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INFLUENCE OF DIFFERENT ROW SPACING ON AGRONOMIC TRAITS IN DIFFERENT WHEAT VARIETIES

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ABSTRACT

A series of experiment was conducted at Malir Experimental Farms, Sindh Agriculture University, Tandojam during 2009-10 to study the response of different wheat varieties under various row spacing. The experiment was laid out in RCB design with split plot arrangements having four replications. Three varieties of wheat (Sarsabz, Kiran - 95 and TD-1) and three rows spacing (15.00, 22.50 and 30 cm) were used studied. The results indicated that maximum biological yield (10017 kg ha^{-1}), plant height (104.00) in Sarsabz, spike length (12.65 cm), grain yield (4659.0 kg ha^{-1}) in Kiran-95, tillers (333.00 m^2), number of grains $spike^{-1}$ (46.66), grain weight $spike^{-1}$ (45.41 g) in TD-1 were recorded under 30.00 cm row spacing; while 1000- grain weight (44.75 g) in under 22.50 row spacing and harvest index (48.10 %) under 15.00 cm row spacing in TD-1 variety. Based on the findings it can be concluded that wheat variety Kiran-95, followed by T D-1 and Sarsabz produced better performance with respect to yield and yield components. Similarly, 30 cm row apart was superior to 15.00 and 22.50 cm row spacing.

INTRODUCTION

Wheat is the basic staple food for most of the population and largest grain source of the country. Its importance is always recognized when formulating agricultural policies. It contributes 12.5 percent to the value added in agriculture and 2.6 percent to GDP. Wheat is cultivated in an area of 8666 thousand hectares in 2011-12, showing a decrease of 2.6 percent over last year's area of 8901 thousand hecctares. The production of 23.5 million tons is estimated during July-March, 2011-12 (GoP, 2011-12). Among the factors responsible for low wheat yield, delay in sowing, traditional sowing methods, low seed rate and improper row spacing are very important. Under the present practice of sowing wheat after rice and cotton, wheat sowing often gets delayed, reducing the yield to a considerable extent (Iqbal *et al.,* 2010). According to Singh and Uttam (1994) the highest yield was obtained by using a seed rate of 125 kg whereas, seed rate of 160 kg for getting maximum yield was suggested by Ram *et al.,* 1988. 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 such as by increasing seed rate and by changing row spacing (Sial *et al.,* 2001). 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. Human beings practically attain all their food directly or indirectly from plants. Thus the focus of the researchers' is to increase the per unit area production. The increased advanced cultural practices like using certified seed of improved varieties, optimum seed rate, timely sowing, proper irrigation and fertilizers. Due to the above mention usefulness of proper row spacing it may be helpful to increase and improve the yield components of wheat crop. This low production is indication of the vast potential gap, which can be bridged up through vertical increase in the crop yield by seed density and row spacing (Habibullah *et al.,* 2007). The present study was aimed to determine the influence of row spacing on grain yield and yield components of spring wheat varieties in our environment.

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MATERIALS AND METHODS

Plant material and details of experiments

The field experiment was conducted at Malir Farm, Sindh Agriculture University Tandojam, Pakistan located at 25o25'60'N 68o31' 60E during 2009-2010. The three spring wheat varieties were planted under three different rows spacing to determine the influence on yield components. The experiment was conducted in three replicated randomized complete block design (Factorial) and plot size of 1.2 x 2 m = 2.4 m2 (2m long 4 rows) with three wheat varieties; Sarsabz, Kiran-95 and TD-1 under row spacing 15.00, 22.50 and 30.00 cm. The standard seed rate of 125 kg ha-1 was used in this experiment. Twelve plants were selected randomly from each treatment for further observations. Meteorological data for season (2009-2010) were obtained from Wheat Section, Plant Breeding & Genetics Division, Nuclear Institute of Agriculture (NIA), Tandojam. Recommended land preparation operations were performed for equal distribution of canal irrigation. Sowing was done with single coulter hand drill. The crop was sown on 12th November in Rabi season.

