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Effect of Row Spacing on the Grain Yield and the Yield Component of Wheat (*Triticum aestivum* L.)

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Abstract: An experiment was conducted to determine the effect of different row spacing on grain yield and yield components of wheat variety Inqilab 91 at the agronomic research area, Faculty of Agriculture, Gomal University, D.I. Khan. The results revealed that different row spacing significantly affected plant population m^{-2}, number of spikes m^{-2}, 1000 grain weight, biological yield and grain yield. Number of grains spike^{-1}, spikelets spike^{-1}, spike length and harvest index remained non significant. Maximum tillers m^{-2} (418.5) and spikes m^{-2} (408) were observed at cross drill sowing techniques of 30 × 30 cm^2. While maximum 1000 grain weight (48.70 g) were recorded at wider row spacing of 60 cm. Maximum biological yield (14.13 t ha^{-1}) and grain yield (5.65 t ha^{-1}) were also observed in cross drill sowing (30 × 30 cm^2).

Key words: Row spacings, grain yield, yield components, wheat

Introduction

The grain yield is a function of interaction between genetic and environmental factors like soil type, sowing time and method, seed rate, fertilizers and time of irrigation. Among these factors row spacing plays a vital role in getting higher grain yield.

Wheat is generally planted by broadcast method by most of the farmers in the country and only progressive farmers and researchers use line sowing. Now-a-days due to infestation of weeds, it has become necessary to sow the crop in lines with a suitable row spacing, which may help in cultural operations, herbicides application, inter-cropping and increasing or decreasing seed rate without any adverse effect on the final grain yield. Proper row spacing is important for maximizing light interception, penetration, distribution in crop canopy and average light utilization efficiency of the leaves in the canopy, and thus affect yield of a crop. Wider spacing between rows or pairs of rows, not only allow more light to reach the lower leaves at the time of grain formation but also allows easy inter-culture for weed control and inter-cropping (Ayaz ***et al.***, 1999). Similarly Nazir ***et al.*** (1987), Shafi ***et al.*** (1987) and Surendra ***et al.*** (1985) led to the conclusion that wheat grain yield was not reduced to a significant extent by increasing the row spacing and suggested that wider planting geometry technology can be adapted without any risk of reduction in yield, may facilitate inter-tillage devices for effective weed control and inter-cropping in wheat.

Knowledge of yield components responses to manipulations of management inputs is basic for the establishment of consistent and profitable intensive management system for wheat. In northern USA, the commonly used row spacing is 17.8 cm, but based on studies in Pennsylvania, a row spacing of 12.7 cm should give consistent increase in yield. [Roth ***et al.*** (1984)] but Frederic and Marshall (1985) stated that decreasing the row spacing resulted in significant grain yield increases ranging from 6.0 to 13.2% with a mean of increase 8.2%.

Dhiman ***et al.*** (1984) reported that wheat varieties gave 13-18% higher grain yield when planted by disc drill in cross rows than in one direction only. Singh and Uttam (1993) in a field trial also found that grain yield was higher with bi-directional method of sowing. Arif ***et al.*** (1997) also found that line or bi-directional sowing gave significantly higher grain yield than broadcasting.

The main objective of this experiment was to determine the effect of different row spacings and cross drill sowing on the yield and yield components of wheat variety Inqilab under the agroclimatic conditions of Dera Ismail Khan during 1999-2000.

Materials and Methods

The experiment was conducted at the Agronomic research area, Faculty of Agriculture, Gomal University, Dera Ismail Khan, NWFP, Pakistan during 1999-2000, to study the effect of row spacing and cross drill sowing technique on yield components and grain yield of wheat. The experiment was laid out in randomized complete block design by using plot size of 2.5×5 m^2. Wheat variety Inqilab 91 was sown at different row spacings as detailed below:-

T_1 08 cm apart rows.
T_2 18 cm apart rows.
T_3 30 cm apart rows.
T_4 $30{\times}30$ cm^2 cross drill method of sowing.
T_5 45 cm apart row.
T_6 60 cm apart rows.

