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# Impact of Intra-specific Competition on the Agronomic Traits of Wheat

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**Abstract:** Longer of growth period from germination to maturity in case of 10th November sown plants is probably contributed to higher grain yield and biological yield even compensating the highest lodging as result of maximum: plant height, productive tillers $m^{-2}$, grain spike$^{-1}$ spikelets spike$^{-1}$, 1000 grain weight. Various seed rate had significantly affected all the characters except days to maturity and 1000 grain weight. Seed rate of 200 kg ha$^{-1}$ with intermediate productive tillers $m^{-2}$, lowest grains spike$^{-1}$ and lowest spikelets spike$^{-1}$, having maximum plant height and maximum lodging and resultantly lower grain yield, but highest biological yield. Seed rate of 150 kg ha$^{-1}$ showed superiority in grains yield over others mainly because of highest productive tillers $m^{-2}$, although its grain spike$^{-1}$ or 1000 grain were not highest. Its plant height, lodging % ,spikelets spike$^{-1}$ and 1000 grain were at par with the seed rate of 100 kg ha$^{-1}$. Variety Inquilab-91 took maximum days to maturity, gained maximum height, maximum 1000 grain weight, maximum lodging, but lowest grains spike$^{-1}$ ,although its grain yield and biological yield were at par with Bakhtawar-92.
Date of sowing and seed rate (DxS) interaction showed that productive tillers $m^{-2}$ and grain yield were highest at seed rate of 150 kg ha$^{-1}$, sown on 10th November. Maximum plant height and lodging were recorded at the seed rate of 200 kg ha$^{-1}$ seeded on 10th November.

**Key words:** Wheat, tillers, 1000 grain weight, biological yield, date of sowing and seed rate, cultivars

## Introduction

In order to minimize the cost of production farmers are very anxious about the price of inputs, time of sowing is considered least important mainly because of lack of awareness about its significance. Wheat planted early in the season will gain maximum growth and development before the adverse effect of any climatic factors. Late sown crop usually face low temperature at the very early stage and therefore in addition to its negative effect on its various growth characteristic, minimum duration of grain filling and early maturity worsen the crop yield. Sowing of wheat in November is superior to that sown in month of December, as November sowing had higher grain weight and higher grain yield ha$^{-1}$ ( Jan *et al.*, 2000). Agarwal and Dhaka (1974) noticed a decrease of yield from 4.33 t ha$^{-1}$ to 2.35 t ha$^{-1}$ when the sowing was delayed from November to December. Ghildiyal *et al.* (1981) recommend November 15th as it produced 5 to 8 time more yield than December 25th sown crop. Wheat sown in 3rd work of November had more yield then sown earlier or late (Waraich *et al.*, 1982).

Planting wheat at optimum seed densities is very important from both physiological and economical point of view. Greater plant population can be obtained from higher seed rates, but result in poor growth and development which ultimately will have adverse effect on the yield and yield components of crop. Barriga and Pinan (1980) recommended seed rate of 120 kg ha$^{-1}$ as it gave highest yield as compared with 80, 200 and 240 kg ha$^{-1}$. Highest grain yield was observed when wheat was sown at rate of 125 kg ha$^{-1}$ having plant to plant distance of 20 as compared with 100 and 150 kg ha$^{-1}$. ( Upadhyay and Kuberkar, 1981). Surendra *et al.* (1986) recommended 170 kg ha$^{-1}$ as compared with 90, 130 and 210 kg ha$^{-1}$. Thakur *et al.* (1996) recorded maximum grain yield and straw yield and net higher return at seed rate of 200 kg ha$^{-1}$ as compared with 150 &175 kg ha$^{-1}$, While Ahuja *et al.*( 1996) observed that number of grain spike$^{-1}$ and spikelets spike$^{-1}$ were least affected by 250 kg ha$^{-1}$ seed rate.

Thus the use of proper seed rate with aim to avoid any possible conflict of intra-specific competition and reduce cost of production, and optimum sowing date for the currently promising varieties of the wheat are the important factors which contribute substantially to the final yield and thus needs due attention. Consulting the available literature and on the finding of previous work of the authors (Jan *et al.*, 2000), the present experiment was modified by including (I) another promising wheat variety (ii) seed rate was increased to 200 kg ha$^{-1}$ (seed rate were 50, 100, 150 200) and (iii) the crop was sown on 10th, 20th and 30th November and 10th December with the objectives to determine optimum seed rate and sowing date for the two wheat varieties.