The basal dose rate of NPK fertilizers at the rate of 140-60-30 kg ha^{-1} was applied in the form of urea, Di-ammonium phosphate and sulphate of potash, respectively. All P, K and half N were applied at sowing time; while remaining N was equally divided into two splits and applied at first and third irrigation time. First irrigation was applied 25-30 days after sowing and subsequent irrigations were applied as soil and crop requirement. Weed management practices were done manually for reducing weed crop completion. The soil analysis of experimental areas showed that soil was clay loam in texture, non saline (pH= 7.0- 7.3), low in organic matter (0.82-0.94%), total nitrogen (0.52-0.61%), available phosphorus (0.90-156 mg kg-1) and exchangeable potassium (234-284 mg kg-1). The experiment was harvested on 4th April during 2010. The minimum mean temperature 17.75 ^{o}C, maximum 32.38 ^{o}C and humidity 69.25 % was recorded during Rabi season 2009-2010. The temperature was favourable during December to February for growth period.

Determinations of agronomical characters

Plant height was measured from ground level to the top of the spike termination node. Tiller count was done from m^{-2} area in each treatment and these tillers were also used for nodes stem^{-1} and internodes length (through measuring tape). Spike length was measured from 10 randomly selected spikes through measuring tape. These spikes were separately threshed and grains were counted and weighed on top loading digital balance. Number of grains spike^{-1} was counted from ten randomly selected spikes in each replication at harvest. Grain weight spike^{-1} was recorded by using digital electronic balance at harvest. The 1000 grains were weighed on same electronic balance for seed index. Biological and grain yield were recorded from four rows at the time of harvest from each treatment. Harvest index of each treatment was calculated by using formula, harvest index = Grain yield/ biological yield x 100. The crop was harvested during March, 30th to April 4th of 2009 and 2010.

Statistical analysis

The experimental data were recorded and statistically analyzed through Statistix 8.1 computer software (Analytical Software, 2005), the means were separated using least significant difference (LSD) test. All differences described in the text were significant at the 5% level of probability.

RESULTS AND DISCUSSION

Tillers (m^{-2})

It is considered that tillers per unit area increase with increase in row spacing. The data presented in Table 1 showed that significant differences were found in number of tillers m^{-2} at row spacing in all wheat varieties. The mean value for varieties showed that maximum tillers m^{-2} (320.00) were observed in TD-1, While maximum was found (310.89) under row spacing (22.50 cm). The interactive between varieties x row spacing was also significant. The maximum tillers m^{-2} (333.33) was found in TD-1 under row spacing (30.00 cm) and minimum tillers m^{-2} (234.67) was recorded in Kiran - 95, under row spacing (30.00 cm).

Table 1. Influence of row spacing on tillers (m^{-2}) of wheat varieties during 2009-10

Row spacing (cm)/ Varieties	Tillers (m^{-2})			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	281.67 a	299.33 a	307.00 a	296.00 a
22.50	296.67 a	316.33 a	319.67 a	310.89 a
30.00	304.00 a	234.67 a	333.33 a	290.67 a
Mean of varieties	294.11 a	283.44 a	320.00 a	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		2.174		3.606
Row spacing (R)		2.174		3.606
Interactive V x R		4.06		6.77

The results agreed with (Kabir *et al.,* 2009) that the number of grains spike^{-1} and number of productive tillers m² decrease with the increasing of seed rate kg ha^{-1} and also the highest grain yield of 4280 kg ha^{-1} was obtained with 100 kg ha^{-1} seed rate and 30cm apart-rows followed by the plot of 125 seed rate kg ha^{-1} and 30 cm apart rows giving yield of 4075 kg ha^{-1}. The results supported by Singh and Srivastava (1991) that tiller numbers increased with increasing row spacing. The highest number of productive tillers m² tillers was noted in 30 cm row spacing followed by 22.50 cm row spacing, while the lowest number of productive tillers per m² was observed in 15 cm row spacing. The results also confirmed by Habibullah *et al.* (2007). Similar results are also reported by Rajput *et al.* (1989).

Table 2. Influence of row spacing on plant height (cm) of wheat varieties during 2009-10

Row spacing (cm)/ Varieties	Plant height (cm)			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	99.67 cd	98.67 d	78.00 g	92.11 c
22.50	102.00 b	100.00 c	79.33 f	93.77 b
30.00	104.00 a	101.67 b	81.00 e	95.55 a
Mean of varieties	101.89 a	100.11 b	79.44 c	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		0.281		0.596
Row spacing (R)		0.281		0.596
Interactive V x R		0.487		1.033

Plant height (cm)

The results of the experiment revealed that the mean values for maximum plant height was observed (101.89 cm) in Sarsabz variety, while maximum plant height (95.55 cm) for mean value (95.55) under row spacing 30.00 cm in Table 2. The interactive between varieties x row spacing indicated that maximum plant height (104.00 cm) was observed in Sarsabz under row spacing (30.00 cm) and minimum plant height (78.00 cm) was recorded in TD-1 under row spacing (15.00 cm). The differences of plant height could be due the genetic make-up of varieties. Similar results are also reported by Rajput *et al.* (1989).