Crop was sown at recommended seed rate of 100 Kg ha^{-1}. Five irrigations were applied during the course of experiment. Nitrogen was applied @ 100 Kg ha^{-1} as Urea and phosphorus was applied @ 60 kg ha^{-1} as Single super phosphate. Half dose of nitrogen and full dose of phosphorus was applied at the time of sowing and was thoroughly mixed into soil by ploughing and planking. Rest of nitrogen was applied with first irrigation. All other cultural practices were kept according to Shah, 1994.

The procedures used for data collection on the different parameters was as under:

Number of plants and spikes m^{-2}

An area of 1 m^2 was selected at random in each plot to count total number of plants and spikes.

Spike Length (cm), Spikelets $Spike^{-1}$ and Grains per Spike

Twelve spikes were randomly selected from each plots. Each spike was measured with rural from the base of the spike to the apex to record the spike length in cm. No. of spikelets were also counted of each spike. To record the grain per spike, each spike was threshed separately and grain of each spike were counted and average.

1000-Grain Weight (g)

1000 grains were counted at random from each plot and their weights were taken by electric balance.

Biological Yield (t ha^{-1})

Crop of each plot was harvested manually and tied into bundles. The biological yield was recorded in kg by weighing the bundles of each plot with the help of spring balance and then subsequently converted into t ha^{-1}.

Grain Yield (t ha^{-1})

Wheat bundles of each plot were sun dried and then threshed separately. The grain weight of each plot was recorded in kg and then subsequently converted into t ha^{-1}.

Harvest Index (%)

Harvest index of each plot was calculated by using the following formula:

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield}}{\text{Biological Yield}} \times 100$$

Data so collected were analyzed by using the analysis of variance techniques (Steel and Torrie, 1984) and Duncan Multiple Range Test was used to see the significance of treatment means (Duncan, 1955).

Results and Discussion

Plant population m^{-2}

Table indicated that all the treatment means had a significant difference among themselves. Cross drill sowing technique gave higher plant population count (418.5) over other treatments. While narrow row spacing (8 cm) followed the cross drill technique. The lowest count (271.8) were produced by 30 cm apart rows (usual row to row distance) wheat spacing which was statistically at par with wider row spacing of 60 cm. The reduced plant population in increased row spacing might be due to more interplant competition within the row.

These results agree with those of Shafi ***et al.*** (1987), Rajput and Alam (1990) and Ahmad ***et al.*** (1999) reported that narrow row spacing produced significantly more tiller m^{-2}. Holliday (1963) reported 2 to 10% increase in grain yield by increasing tiller count from using a narrow row spacing.

Spikes m^{-2}

Data presented in table revealed that row spacing had significant effects on the number of spikes m^{-2}. Maximum numbers of 408 spikes m^{-2} were produced in cross drill sowing technique, while the lowest number 265.8 spikes m^{-2} were recorded in 30 cm apart rows. Narrow row spacing

(8 cm) produced second highest number of spikes (376.8). The increased spike count with narrow spacing might be due to lack of interplant competition and uniform distribution of seed. Similarly Fredrick and Marshall (1985) reported that significantly more spikes m^{-2} in narrow row spacing. These results also coincide with the results of Velloso ***et al.*** (1988) and Yoon ***et al.*** (1991).

Spike length (cm)

Spike length is associated with number of grains and longer spike produced maximum number of grains. The data in the table showed all the treatments were statistically at par with each other. However, maximum (11.95 cm) spike length was recorded in wider row spacing of 60 cm. Minimum spike length (10.55 cm) were observed in 08 cm apart rows. It might be due to more space, light and nutrients available to the plants in wider row spacing. Although all treatments are statistically at par. So, it can be concluded from these results that spike length is genetic character of a variety, which is less influenced by agronomic practices. Khan ***et al.*** (2001) reported that varieties have different genetic potential regarding the spike length.

Spikelets per spike

The data regarding the number of spikelets $spike^{-1}$ have been presented in Table 1 and was non-significant. Kalwar ***et al.*** (1993) and Muhammad ***et al.*** (1999) also observed non-significant difference in number of spikelets $spike^{-1}$. Moreover Jan ***et al.*** (2000) reported that spikelets $spike^{-1}$ is inherent character of a variety which is slightly influenced by environmental factors.