## Materials and Methods

The experiment was laid out in RCB design with split plot arrangement having four replications. Wheat varieties (Bakhtawar-92 and Inquilab-91) were planted on November, 10, 20, 30 and December 10, 1997, using various seed rates i.e. 50, 100, 150 and 200 kg ha$^{-1}$. Date of sowing and varieties were allotted to main plots and seed rate were allotted to subplots. Row to row distance was 30 cm. Main plot size was kept 28.8 $m^{-2}$ while sub plot size was 7.2 $m^{-2}$ having 6 rows. A basal dose of 123 kg N and 60 $P_2O_5$ kg ha$^{-1}$ was applied. All the P and half of the N was applied at the time of sowing and remaining N was applied with the first irrigation. Data was recorded on productive tillers/$m^{-2}$, days to maturity, lodging percentage, plant height, number of spikelets spike$^{-1}$. , number of grains spike$^{-1}$, grain yield, biological yield and 1000 grain weight.

All the data collected were statistically analyzed. Upon obtaining significant differences, Least Significant Difference (LSD) test was applied for the comparison of treatment means at 5% level of probability.

## Results and Discussion

Table 1 showed that differences in mean number of productive tillers $m^{-2}$ were significantly affected by date of sowing, seed rate and DxS interaction at 5 % probability level. Number of productive tillers $m^{-2}$ (417) were significantly higher in plots sown on 10th November and it decreased with the delay in sowing. These results are in conformity with those reported by Waraich *et al.* (1982) who concluded that different sowing dates had significant effect on number of fertile tillers. These results are also supported by Razzaq *et al.* (1986) who reported that mid October to mid November planting produced the greatest number of tillers per unit area and planting later than this had negatively affected tillers. Plot sown in Ist week of November had significantly higher productive tiller than sown later (Jan *et al.*, 2000).

Number of productive tiller/$m^{2}$ were significantly higher at seed rate of 150 kg $ha^{-1}$ (369) and decreased with further increase in seed rate upto 200 kg $ha^{-1}$ . These results are not in agreement with those reported by Ayaz *et al.* (1997) who reported that different sowing rate (50, 100 and 150 kg $ha^{-1}$ ) had not significantly affected number of tillers $m^{-2}$, although it increase within the range of seed rate used. Mean values for varieties indicated that higher number(355) of productive tillers/$m^{-2}$ were produced in plots sown with Inquilab-91 than plots sown with Bakhtawar-92 (352) although this difference was not statistically significant. The date of sowing and seed rate (DxS) interaction had also significant effect on productive tillers $m^{-2}$. Maximum tillers were obtained when 150 kg seed rate was used and the plantation was done on 10th November. Similarly the lowest number of productive tillers were recorded with a seed rate of 50 kg $ha^{-1}$ when plantation was done on 10th December. Sowing dates and seed rate interaction showed that number of productive tillers decreased with the delay in sowing and increase in seed rate upto 150 kg $ha^{-1}$ but declined at 200 kg $ha^{-1}$ which could be due to lower temperature which dropped with delay in sowing on one hand and competition between plants for inputs at higher seed rate.

Data concerning days to maturity are shown in Table 1. The data showed that date of sowing and varieties had a significant effect on days to maturity. Mean values for date of sowing indicated that maximum (164) days to maturity were taken by plots sown on 10th November while minimum of 142 days to maturity were taken by plots sown on 10th December. Delay in sowing has decreased days to maturity and is in agreement with result of Waraich *et al.* (1982) and Jan *et al.* (2000). Mean values for varieties showed that the maximum of 155 days were taken by plots of Inquilab-91 than Bakhtawar-92 (152). The differences in days to maturity between varieties may be due to the genetic variation among varieties itself that one mature earlier than the others.