Table 3. Influence of row spacing on spike length (cm) of wheat varieties during 2009-10

Row spacing (cm)/ Varieties	Spike length (cm)			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	10.25 h	12.32 c	11.53 e	11.36 c
22.50	10.40 g	12.48 b	11.64 d	11.50 b
30.00	10.49 f	12.65 a	11.71 d	11.61 a
Mean of varieties	10.380 c	12.48 a	11.630 b	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		0.021		0.045
Row spacing (R)		0.021		0.045
Interactive V x R		0.037		0.078

Grains spike^{-1} (No.)

The mean for varieties indicated maximum number of grain spike^{-1} was 45.71 in T D - 1 and maximum mean value 44.38 under row spacing (30.00 cm) was observed. The data presented in Table 4 showed for interactive influence of varieties and row spacing that maximum grains spike^{-1} 44.66 in TD-1 under 30.00 cm row spacing and minimum 38.00 in Sarsabz under 15.00 cm row spacing were found in number grains spike^{-1}. Singh and Srivastava (1991) reported that numbers of grains spike^{-1} increased with increasing row spacing. The differences in number of grains spike^{-1} were probably due to variation in genetic potential from variety to variety. Inamullah *et al.* (2006) also observed significant differences in grains per spike among different wheat varieties. The results also agree with the finding of Barria and Pihan (1981).

Table 4. Influence of row spacing on grains spike^{-1} (No.) of wheat varieties during 2009-10

Row spacing (cm) /Varieties	Grains spike^{-1} (No.)			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	38.00 f	42.33 d	44.80 b	41.71 c
22.50	39.66 e	43.76 c	45.66 b	43.03 b
30.00	41.66 d	44.83 b	46.66 a	44.38 a
Mean of varieties	39.77 c	43.64 b	45.71 a	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		0.248		0.525
Row spacing (R)		0.248		0.525
Interactive V x R		0.429		0.910

Grains weight spike^{-1} (g)

The results for grains weight spike^{-1} in Table 5 indicated that maximum grains weight spike^{-1} for mean of varieties (45.21 g) and row spacing mean value (44.05 g) were recorded. The results indicated for interactive influence of varieties and row spacing that maximum grains weight spike^{-1} (45.41 g) in T D - 1 variety under 30.00 cm row spacing while minimum grains weight spike^{-1} (40.80 g) in Sarsabz variety under 15.00 cm row spacing were observed. Yadev *et al.* (2001) also found similar results and suggested that seed rate of 125 kg ha^{-1} had significantly higher values in grain weight spike^{-1}.

Table 5. Influence of row spacing on grains weight spike^{-1} (g) of wheat varieties during 2009-10

Row spacing (cm) /Varieties	Grains weight spike^{-1} (g)			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	40.80 e	42.84 c	45.09 a	42.91 c
22.50	41.84 d	43.62 b	45.12 a	43.52 b
30.00	42.76 c	43.98 b	45.41 a	44.05 a
Mean of varieties	41.80 c	43.48 b	45.21 a	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		0.134		0.285
Row spacing (R)		0.134		0.285
Interactive V x R		0.233		0.495

1000-grains weight (g)

The data regarding 1000 grains weight is presented in Table 6. 1000-grain weight is also an important yield determining component of wheat. The analysis of the data indicates that maximum mean value (44.61 g) for varieties and (43.53 g) was recorded mean value for row spacing was produced. The interactive influence of varieties and row spacing showed that maximum (44.75 g) in T D - 1 under 22.50 row spacing and minimum was noted 40.14 g in Sarsabz under 15.00 cm row spacing in 1000 grain weight. Singh and Srivastava (1991) reported that 1000-grain weight increased with increasing row spacing.

