COMPARISON OF WIDER ROW SPACING WITH NORMAL ROW SPACING IN FIVE WHEAT CULTIVARS

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ABSTRACT

An experiment was conducted to compare the effect of wider row spacing (45 cm) with normal row spacing (30 cm) on grain yield and yield components in five wheat varieties viz; MH-97, Sughat, Daman-98, Fakhar-e- Sarhad and Tatara at the Research area, Agricultural Faculty, Gomal University, Dera Ismail Khan. The outcomes shown that the two row spacing pointedly effected plant height, plant population m^{-2} , spikes m^{-2} , spikelets spikes^{-1}, spikes m^{-2}, number grains spike^{-1}, and 1000 grains weight. Grains yield and spike weight remained non-significant. Among varieties Daman-98 produced taller plants, maximum spike length, number of spikelets^{-1} spike, spike weight, number of grains and thousands grain weight. Maximum grain yield were recorded by Tatara, MH-97 and Fakhar-e-Sarhad respectively.

Keywords: *Row Spacing, Wheat varieties*

INTRODUCTION

The wheat is considered as the global major source of human food diet across the globe, followed by rice and maize. In this scene the wheat is one of the leading chief cereal crop of Pakistan. It is well adopted for cultivation in both irrigated and rain fed areas of the country. In country in the year 2013-2014 the wheat crop is cultivated on an area of 9.039 million hectares, with a produce of 25.3 million tons. The increase in the area is due to attractive market rates and introduction of early maturity cotton varieties (Anonymous 2014). The impact of wheat is very vital for the country economy and has a social impression as well (Fuente, Susan, Suarez & Ghersa, 2003). Although Pakistan is agrarian based economy but still importing wheat (Baksh, Hussain, Dasti, Mahmood, Aminud & Naqvi, 2006). Agronomics practices such as planting pattern play pivotal role in the stability of yield.

The research can predict the cropping potentials and in result can design better research trails for the wheat productivity enhancement (Satorre & Slafer, 2000). In Pakistan there is great potential to increase the wheat productivity through the adaptation of the improved agronomic packages. (Mahboob, Arain, Mazhar, Naqvi, Dahot & Nizamani, 2005; Hussain, Khan & Khan, 2010) Similarly Lafond, Domitruk, Bailey and Derksen (1996), Panda, Pattanaik, Rath, Tripathy and Behera (1996) stated that wider row spacing has not impacts in grain yield losses of wheat. The diversified approach i.e. agronomic

practices, timely and wise use of inputs, use of high yielding varieties etc. can lead to high yield marks (Shah, 1994). The proper wheat cultivar gave good produce in various climatic conditions, while as internal genetic factors the cultivars have shown different responses in terms of their grain yield potentials and that reasons make the choice difficult to select the proper wheat cultivar for the specific areas under various environmental conditions (Anwar, Hussain, Ali, Hussain, Saleem, Subhani, Ahmad & Munir, 2011). The main objectives of this experiment were to compare normal row spacing (30 cm single row drill) with wider row spacing (45 cm single row drill) using five wheat varieties.

MATERIALS AND METHODS

A five wheat varieties trail was conducted to evaluate the performance. These varieties belonging to different production zones of Pakistan comparing wider row spacing with normal row spacing regarding their agronomic traits in the specific agro-ecological environment of D.I.Khan. The study was carried out at the research area, Faculty of Agriculture, Gomal University, Dera Ismail Khan during the year 2010-11. The design of the trail was split plot design with four replications while plot area was 10 m^2. Five wheat varieties i.e. MH-97, Sughat, Daman-98, Fakhar-e-Sarhad and Tatara were allotted to main plots while two row spacing i. e. 30cm apart and 45 cm apart were allotted to sub plots.

Plots were sown on November 12, 2010, in rows. Sowing was completed with single line (manual drill) and seed rate of 115 kg ha^{-1} was used. Fertilizers to supply 135 and 55 kg NP ha^{-1}, respectively, were applied (Urea & Single super phosphate). Full dose of phosphorus and 1/2 nitrogen dose was applied during the sowing, while the left dose of N was used with 1st and 2nd irrigation respectively. Crop received four irrigations timed appropriately to suit the crop requirements. The "Quatro" herbicide at the rate of 1.83 lit ha^{-1} was sprayed after the 1^{st} irrigation.

Plant height (cm) at maturity

A total number of 20 tillers from each single plot were picked randomly from three sites and their height was recorded in cm.

Number of plant and spikes m^{-2}

This date was collected from 1 m^2 randomly from three sites and then every site data calculated, average was listed and used in statistical analysis.

Spike Length (cm) spikelets per spike and Grains per Spike

From each plot selected a number of spikes (10), measured (cm) with measuring scale, from base to apex in order to capture the length. 10 spikes selected and picked, counted spikelet's and means recorded while for grains per spike data was calculated after threshing of the spikes, averaged and recorded.

