications. At maturity 30 plants were randomly selected from each genotype and treatment for agronomic studies. An area of 5.5 m^2 was harvested and threshed to determine grain yield. The data were statistically analyzed over years and means were compared using Duncan's Multiple Range Test.

Results and discussion

Row spacing and seeding rate in present studies showed significant effect on grain yield and yield components viz. main spike yield, spike length, number of grains per spike, number of spikelets per spike and plant height in both the years (Table 1). Significant genotypic differences ($P<0.05$) were observed for all the measured traits except number of grains per spike. Sarsabz produced significantly higher grain yield than SI88123 and SI88231 in 1994-95; whereas, SI88123 gave similar yield as Sarsabz but slightly higher than SI88231 in the year 1995-96. In the overall performance, Sarsabz produced the highest grain yield (4991 $kgha^{-1}$), followed by SI88123 (4837 $kgha^{-1}$) and SI88231 (4430 $kgha^{-1}$). Changing plant geometry also induced significant effects in yield and yield components of the three cultivars. Narrow row spacing (15cm) with high seeding rates 150 and 200 $kgha^{1}$- produced significantly more grain yield than wider row spacing (30 cm) with low seeding rates (100 $kgha^{-1}$) in both cropping seasons. During year 1994-95 the average yield increased at narrow row spacing (15 cm) with higher seeding rates (150 and 200 $kgha^{-1}$) was 16% and 18.8% respectively as compared to wider space of 30 cm and the differences were statistically significant. In the following year (1995-96) this increase was 12% and 8.9% respectively (Table 1). Joseph *et al.*, (1985) reported a 12% yield increase for narrow row spacing. Such increase in yield with narrow row spacing in wheat has been reported by many workers (Ciha, 1983; Johnson *et al.*, 1988; Khan and Makhdum, 1988 and Marshall and Ohm, 1987). Donald (1968) proposed an upright-leaf, uniculm plant for a wheat ideotype and suggested that it should be grown at narrow row spacing with high seeding rates to maximize the use of resources.

The year x genotype and year x genotype x treatment interaction were non significant for all the traits, while genotype x treatment interaction mean squares were significant for all the characters except grain yield per plot. Significant genotype x treatment interaction indicates the varying response of genotypes to a particular environment (row spacing and seeding rate). Ciha (1983) reported a significant cultivar x seeding rate interaction of grain yield for spring wheat, while, Johnson *et al.* (1988) reported non-significant cultivar x seeding rate and cultivar x row spacing interactions for grain yield, number of spikes/m^2, number of seeds/spike and single grain weight among five winter wheat cultivars. In our studies all cultivars yielded significantly more grain yield with narrow rows (15 cm) and high seeding rates (150 and 200 kgha-^{1}). Genotype SI88123 and Sarsabz produced maximum high grain yield at row spacing of 15 cm with seeding rate 150 kgha-^{1}, while SI88231 gave the maximum yield when 200 kgha-^{1} seeding rate was used with 15 cm row spacing (Table 2).

Sarsabz, which is known to be a high yielding, wide-adapted variety in the province of Sindh possessed longer spikes and more number of grains per spike (Table 2). In both the years, spike length, number of spikelets/spike, number of grains/spike and spike yield was significantly higher at 100 kgha-^{1} seeding rate with 30 cm row spacing as compared to narrow row spacing (15 cm) with higher seeding rates (200 kgha-^{1}). This was mainly due to presence of less number of plants per unit area which received ample nutrients from the soil substrate. Similar findings were noted by Finlay *et al.*, (1971); Bajwa *et al.*, (1977); Darwinkel (1978); Shaheena *et al.*, (1987); Khan and Makhdum (1988). Grain yield is a complex phenomenon and is affected by the interaction of environment and yield components (Marshall and Ohm, 1987; Cholick 1978). In present study, the narrow row spacing (15 cm) with combination of high seeding rates (150 kgha-^{1}) had helped in exploiting the potential and stability of grain yield in wheat genotypes.

Table 1. Comparison of wheat genotypes in row spacing cum seeding rate trial over two years.