Table 6. Influence of row spacing on 1000-grains weight (g) of wheat varieties during 2009-10

Row spacing (cm)/ Varieties	1000-grains weight (g)			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	40.14 e	42.43 c	44.36 a	42.31 c
22.50	41.36 d	43.25 b	44.75 a	43.12 b
30.00	42.54 c	43.31 b	44.73 a	43.53 a
Mean of varieties	41.35 c	43.00 b	44.61 a	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		0.173		0.367
Row spacing (R)		0.173		0.367
Interactive V x R		0.300		0.636

Grains yield (kg ha^{-1})

The data regarding grain yield is presented in Table 7. The results indicated that maximum mean value of grain yield 4559.0 kg ha^{-1} in Kiran - 95 and maximum mean value 4457.6 grain yield kg ha^{-1} was obtained under 30.00 cm row spacing. The interactive influence of varieties and row spacing indicated that maximum mean value for grain yield of 4659.0 kg ha^{-1} was obtained in Kiran - 95 under 30.00 cm row spacing and minimum 4054.3 grain yield kg ha^{-1} in Sarsabz under 15.00 cm row spacing. There are controversial reports in the literature regarding the role of row spacing in wheat production. Sharma and Thakur (1990) investigated that grain yield was non-significantly affected by sowing wheat either at 22 or 30 cm row spacing. Raj *et al*. (1992) reported that row spacing (15, 22.5 or 30 cm) had no effect on grain yield but

the yields were lower in the wider row spacing (30 cm). The results confirm by Dawood (1994) that grain yield increased with increasing row spacing. The results further confirmed by Habibullah *et al.* (2007) that highest grain yield was obtained from the plots with wider spacing 30cm followed by the same row spacing of 22.50 cm.

Table 7. Influence of row spacing on grains yield (kg ha^{-1}) of wheat varieties during 2009-10

Row spacing (cm)/ Varieties	Grains yield (kg ha^{-1})			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	4054.3 g	4454.7 d	4459.3 d	4322.8 c
22.50	4148.0 f	4563.3 b	4503.0 c	4404.8 b
30.00	4160.7 e	4659.0 a	4553.0 b	4457.6 a
Mean of varieties	4121.0 c	4559.0 a	4505.1 b	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		2.943		3.240
Row spacing (R)		2.943		3.240
Interactive V x R		2.098		4.809

Biological yield (kg ha^{-1})

The data regarding grain yield is presented in Table 8. The results indicated that maximum mean value of biological yield 9963.0 kg ha^{-1} in Sarsabz and maximum mean value 9760.2 biological yield kg ha^{-1} was obtained under 30.00 cm row spacing. The interactive influence of varieties and row spacing indicated that maximum mean value for biological yield of 10017 kg ha^{-1} was obtained in Sarsabz under 30.00 cm row spacing and minimum 9270.0 biological yield kg ha^{-1} in T D - 1 for 15.00 cm row spacing.

Table 8. Influence of row spacing on biological yield (kg ha^{-1}) of wheat varieties during 2009-10

Row spacing (cm) /Varieties	Biological yield (kg ha^{-1})			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	9924 c	9546 f	9270 i	9580.1 c
22.50	9948 b	9659 e	9377 h	9661.4 b
30.00	10017 a	9766 d	9498 g	9760.2 a
Mean of varieties	9963.0 a	9657.0 b	9381.8 c	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		1.081		3.531
Row spacing (R)		1.081		3.531
Interactive V x R		3.336		5.313

Harvest index (%)

The data was recorded on harvest index is shown in Table 9.

Table 9. Influence of row spacing on harvest index (%) of wheat varieties during 2009-10

Row spacing (cm) /Varieties	Harvest index (%)			Mean of row spacing
	Sarsabz	Kiran-95	TD-1	
15.00	40.85 h	46.66 e	48.10 a	45.20 b
22.50	41.69 f	47.24 d	48.02 ab	45.65 a
30.00	41.53 g	47.70 c	47.93 b	45.72 a
Mean of varieties	41.362 c	47.204 b	48.01 a	-
Statistics				
Traits		SE		LSD (5%)
Varieties (V)		0.035		0.075
Row spacing (R)		0.035		0.075
Interactive V x R		0.061		0.131

The mean value for variety indicated that maximum harvest index of 48.01% was noted in T D - 1 and maximum mean value 45.72 for row spacing of 30 cm. While the interactive of varieties x row spacing showed that maximum harvest index value of 48.10% was obtained in T D - 1 under 15.00 cm having row spacing and minimum 40.85% was observed in Sarsabz under 15.00 cm row spacing. The harvest index increase with increasing plant height. The Sarsabz and Kiran - 95 are tall varieties, while the T D - 1 is semi dwarf variety.

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