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Effect of Sowing Rates on the Grain Yield of Wheat Variety Punjab-96

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Abstract: The experiment was conducted to study the effect of sowing rates on the yield components and grain yield of wheat variety Punjab-98 at Agronomic Research Area, Faculty of Agriculture, Gomel University, Dora Ismail Khan during 1998-99. All sowing rates had significant effect on tillers per plot. Sowing rates higher than 100 kg ha^{-1} increased tillers over low seed rate of 50 kg ha^{-1}. High sowing rates than 100 kg ha^{-1} did not show any significant effect on spike length over low seed rate (50 kg ha^{-1}). Low seed rate produced more number of grains per spike over high seed rates. Sowing rates from 50 kg ha^{-1} to 500 kg ha^{-1} had no significant effect on 1000-grain weight. The highest seed rate did not produce the highest biological yield mainly due to plant competition for nutrients, light and air. The lowest biological yield in *case* of low seed rate was merely due to low plant population. The grain yield was decreased by using seed rate above 250 kg ha^{-1}. The highest grain ratio towards total dry matter production was found in plots sown at low seed rate (50 kg ha^{-1}) which can be attributed to more grains per spike. There was positive correlation between yield components and grain yield.

Key words: Sowing rates, grain yield and wheat

Introduction

During the year 1996-97, wheat was planted on about 8.085 million ha in Pakistan with the production of 16.377 million tones and the average yield of 2026 kg ha^{-1} (Khan, 1997). Wheat being a widely adopted crop is grown under a variety of soil and climatic conditions. Despite all out efforts towards increasing its production, national average yield per hectare is still far below the level of potential yield of our recommended varieties. Read and Warder (1982) obtained maximum yields of wheat on fallow and stubble from maximum sowing rates of 80 kg ha^{-1}. Khan (1992) observed the effect of different seed rates and nitrogen levels on the yield and yield components of wheat. The results indicated that all the yield components except 1000-grain weight were invariably affected significantly by various nitrogen levels, while the seed rate only affected number of tillers per unit area. The highest grain yield of 56.33 quintal per hectare was obtained from the plots fertilized with 125 kg nitrogen per ha, while the maximum of 49.01 quintal per ha obtained from the plots seeded with 150 kg ha^{-1} against the maximum of 33.04 quintal in check plots. The harvest index decreased progressively with each successive increase in sowing rates from 100-150 kg ha^{-1}. Similarly it increased up to fertilizers dose of 125 kg nitrogen per hectare and then slightly decreased. The benefit cost ratio was also influenced significantly by various nitrogen levels and different sowing rates. Maximum benefit cost ratio of 5.15 was recorded from the plots seeded with 150 kg ha^{-1} and fertilized with 125 kg nitrogen per ha. Highly significant interaction between nitrogen and seed rates was observed in case of number of tillers per unit area, biological yield, grain yield, harvest index and benefit cost ratio. Singh *et al*. (1992) studied in a field experiment in 1985-87 at Sehore, irrigated wheat cultivar Raj 1555 was sown at 100, 125 or 150 kg seeds ha^{-1} and given 80, 100 or 120 kg nitrogen per ha. Fertilizers were either placed below the seed or applied with the seed at the time of sowing. Sowing rates of 100, 125 and 150 kg produced grain yields of 2.51, 3.02 and 2.81 tons ha^{-}% respectively. Application of 80, 100 and 120 kg nitrogen produced grain yields of 2.58, 2.77 and 3.22 tons per hectare, respectively. Fertilizer placement had no significant effect on grain yield. Grain protein content was unaffected by sowing rate or fertilizer placement method, but increased with nitrogen rate. Akkaya (1994) noted that head number per m^2, grain and total yields were significantly greater at sowing rates of 505-625 seeds per m^2 than at lower rates. Grain number and weight per head and harvest index decreased with increasing sowing rate. Sowing rate × cultivar interactions was not significant for any characteristic. Ahmad *et al*. (1995) planted wheat variety Pirsabak-85 that was planted at the rates of 40, 60, 80, 100 and 120 kg ha^{-1}. Seed rate significantly affected most of the characters. The number of spikes increased from 214-371 per m^2 and the number of grains per spike decreased from 59-43 respectively as these rates increased from 40-120 kg per hectare. Harvest index decreased from 42.98-35.12% and 1000-grain weight decreased from 40.50 g to 39.89 g with increase in seed rate from 40-120 kg ha^{-1}. The highest grain yield of 3583 kg ha^{-1} and straw yield of 8597 kg ha^{-1} were obtained from plots seeded at the rate of 120 kg ha^{-1}. Ayaz *et al*. (1999) reported that maximum grain yield of 2395 kg ha^{-1} was obtained from the highest sowing rates of 150 kg ha^{-1}. Row geometry had significant effects on spikes re and 1000-grain weight. Though, row geometry had no significant effect on grain yield, however, the geometry with 3rd row skip in 30 cm apart rows produced the highest yield of 2302 kg ha^{-1} followed by 4th row skip in 30cm apart rows geometry with 2291 kg ha^{-1}. The highest straw yields of 8407 kg ha^{-1} were produced *at* the highest seed rate and the narrowest planting geometry (pair of 8407 and 6460 kg ha^{-1} were produced at the highest seed rate and the narrowest planting geometry (pair of rows 30 cm apart and 50 cm between pairs) respectively. Planting geometry with 4th row skip in 30 cm apart rows and sowing rate of 50 kg seed ha^{-1} gave the highest harvest indices of 28.12 and 27.73% respectively. It was found that wider row geometry technology could be adapted without having any adverse effect on the ultimate grain yield. This system besides facilitating inter-culture also permits convenient inter-cropping in wheat during vegetative growth period. Keeping in view the importance of this input factor (seed rate), an investigation was carried out to study the effect of sowing rate on the grain yield of wheat variety Punjab-96 under D.I. Khan conditions.