Spike weight per spike (g)

Weights of 10 spikes selected randomly from each unit area in each plot were taken by scientific balance and their average was recorded.

1000-Grain Weight (g)

At random the 1000 grains weight was recorded from every single plot through electronic weight machine.

Grain Yield (t ha^{-1})

The plot was harvested completely, sundried and afterward threshed. In this regard grain yield calculated in Kgs and converted into t ha^{-1}

The data recorded was analyzed using (Steel and Torrie, 1984 and Duncan multiple range test, 1955) analysis of variance techniques

RESULTS AND DISCUSSION

Plant Height (cm)

Comparison of wider and normal row spacing of five wheat varieties is shown in Table-I. Maximum plant height (86.95) was observed in normal row spacing. Daman-98 remained significantly taller (94.49 cm) followed by Sughat (84.48 cm). The interaction between varieties and row spacing also has significant differences. Interaction shows that maximum plant height (97.28) was recorded by normal row spacing of 30 cm with variety Daman-98. This variety may be genetically taller as compared to other varieties. This might be due to genetic make-up of the genotype to better utilize the available growth resources and produce healthy plant under agro-ecological conditions of D.I.Khan. Khan et al. (2001) also confirmed theses findings and reported that Daman-98 produces taller plants. Wider row spacing (45 cm apart rows) reduced the plant height of each variety and recorded low height compared with normal row spacing of 30 cm apart rows. The reason behind this might be the space, as it provided a better chance for light and nutrients uptake. These results are also in agreement with the finding of Khakwani et al. (2012).

Table 1 Effect of two row spacing & plant height (cm) in five wheat varieties

Row Spacing (cm)	Varieties					Means
	MH-97	Sughat	Daman-98	Fakhar-e-Sarhad	Tatara	
30	91.93b	93.28b	97.28a	73.78cd	78.5c	86.95a
45	76.60c	75.68c	91.7b	70.5d	75.2c	77.94b
Means	84.26b	84.48b	94.49a	72.14c	76.85c	--

Means followed by the same letter in the respective category are non significant at 5% level of probability

Plant Population

Row spacing affected the number of plants per square meter in five wheat varieties was shown in Table-2. According to Statistical analysis of variance the difference between two values of row spacing and five wheat varieties were significant. While interaction between varieties and row spacing was found non-significant. Maximum plant population (296.75) was recorded in Sughat, followed by Tatara (287.63) when it was planted in normal row spacing. Among varieties sughat produced significantly more plant than any other varieties. Normal row spacing of 30 cm produced significantly more plants than wider row spacing. The decrease in plant number in wider row spacing is may be due to more competition among interplants. Khan *et al.* (2001) and Hussain *et al*.(2010) confirmed our results and reported that Daman-98 and Fakhar-e-Serhad are low tillering varieties.

Table 2 Effect of two row spacing on plant population in five wheat varieties

Row Spacing (cm)	Varieties					Means
	MH-97	Sughat	Daman-98	Fakhar-e-Sarhad	Tatara	
30	339.25NS	355.5	248.5	197.75	291.5	286.50a
45	218.25	238.0	207.0	224.5	283.75	234.30b
Means	278.75b	296.75a	227.75c	211.13d	287.63ab	

NS = Non significance

Means followed by the same letter in the respective category are non significant at 5% level of probability

Spikes (m^{-2})

This data shows significant results (Table 3) while the findings of the Interaction among varieties were non-significant. The maximum Spikes (m^{-2}) was counted in Sughat (286.0) followed by Tatara (280.88), MH-97 (270.5), Daman 98 (218.75) and Fakhar-e-Sarhad (200.63). Normal row spacing of 30 cm recorded (278.15) more spikes than wider row spacing (224.6). The higher number of spikes in Sughat, Tatara and MH-97 might be due to their more tillering potential as compared to other varieties. The more spike count with normal row spacing of 30 cm and the reason could be minimum interplant rivalry and even distribution of seed in rows. Velloso et al. (1988), Yoon et al. (1991) and Hussain et al. (2010) have also reported same findings.

Table 3 Effect of two row spacing on spikes m^{-2} in five wheat varieties

Row Spacing (cm)	Varieties					Means
	MH-97	Sughat	Daman-98	Fakhar-e-Sarhad	Tatara	
30	331.5NS	341.75	240.0	191.75	285.5	278.15a
45	209.5	230.25	197.5	209.5	276.25	224.6b
Means	270.5ab	286a	218.75bc	200.63c	280.88ab	---

NS = Non significance

Means followed by the same letter in the respective category are non-significant at 5% level of probability

Spike Length (cm)

The association of the spike length with number of grains is understood as the lengthy spikes produced more grains in number. The data in Table 4 showed that row spacing did not significantly affect the spike length. There were significant differences in spike length of the five wheat varieties. While interaction between row spacing and varieties was also non significant. Daman-98 produced longer spike (13.25cm). Tatara recorded shortest spike (10.08cm) longer spikes recorded in Daman-98 might be due to its genetic makeup. Khan et al. (2001) also produced the results of same nature and reported that Daman-98 have genetic ability to produce longest spikes.