Data pertaining to lodging percentage is presented in Table 1. which showed that sowing dates, seed rate and DxS interaction had a significant effect on lodging. Maximum (17.50 %) lodging was recorded in plot sown on 10th November while minimum (0.20 %) lodging was recorded when plot was sown on 10th December. It may be due to the fact that early planted wheat had sufficient time for growth and gained maximum plant height and had more lodging as compared to late sown crop. Early sowing of wheat probably prolong the tillering period and encourages profuse vegetative growth. As for as the seed rate are concerned that data showed that lowest lodging (1.8 %) was recorded in plots seeded with 50 kg $ha^{-1}$, while highest lodging was noticed in plot sown with 200 kg $ha^{-1}$ (13.8 %). The reason for highest lodging at higher seed rate could be that for light competition plant height is increased, which usually result more lodging. Lodging may be prevented or reduced by decreasing plant density accomplished by reduced seed rate (Kirby , 1967). Mean values for varieties revealed that greater (13.23) number of plants lodged in plots sown with Bakhtawar-92 than Inquilab-91 (3.39). The combination of DxS data showe that delay in sowing there is decease in lodging.

Mean values of plant height (Table 1) revealed th varieties, date of sowing, seed rate and various interactio had significantly affected plant height. Maximum pla height of 96 cm was attained in plots sown on 10 November. Reduction in plant height was observed wi delay in sowing upto 30th November. Afterward significant effect on plant height was noticed. These resul are in agreement with those reported by Razzaq *et a* (1986) who stated that plant height decreased significant as planting was delayed from mid November to Decembe November sown plant had more plant height than Decemb sown plot (Jan *et al.*, 2000). Higher seed rate produce longer plants than lower seed rates and this may be due low light interception which promote internodes elongatic and reduce culm wall thickness and so lodging. Pla height was maximum at seed rate of 200 kg $ha^{-1}$. This m be due to the fact that at lower seed there was not muc competition for light which produced dwarf plants. Jan *al.* (2000) found no significant effect of seed rates on pla height in the range 62-99 kg $ha^{-1}$. Mean values of the da for varieties indicated that Inquilab-91 attained maximu plant height (92.45 cm) compared with Bakhtawar-9 (88.50 cm). The interaction of DxS showed that with th delay in sowing there was reduction of plant height. Pl sown on 10th November having seed rate of 200 kg ha had maximum plant height. Mean values for VxD interactic showed that in variety Inquilab-91 plant height w maximum in 10th November sown plots. Higher seed ra produced longer plants than lower seed rates. Minimu plant height was recorded in plot sown with seed rate of 5 kg $ha^{-1}$ and maximum plant height by seed rate of 200 k $ha^{-1}$. Inquilab-91 had significantly more plant height whe seeded at rate of 200 kg $ha^{-1}$. The data of VxDxS showe that maximum plant height was obtained when Inquilab-9 was planted on 10th November at the seed rate of 200 k $ha^{-1}$, while lowest plant height was obtained whe Bakhtawar-92 was planted on 30th November at the see rate of 150 kg $ha^{-1}$.

Date of sowing, seed rate and DxS interaction ha significantly affected number of grains $spike^{-1}$. Plots sow on 10th November produced greater number of grair $spike^{-1}$ (49.40) than the remaining sowing dates. Grair $spike^{-1}$ decreased with the delay in sowing time. It may b due to short growth period as in case of late planting, spik could not attained its full size due to early maturity. Thes results agree with those reported by Razzaq *et al.* (198 Nayyar *et al.* (1992) and Khan and Saleem (1985), wh reported that grains $spike^{-1}$ generally decreased with dela in planting time. Lower seed rate of 50 kg $ha^{-1}$ produce greater number of grains $spike^{-1}$ (48.74) than the highes seed rate (38.22) Grain $spike^{-1}$ significantly decreased wit increase in seed rate. These results are in agreement wit those of Singh and Uttam (1997) who concluded th number of grains $spike^{-1}$ decreases with increase in see rates. Ahmad *et al.* (1995) observed decrease in grai $spike^{-1}$ when seed rate was increased from 40 to 120 k $ha^{-1}$. Mean values for DxS interaction indicated th maximum number of grains $spike^{-1}$ were obtained from plo sown on 10th November with a seed rate of 50 kg $ha^{-1}$ Similarly lowest number of grains $spike^{-1}$ were recorded i plot sown on 10th December having seed rate of 200 k $ha^{-1}$. Data collected on spikelets $spike^{-1}$ is shown in Tabl 2. Mean values of the data showed that varieties, see rate and date of sowing had significantly affected numbe of spikelets $spike^{-1}$. Spikes taken from the plots sown o 10th November produced significantly higher number o