Cultivars/ Treatments	Plant height (cm)	Spike length (cm)	No. of spikelets per spike	No. of seeds per spike	Spike yield (g)	Grain yield (kgha^{-1})
Cultivars				**1994-95**		
SI88123	91.66c	9.73c	21.86b	53.30a	2.13b	4674b
SI88231	100.85a	10.21b	23.08a	55.02a	2.38a	4221bc
Sarsabz	96.78b	10.88a	20.55c	53.29a	2.33a	5000a
				1995-96		
SI88123	90.72c	9.56c	21.72b	54.97a	2.20b	5000a
SI88231	101.56a	10.23b	22.92a	55.35a	2.33a	4638a
Sarsabz	96.32b	10.68a	20.78c	55.15a	2.33a	4982a
				Mean over two years		
SI88123	91.19 c	9.65 c	21.79 b	54.14 a	2.17 b	4837 a
SI88231	101.20 a	10.22 b	23.00 a	55.18 a	2.35 a	4430 b
Sarsabz	96.55 b	10.77 a	20.67 c	54.22 a	2.33 a	4991 a
Treatments				**1994-95**		
100 kgha^{-1}+ 30 cm	95.67b	10.58a	22.20a	56.10a	2.35ab	4239b
150 kgha^{-1}+ 30 cm	95.71b	10.08b	21.62b	53.19b	2.23bc	4312b
150 kgha^{-1}+ 15 cm	97.27a	10.43a	21.88b	56.22a	2.40a	4928a
200 kgha^{-1}+ 15 cm	97.08b	10.00b	21.61b	49.97c	2.14c	5036a
				1995-96		
100kgha^{-1} + 30 cm	96.00a	10.33a	22.17a	57.19a	2.31a	4674bc
150kgha^{-1} + 30 cm	95.82a	10.03ab	21.74bc	54.53bc	2.34a	4475c
150kgha^{-1} + 15 cm	96.50a	10.29a	21.93ab	56.13ab	2.29a	5236a
200kgha^{-1} + 15 cm	96.47a	9.96b	21.39c	52.78c	2.20ab	5091ab
				Mean over two years		
100kgha^{-1} + 30 cm	95.83 b	10.46 a	22.18 a	56.64 a	2.33 a	4457 b
150kgha^{-1} + 30 cm	95.77 b	10.06 b	21.68 bc	53.86 b	2.29 a	4394 b
150kgha^{-1} + 15 cm	96.88 a	10.36 a	21.91 b	56.18 a	2.34 a	5082 a
200kgha^{-1} + 15 cm	96.77 a	9.98 b	21.50 c	51.37 c	2.17 b	5064 a

Table 2. Effect of row spacing and seeding rate on yield and yield components of wheat (pooled over two years).

Cultivars	Treatment	Plant height (cm)	Spike length (cm)	No. of spikeletsper spike	No. of seeds per spike	Spike yield (g)	Grain yield ($kgha^{-1}$)
SI88123	100 $kgha^{-1}$+30 cm	87.63h	9.42g	21.25e	55.18bc	2.04h	4420de
SI88123	150 $kgha^{-1}$+ 30 cm	90.42g	9.82ef	22.03cd	55.30bc	2.28def	4529de
SI88123	150 $kgha^{-1}$+ 15 cm	92.60f	9.73f	21.97d	54.05cd	2.18fg	5305ab
SI88123	200 $kgha^{-1}$+ 15 cm	94.10e	9.62fg	21.90d	52.02d	2.16fg	5091abc
SI88231	100 $kgha^{-1}$+ 30 cm	102.58a	10.70h	24.20a	58.53a	2.52a	4149e
SI88231	150 $kgha^{-1}$+ 30 cm	100.87h	9,87def	22.35c	52.12d	2.32cde	4185e
SI88231	150 $kgha^{-1}$+ 15 cm	101.10b	10.07cde	22.75b	57.22ab	2.37bcd	4601de
SI88231	200 $kgha^{-1}$+ 15 cm	100.27h	10.23c	22.70b	52.87d	2.20efg	4801cd
Sarsabz	100 $kgha^{-1}$+ 30 cm	97.28c	11.25a	21.10e	56.22bc	2.43abc	4819bcd
Sarsabz	150 $kgha^{-1}$+ 30 cm	96.02d	10.48b	20.67f	54.17cd	2.26defg	4475de
Sarsabz	150 $kgha^{-1}$+ 15 cm	96.95cd	11.28a	21.00ef	57.27ab	2.47ab	5344a
Sarsabz	200 $kgha^{-1}$+ 15 cm	95.95d	10.08cd	19.90g	49.23e	2.14gh	5308ab

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