Table 4 Effect of two row spacing on spike length (cm)in five wheat varieties

Row Spacing (cm)	Varieties					Means
	MH-97	Sughat	Daman-98	Fakhar-e-Sarhad	Tatara	
30	11.18NS	10.70	12.68	10.43	10.05	11.01
45	10.88	10.55	13.83	10.43	10.10	11.16
Means	11.03b	10.63bc	13.25a	10.43c	10.08c	---

NS = Non significance

Means followed by the same letter in the respective category are non-significant at 5%level of probability

Spikelets per Spike

It is evident from Table 5 that there were significant differences in spikelets per spike of five wheat varieties. Row spacing also significantly affected spikelets per spike but interaction between varieties and row spacing was not significant. Maximum spikelets per spike (20.1) was produced in wheat variety Daman-98. While minimum count was recorded in Tatara. Normal row spacing produced maximum number of spikelets per spike. It might be due to extra tillers produced at wider row spacing which were probably formed late in season/stress period, therefore produced low number of spikelets per spike. Longer spike with high number of spikelets $spike^{-1}$ in Daman-98 might be due to its

genetic makeup. Kalwar et al. (1993) and Muhammad et al. (1999) in row spacing experiments also stated that there is non-significant change in number of spikelet per spike.

Table 5 Effect of two row spacing on Spikelets per spike in five wheat varieties

Row Spacing (cm)	Varieties					Means
	MH-97	Sughat	Daman-98	Fakhar-e-Sarhad	Tatara	
30	18.2NS	19.6	20.43	20.08	17.58	19.20a
45	17.45	18.25	19.78	18.93	17.60	18.4b
Means	17.83c	18.93ab	20.10a	19.5a	17.59c	---

NS = Non significance

Means followed by the same letter in the respective category are non significant at 5% level of probability

Spike Weight (g)

Spike weight is controlled by environment, genetic make-up, soil fertility and plant density. The table 6 showed significant findings in spike weight of different five wheat cultivars. The row spacing and interaction between row spacing and cultivars did not significantly affect the spike weight. Daman-98 produced heavier spikes. This variety is considered genetically producer of minimum tillers but heavier and longer spikes. So it might be it's genetically superiority in this regard over other varieties. The different genetically potentials of varieties is also reported by Khan et al. (2001). So this is very evident that this character is a genetic, and having less affected with cultural modifications etc. , while these figures are in agreement with the finding Hussain et al. (2010) and Khakwani et al. (2012)

Table 6 Effect of two row spacing on Spike Weight in five wheat varieties

Row Spacing (cm)	Varieties					Means
	MH-97	Sughat	Daman-98	Fakhar-e-Sarhad	Tatara	
30	3.23NS	2.83	4.43	2.68	3.7	3.37
45	3.3	2.88	4.55	3.20	3.68	3.52
Means	3.26bc	2.85	4.49a	2.94c	3.69b	

NS = Non significance

Means followed by the same letter in the respective category are non significant at 5% level of probability

Number of Grains

The potential of grains per spike is measured in terms of its number of grain, so very close relationship between grain yield and grains per spike occurred. The data presented in table 7 manifested that there were significant differences in grains spike^{-1} in

comparison of normal row and wider row spacing. Varieties also have significant differences in this regard. But interaction between the two factors was not significant. Maximum number of grains (71.1) was found in Daman-98 when row spacing was 30 cm apart. Among varieties Daman-98 showed clear dominance in this regard. Minimum number of counts in grain spike^{-1}(56.35) was recorded in wheat variety MH-97. Normal row spacing of 30 cm recorded more grains than wider row spacing. The greater number of grains spike^{-1} in normal row spacing might be due to uniform distribution of seed in rows .Hence efficient utilization of space and nutrients by plants in normal row spacing resulted in greater number of grains spike^{-1}. These results are in accordance with the results of Muhammad et al. (1999). Who observed that grains spike^{-1} is an inherent character of wheat varieties but affected by row spacing.