Table 1: Number of productive tillers $m^{-2}$, days to maturity, lodging (%), plant height and grain spike$^{-1}$ of the two wheat varieties as affected by sowing dates and seed rates

| Sowing Date | Productive Tiller $m^{-2}$ | Days Maturity | Lodg (%) | Plant Height (cm) | Grains Spike$^{-1}$ |
|---|---|---|---|---|---|
| 10 Nov. | 417.0 a | 164.0 a | 17.5 a | 96.0 a | 49.40 a |
| 20 Nov. | 398.0 b | 157.0 b | 15.6 ab | 92.0 b | 43.25 b |
| 30 Nov. | 352.0 c | 149.0 c | 0.2 b | 87.0 c | 41.53 bc |
| 10 Dec. | 245.0 d | 142.0 d | 0.2 b | 87.0 c | 38.43 c |
| LSD | 5.47 | 0.67 | 1.9 | 1.94 | 2.99 |
| **Seed Rate (kg$^{-1}$)** | | | | | |
| 50 | 343.0 c | 152.0 | 1.8 c | 89.0 c | 48.74 a |
| 100 | 347.0 c | 152.0 | 7.2 bc | 90.0 b | 44.43 b |
| 150 | 369.0 a | 153.0 | 10.5 ab | 90.0 b | 40.21 c |
| 200 | 352.0 b | 152.0 | 13.8 a | 93.0 a | 38.22 d |
| LSD | 3.71 | ns | 0.63 | 0.09 | 1.92 |
| **Varieties** | | | | | |
| Inquilab-91 | 355.0 | 155.0 a | 3.39 b | 92.45 a | 43.0 |
| Bakhtawar-92 | 352.0 | 152.0 b | 13.23 a | 88.50 b | 43.0 |
| **Interactions** | | | | | |
| VxS | ns | ns | ns | * | ns |
| VxD | ns | ns | ns | * | ns |
| DxS | * | ns | * | * | * |
| VxDxS | ns | ns | ns | * | ns |

Means of the same category followed by different letters are significantly different at the 5% level of probability.
Varieties x Seed rates( VxS) = ns (Not Significant) = Varieties x Date Of Sowing (VxD) = ns = Date Of Sowing * Seed Rates (DxS) = * (Significant) = Varieties x Date of Sowing x Seed Rates (VxDxS) = ns

Table 2: Number of Spikelet Spike$^{-1}$, grain yield kg ha$^{-1}$, biological yield kg ha$^{-1}$ and 1000 grain weight the two wheat varieties as affected by sowing dates and seed rates

| Sowing Date | Spikelet Spike$^{-1}$ | Grain Yield (kg ha$^{-1}$) | Biol. Yield (kg ha$^{-1}$) | 1000 grain weight(g) |
|---|---|---|---|---|
| 10 Nov. | 18.09 a | 3201.0 a | 63880.0 a | 33.63 a |
| 20 Nov. | 16.72 b | 3040.0 b | 5446.0 b | 31.59 ab |
| 30 Nov. | 16.13 b | 2377.0 c | 3516.0 c | 30.63 b |
| 10 Dec. | 15.96 b | 1643.0 d | 3394.0 c | 30.91 b |
| LSD | 0.86 | 132.2 | 771.4 | 2.05 |
| **Seed Rate (kg$^{-1}$)** | | | | |
| 50 | 17.38 a | 2291.0 c | 3342.0 d | 32.34 |
| 100 | 16.70 b | 2749.0 b | 4144.0 c | 32.09 |
| 150 | 16.59 bc | 2949.0 a | 5282.0 b | 31.28 |
| 200 | 16.23 c | 2308.0 c | 5968.0 a | 31.03 |
| LSD | 0.42 | 81.3 | 358.7 | ns |
| **Varieties** | | | | |
| Inquilab-91 | 16.36 b | 2598.0 | 4659.0 | 33.45 a |
| Bakhtawar-92 | 17.08 a | 2533.0 | 4709.0 | 29.92 b |
| **Interactions** | | | | |
| VxS | ns | ns | ns | ns |
| VxD | ns | ns | ns | * |
| DxS | ns | * | ns | ns |
| VxDxS | ns | ns | ns | ns |

Means of the same category followed by different letters are significantly different at the 5% level of probability.
VxS = ns (Not Significant) = VxD = ns = DxS = * (Significant) = VxDxS = ns

spikelets spike$^{-1}$ (18.09) than others Plots having seed rate of 50 kg ha$^{-1}$ produced significantly more spikelets spike$^{-1}$ (17.38) when compared with other seed rates. Number of spikelets spike$^{-1}$ decreased with increase in seed rate. These results agree with the findings of Dos and Verma (1956) who concluded that high seed rate reduced the number of spikelets spike$^{-1}$. Mean values for varieties indicated that number of spikelets spike$^{-1}$ were significantly more in Bakhtawar-92 (17.08) than in Inquilab-91 (16.36) might be due to the fact that different varieties have different genetic potentials of producing spikelets.