Materials and Methods

An experiment to asses the effect sowing rates on wheat yield was conducted at the Agronomic Research Area, Faculty of

griculture, Gomel University, Dora Ismail Khan, NWFP, Pakistan, during the rabi season 1998-99. The experiment was laid out in a randomized complete block design (RCBD) with 4 replications. The plot size was 2 m^2. Seed was sown at rate of 50, 100, 150, 200, 250, 300, 350, 400, 460, 500 kg ha^{-1}. The wheat variety "Punjab-96" was used in the experiment. Seeds were counted for each treatment separately. The crop was sown on a well prepared seedbed. The land was prepared thoroughly by ploughing 3-4 times. More emphasis was given to the levelling of land for uniform distribution of irrigation water. The crop was sown on November 13, 1998. The crop was planted by hand in lines 25 cm apart. There were eight rows per plot. The first irrigation was applied at the crown root initiation stage and subsequently at 2-3 week interval. The fertilizer (NPK) was applied at the rate of 135-55-55 kg ha^{-1}. All the phosphorus and potassium were applied at the time of sowing whilst half of the nitrogen was given with 1st irrigation and remaining with 2nd irrigation. The sources of NPK were (Urea) Tripple Super Phosphate (TSP) and Potassium Sulphate (SDP). All productive tillers were counted in each plot at the time of harvesting the crop and recorded. Sixteen spikes were randomly selected from each plot. Their length was measured by using a measuring tape, averaged and recorded. These spikes were threshed individually. Their grains were counted and averaged. Thousand grain were counted from each treatment and weighed. The crop was harvested on 19th of April 1999. The bundles were made and sun dried. Biological yield in each plot was weighed before threshing with the help of a spring balance. The bundles from each treatment were then threshed separately and weighed to record the grain yield per plot. The harvest index (%) for each treatment was calculated by using the following formula:

$$\text{Harvest Index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The data so collected were analyzed by using the analysis of variance Techniques (Steel and Torrie, 1984) and Duncan's Multiple Range Test (Duncan, 1955) was used to compare the difference among the treatment means. The analysis were performed with the help of computer "MSTATC" software package (Bricker, 1991).

Results and Discussion

Fertile Mem There was consistent increase in the number of spikes per plot with increasing sowing rates Table 1. This increase was found highly significant statistically at 1% level of probability. The sowing rates of 350 kg ha^{-1} showed a decrease of 19 spikes over the pervious sowing rates of 300 kg ha^{-1}. It might be due to low germination. The low number of spikes in wheat plots where high seed rates were used was mainly due to increased competition among plants. Lodging of plants was increased as the sowing rates increased. Although there are significant differences in the number of fertile tillers produced by using high or low seed rates but low seed rate did not differ significantly from the results of the recommended seed rate. The non significant difference between low and recommended seed rate showed decrease in tillering capacity of this variety with increasing sowing rates. These results are in conformity with the finding of Poswal (1974) who reported that varieties and sowing rates had significant effect on tillering.

Spike Length (cm): Table 1 shows that sowing rates had no significant effect on the spike length. Sowing rates of 100 and 500 kg ha^{-1} produced smaller spikes when compared with rest of sowing rates. It is evident from these results that sowing rates whether low or high than the recommended rate of 100 kg ha^{-1} did not show any large increase or decrease in the spike length. These results show that plants of wheat variety Punjab-98 are able to maintain their genetic potential about ear length and are not adversely affected by the low or high sowing rates. These results differ from the findings of Sourour and El. Sharkway (1976) who reported decline in ear length at increased seed rates which might be due to strong genetic trait of the variety used in this trial.

Grains per Spike (no): The results showed that sowing rates had significant effect on the number of grains per spike. The lowest seed rate produced the greater number of grains over all other sowing rates used. These results also suggest that there is slight decrease in the number of grains per spike as sowing rates increased. The highest grain number obtained in the lowest sowing rates can be attributed to more light penetration through plant canopy. Hence, increased photosynthetic activity of thin plant stand increased the grains contained per spike. This is further clear in the plots shown with the highest seed rate which produced the lowest number of grains per spike. The difference between the highest and the lowest seed rate is statistically significant. The lowest number of grains per spike in case of highest sowing rates might be due to more competition among crop plants for light, air, moisture and nutrition. This competition decreased the conversion rate of radiation towards grain production through the increase in plant densities. These results are in accordance with Akkaya (1994).