Grains per spike

Grains per spike (Table 1) had a non-significant statistically difference among the treatments. Sowing of wheat in 30×30 cm^2 cross drill sowing produced maximum grains (54.25). Narrow row spacing 08 cm and 18 cm followed it. The greater number of grains $spike^{-1}$ of wheat in cross dill sowing might be due to more space and nutrients utilization by the plants. Hence efficient utilization of space and nutrients by plants 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 $spike^{-1}$ are purely inherent character of wheat varieties and not affected by row spacing.

1000-Grain weight (g)

1000-grain weight is an important yield determining component of wheat. The table witnessed that 1000-grain weight was non-significant. The maximum 1000-grain weight (48.70) was observed in 60 cm apart row of wheat which differed significantly from all treatments except 45 cm apart row of wheat. The minimum 1000-grain weight of (43.20) was recorded by 8 cm apart rows of wheat. It is concluded from these results that grain weight increased with increase in row spacing. Similar results were obtained by Sheikh ***et al.*** (1995) and Ayaz ***et al.*** (1999) who reported that row spacing had significant effects on 1000-grain weight.

Table 1: Effect of row spacing on the grain yield and the yield component of wheat (*Triticum aestivum* L.)

Treatments	Row spacing (cm)	Tillers m^{-2}	Spikes m^{-2}	Spike length (cm)	Spikelets per spike	Grains per spike	1000 grain weight (g)	Biological yield (t ha^{-1})	Grain yield (t ha^{-1})	Harvest index (%)
T_1	08	383.8AB	376.8AB	10.55*	14.95*	53.0*	43.20B	10.45BC	4.575BC	45.50*
T_2	18	303.5BC	292.8BC	11.20	16.63	52.0	45.10CD	10.13C	3.550C	35.75
T_3	30	271.00C	265.8C	11.90	17.85	50.73	46.25ABC	10.45BC	4.375BC	42.00
T_4	30×30	418.5A	408.0A	10.90	15.25	54.25	45.50BCD	14.13A	5.650A	40.25
T_5	45	288.5BC	281.3BC	11.58	16.05	49.35	48.45A	7.875D	3.650C	46.5
T_6	60	272.3C	266.8C	11.95	16.18	47.05	48.70A	9.825C	3.750C	38.25

Figures not sharing a letter in common differ significantly at 5% level of probability, * Non significant

Biological yield (t ha^{-1})

The data presented in table revealed that biological yield (t ha^{-1}) of experimental treatments. Significant difference were found among different treatments. The average biological yield varied from 7.875 to 14.13 t ha^{-1}. The effect of row spacing showed that the highest biological yield of 14.13 t ha^{-1} was obtained from cross sowing of 30 × 30 cm^2 apart while lowest 7.88 t ha^{-1} was obtained from 45 cm apart rows. The results obtained agree with Nazir ***et al.*** (1987) who reported that cross sowing increased biological yield.

Grain yield (t ha^{-1})

The grain yield is attributed to the cumulative effect of various yield components.

The data of grain yield (Table 1) evidenced that row spacing had significant effects on the grain yield. The maximum grain yield (5.65 t ha^{-1}) was shown by cross sowing method. The lowest grain yield of wheat was produced by 60 cm apart rows and 45 cm apart rows. It can be concluded from these results that 30×30 cm^2 cross drill sowing in depicted significantly higher yield over all other treatments. It might be due to uniform distribution of seed, utilization of environmental resources and less lodging with more wind resistance. These results of this experiment are quite in line with the results reported by Nazir ***et al.*** (1987), Perihar and Singh (1995) and Arif ***et al.*** (1997).

Harvest index (%)

The ability of a variety to convert the total dry matter into economic yield is indicated by its harvest index value. The data in Table 1 revealed that harvest index was statistically at par among various treatments. 45 cm apart rows of wheat recorded maximum harvest value (46.5%) while minimum harvest index recorded by 60 cm apart rows. A little depression is observed in harvest index in 30×30 cm^2 cross sowing is quite in line with Smid and Jenkinson (1979) and Mariscal and Hunt (1991). Harvest index was related to grain weight but not to number of grains $spike^{-1}$. However these results suggested that positive yield - spike number $unit^{-1}$ land area relationships are determined predominated by increase in dry matter production and not by increasing harvest index. The results obtained are in conformity with the findings of Borojevic and Kraljevic (1982).

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