Mean values of the grain yield data presented in Table 2 revealed that grain yield was significantly affected by sowing dates, seed rate and the interaction of DxS. Maximum grain yield of 3201 kg ha$^{-1}$ was obtained from plots sown on 10th November while minimum of 1643 kg ha$^{-1}$ was produced in plots sown on 10th December. Grain yield decreased with delay in sowing from 10th November. The decrease in grain yield with delay in sowing are in line with those reported by Agarwal and Dhaka (1974), Ghildiyal *et al.* (1981), Nayyar *et al.* (1992) Sing *et al.* (1997) and Jan *et al.* (2000). Seed rate of 150 kg ha$^{-1}$ gave the highest grain yield of 2914 kg ha$^{-1}$ followed by a seed rate of 100 kg ha$^{-1}$, having grain yield of 2749 kg ha$^{-1}$, while minimum was recorded in seed rate of 50 kg ha$^{-1}$. Shrivastava *et al.* (1994) obtained highest grain yield at seed rate of 120 kg ha$^{-1}$ as compared with seed rate of 90 kg ha$^{-1}$. Jackson and Page (1958) recommended seed rate of 190 kg ha$^{-1}$ against a seed rate of 314 kg ha$^{-1}$. Unpadhyay and Kuberkar (1981) obtained maximum grain yield in plot seeded at rate of 125 as compared with those seeded at rate of 100 or 150 kg ha$^{-1}$ having row space of 20 cm apart. Surendra *et al.* (1986) recorded highest grain yield at 170 kg ha$^{-1}$ as compared with other seed rates, while Suresh *et al.* (1994) recommended 125 kg ha$^{-1}$ against 100 or 150 kg ha$^{-1}$. Nayyar *et al.* (1992) found no significant differences in grain yield when seed rate was used in range of 75-150 kg ha$^{-1}$. No significant difference in grain yield due to a seed rate in range of 62-99 kg ha$^{-1}$ have reported by Jan *et al.* 2000). Mean values for varieties indicated no significant differences in grain yield between Inquilab-91 and Bakhtawar-92 which produced 2598 and 2533 kg ha$^{-1}$ respectively. Mean values for DxS interaction indicated that 10th November sown plots produced higher grain yield when plot was seeded at the rate of 150 kg ha$^{-1}$.

Biological yield was also significantly affected by sowing dates and seed rates. Maximum biological yield of 6380 kg ha$^{-1}$ was produced in plots sown on 10th November while minimum of 3394 kg ha$^{-1}$ was recorded in 10th December sown plots, although it was at par with plot sown on November 30th. The higher biological yield at early sowing date may be due to fact that early planted wheat had sufficient time for its growth and development, attained maximum plant height. Highest biological yield of 5968 kg ha$^{-1}$ was recorded when plots were sown at seed rate of 200 kg ha$^{-1}$. Biological yield increased with the increase in seed rate. It may be due to the more seed rate which produce more plants/ unit area. Increase in biological yield with increase in seed rate have been reported by Ayaz *et al.* (1997). Variety Bakhtawar-92 although produced higher biological yield than variety Inquilab-91 but this difference was not statistically significant.

Data regarding thousand grain weight is shown in Table 2. Plots sown on 10th November produced significantly heavier grains of 33.63 gram than later sown plots. It may be due to short growth period in case of late sown crop, where grains did not develop properly and hence resulted in low weight. These results agree with Khan and Saleem (1985) who reported lower grains weight with the delay in sowing. As for as seed rate is concerned its was not significant, although slight decrease in weight with increase in seed rate was there. Statistical analysis of the data showed that differences in thousand grain weights of the two varieties were significant. Mean values for the varieties indicated that heavier grains (33.45 g) were produced by Inquilab-91 than Bakhtawar-92 (29.92 g). Mean values for VxD interaction showed no consistent trend in thousand grains weight between the two varieties. However, highest of (37.56 g) thousand grain weight was recorded when Inquilab-91 was sown on 10th November.

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