1000-Grain Weight (g): The Table 1 shows that all the sowing rates had non-significant effect on grains weight. The lowest 1000-grains weight produced by using seed rate of 100 kg ha^{-1}. These results disagree with the recent findings of Ayaz *et al*. (1999) who reported that sowing rates of 50, 100 and 150 kg ha^{-1} had significant effect on 1000-grain weight. However, Khotyleva *et al*. (1990) reported that 1000-grain weight was not much affected by sowing rate.

Biological yield (kg ha^{-1}): The results shown in Table 1 revealed that all-sowing rates had affected significantly the biological yield of wheat variety Punjab-96. The lowest sowing rates produced the lowest biological yield, which did not differ significantly from the biological yields obtained by using seed rates of 100, 150 and 500 kg ha^{-1} respectively. These three sowing rates include recommended rate of sowing which is again non-significant to the other high sowing rates except 450 kg ha^{-1}. The reason for the lowest biological yield by using a seed rate of 50 kg ha^{-1} is very clear that is the lowest plant density. These results are in conformity with the findings of Ballatore *et al*. (1985) who concluded from their experiment on sowing rates that biological yield was more at higher sowing rates than the lower.

Grain yield (kg ha^{-1}): Table 1 suggested that all the sowing rates had no significant effect on increasing the grain yield. Seed rate of 50 kg ha^{-1} produced the lowest grain yield. The results show that if nutrition requirements of plants are well managed, low seed rate can produce equally good grain yield

Table 1: Effect of sowing rates on yield components and grain yield of wheat variety Punjab-96

Sowing rates kg ha^{-1}	Fertile tillers (no)	Spike length (cm)	Grains per (no)	1000 Grain weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Harvest index (%)
50	505.5E**	14.18NS	74.16A**	45.85NS	13125.0c*	41.21 NS	41.21NS
100	609.3DE	14.02	71.81AB	43.41	15625.Obc	35.75	35.75
150	728.0CD	14.23	66.83CD	45.44	18750.Oabc	33.48	33.48
200	809.8BC	14.40	69.96ABC	45.13	2000.Oab	35.81	35.81
250	922.OAB	14.48	66.62BCD	45.93	21875.Oab	35.74	35.74
300	962.8AB	14.90	70.54AB	45.54	21250.Oab	31.46	31.46
350	943.8AB	14.59	68.07BCD	44.81	20000.Oab	30.54	30.54
400	1018.0A	14.41	63.93CD	46.27	212505.0ab	26.48	26.48
450	1043.0A	14.43	67.01BCD	46.27	22187.5a	28.58	28.58
500	958.8AB	14.15	63.570	46.43	18750.0abc	34.05	34.05

** Any two means having common letters are not significantly are not significantly different at 1% level of probability.
* Any two means having common letters are not significantly different at 5% level of probability.

Table 2: Correlation Coefficient

	Grains per spike (no)	1000-grain wt (g)	Grain yield (kg ha^{-1})
Fertile tillers (no/2 m^2)	-0.75*	+0.51NS	+0.50^{NS}
Grains per spike (no)		-0.62NS	+0.06^{NS}
1000-grain wt (g)			+0.39^{NS}

of wheat variety Punjab-96. The plots sown at the rate of 200 and 250 kg ha^{-1} produced almost equal grains yield. Sowing rates above normal sowing rates slightly increased the grain yield. The results further indicate that sowing rates more than 250 kg ha^{-1} upto 500 kg ha^{-1} reduced grain yield consistently. These results agree with Sorour and El-Sharkawy (1976), Singh ad Singh (1984), Yoon *et al*. (1991) and Ahmad *et al*., (1995) who reported that increase in seed rate upto certain limit increased the grain yield. It can be concluded from these results that there was slight increase in the grain yield by an increase in the sowing rates but beyond the seed rate of 250 kg ha^{-1} did not increase the grain yield.

Harvest Index (%): The harvest index (%) denotes grain yield as percentage of the total dry matter production (Ayaz *et al*. 1999). The results in Table 1 show that sowing rates had non-significant effect on the harvest index (%) of Punjab-96. The highest grain ratio was found in plots where wheat was sown at low seed rate. The results further show that increase in sowing rates reduced harvest index (%).

Correlation Coefficient: Grain yield of wheat is ultimate interaction of yield components. The relationship of each component was found applying a simple correlation analysis (Little and Hills, 1978). The results are presented in Table 2. It revealed that number of tillers per plot had negative correlation with number of grains per spike. But tillers per plot had positive correlation with 1000-grain weight an d grain yield although it was found non-significant at 5% level of probability. Number of grains per spike is negatively correlated with 1000-grain weight but it had positive correlation with the grains yield. The 1000-grain weight is positively correlated with the grain yield. These results suggest that grain yield is dependent on the number of fertile tillers per unit area, number of grains per spike and 1000-grain weight. These three yield components had shown positive correlation with grain yield which mean that sowing rates had no adverse effect on yield contributing components of wheat variety Punjab-96.

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