Table 7 Effect of two row spacing on number of grains spike-1 in five wheat varieties

Row Spacing (cm)	**Varieties**					**Means**
	MH-97	**Sughat**	**Daman-98**	**Fakhar-e-Sarhad**	**Tatara**	
30	56.43NS	55.93	71.1	55.25	64.85	60.71a
45	56.35	53.85	70.08	55.93	63.20	59.88b
Means	56.39c	54.89c	70.59a	55.59c	64.03b	

NS = Non significance

Means followed by the same letter in the respective category are non significant at 5% level of probability

1000-grain weight (g)

The 1000-grain weight is very imperative feature for the yield estimation of wheat grain yield. Kazi et al. (2012) and Roder et al. (2008) reported that 1000 grain weight as major traits in yield and have been important selection criteria of higher yielding varieties. The table-8 witnessed that 1000-grain weight is significantly different between two row spacing and in five wheat varieties. The interaction between two factors i. e varieties and row spacing was also significant. The maximum 1000-grain weight was observed in wider row spacing of 45 cm apart which differed significantly from normal row spacing of 30 cm apart. Among varieties, Daman-98 dominated over all other varieties.Daman-98 (50.83) also recorded maximum 1000-grain weight when it was sown at wider row spacing. Khan et al. (2001) argued about this character of Daman-98 that heavier grains of this variety might be due to its longer grain filling period and more acclimatization in agro-ecological conditions of Dera Ismail Khan.

These findings are in agreement with Hussain et al (2010). Who observed that a longer filling period enables the plant to store assimilates/metabolites (carbohydrates and proteins) in the grain for longer period that results in a healthier grain with more grain weight. It is also concluded from these results that grain weight increased in wider row

spacing. Similar results were obtained by Sheikh et al. (1995), Ayyaz et al. (1999) and Hussain et al. (2003). They all reported that row spacing had significant effects on 1000-grain weight.

Table 2 Effect of two row spacing on 1000-grain weight (g) in five wheat varieties

Row Spacing (cm)	Varieties					Means
	MH-97	Sughat	Daman-98	Fakhar-e-Sarhad	Tatara	
30	37.33d	38.58d	48.29ab	41.10c	43.35b	41.73b
45	40.23c	41.15c	50.83a	43.08b	44.35b	43.93a
Means	38.78c	39.87c	49.56a	42.09b	43.85ab	

CV. = 5.11

Means followed by the same letter in the respective category are non significant at 5% level of probability

Grain yield (t ha-1)

Kazi *et al*. (2012) described the grain yield contributing components. The grain yield of wheat is determined by number of spikes, number of grains spike[1] and grain weight. The means data across the year, recording grain yield per hectare envisaged that grain yield significantly affected by different cultivars (Table 9). However, row spacing and interaction among two factors found non- significant. This shows that due to inter-tillage the weeds population is checked and wider planting geometry method is adopted with minimum risk of yield reduction. Among wheat varieties, Tatara, MH-97, and Fakharre – sarhad produced maximum grain yield over Daman-98 and Sughat. Evidently the superiority of wheat varieties Tatara, MH-97 and Fakhare- sarhad are due to its better adaptability under ecological conditions prevailing in Dera Ismail Khan (KPK) Pakistan and due to their maximum count in plant population m-$^{2.}$ Satorre and Slafer (2000) argued that plant population is the main factor controlling the grain yield. While Calderini *et al*. (1995) also reported that surveys of commercial crops have demonstrated that grain yields are positively co-related with spike population. Khan *et al*. (2007) also proved that tatara is best wheat variety among tested ten wheat varieties in their varietal trial, which were tested for grain yield stability at five different locations in the Khyber Pakhtun Khwa province of Pakistan.

Ayyaz et al. (1999) findings also shown that two row spacing have non-significant affect. They reported that wider row spacing, not only allow more light to reach the leaves at the time of grain formation which leads to bold and heavy grain development. Similarly Ahmad et al. (1999), Nazir et al. (1987) and shafi et al. (1987) also confirmed our results. Rana et al. (1995) concluded from their results that wheat crop genotypes usually have great plasticity. Evidence of this may be obtained by comparing the performance of plants at wider spacing with normal spacing. Wheat plants under density stress are

smaller and have few spikes and grains than widely spaced plants. Due to low availability of crop growth resources, plants under severe competition show a progressive reduction in growth rate which leads to minimize their grain yield. Lafond et al. (1996) and Panda et al. (1996) proved from their experiments that wider row spacing did not result in wheat grain yield losses.

Table 9 Effect of two row spacing on grain yield (t ha-1) in five wheat varieties

Row Spacing (cm)	**Varieties**					**Means**
	MH-97	**Sughat**	**Daman-98**	**Fakhar-e-Sarhad**	**Tatara**	
30	5.93NS	5.53	6.33	5.85	6.30	5.99NS
45	6.28	3.68	5.30	6.35	6.50	5.52
Means	6.10a	4.60c	5.81b	6.10a	6.40a	

NS = Non significance

CV=7.09

Means followed by the same letter in the respective category are non significant at 5% level of probability

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