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EFFECT OF SEEDING DENSITY AND PLANTING TIME ON GROWTH AND YIELD ATTRIBUTES OF WHEAT

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ABSTRACT

In rice-wheat cropping system, farmers usually use normal wheat seed (100 kg ha^{-1}) even under late planting. The negative effect of late sowing may be compensated by the subsequent increase in seed quantity. In order to optimize seed rate and time of sowing of wheat variety Hashim-8, an experiment was conducted at the Agricultural Research Institute, Dera Ismail Khan on different sowing dates viz. October-25, November-10, November-25, December-10 and December-25 with seeding rates of 100, 125, 150, 175 and 200 kg ha^{-1}. Data indicated higher number of tillers, spike length, plant height, 1000-grain weight and the grain yield with seed rate of 150 kg ha^{-1}. Similarly, sowing wheat on October-25 and November-10 produced the highest number of tillers, spike length, plant height, 1000-grain weight and the grain yield, which subsequently decreased with successive sowing dates. On the basis of results obtained, it is concluded that wheat variety Hashim-8 should be sown between October-25 to November-10 with seed rate of 150 kg ha^{-1}.

Key words: Wheat, *Triticum aestivum*, sowing time, seed rate

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important staple food crop of Pakistan. It occupies 9.042 million hectares of the country with a total production of 23.864 million tones and the national average yield of 2639 kg ha^{-1} (Anonymous, 2010). Wheat yield is low in Pakistan on account of many biotic and abiotic factors. Among these, the time of sowing and planting density are of great significance which determine the proper stand establishment of the growing crop through balancing the plant to plant competition and ultimately affect the yield (Kabesh *et al.,* 2009; Nakano and Morita, 2009). It has been observed that early sowing gives high yield than late sowing due to longer growing period (Munir *et al*., 2002; Tanveer *et al.,* 2003) and vigorous growth associated with rapid and uniform seedling emergence (Kirby, 1993) and better combination of leaf size and tiller number (Regan *et al.,* 1992). Kristo *et al*. (2006) showed that winter wheat grown under more favourable conditions (October sowing with 600 seeds m^{-2}) responded to the treatments more even compared to those grown under unfavourable conditions (November sowing with 300 seeds m^{-2}). Whereas, delay in sowing from 20th November onward decreased the wheat grain yield @ 39 kg ha^{-1} day^{-1} (Singh and Uttam, 1994). Similarly, 15% increase in grain yield was recorded when the seeding rate was increased from 41 to 95 kg ha^{-1} (Ali, 1982). It has also been noted that the increase of seeding rate at early and optimal sowing time is unfavourable, but the negative effect of late sowing could be compensated by the increase of seed quantity (Pan *et al*., 1994). Hiltbrunner *et al*. (2007) advocated that a rationale increase of the seeding density with that of sowing time is an effective mean to increase the grain yield.

From an agronomic point of view, a key factor which is reflected in high wheat production is the well understanding of early crop establishment factors (Soomro *et al*., 2009) including time of planting, soil characteristics, seed viability and availability of plant machinery (Sulieman, 2010). It is important to define the optimal sowing date and seeding rate of winter wheat breeds, due to the climate-change of habitats, not only from agro-technical factors (sowing date), but also from economic point of view (Kristo *et al*., 2006). The work of Yan *et al*. (2008) also revealed that proper sowing date brings the highest protein content and yield in wheat grain.

Keeping the importance of sowing date and seed rate in view, a research trial was undertaken to optimize these factors for a newly approved wheat variety "Hashim-8" under the agro-climatic conditions of Dera Ismail Khan.

MATERIALS AND METHODS

The wheat variety Hashim-8 was sown at the Agricultural Research Institute, Dera Ismail Khan on October-25, November-10, November-25, December-10 and December-25 (Factor-A) with seeding densities of 100, 125, 150, 175 and 200 kg ha^{-1} (Factor-B). The experiment was laid out in a randomized complete block design (factorial) with three replications using a standard sub-plot size of 1.8x5m^2 with 6 rows, 5m long and 30cm apart. Fertilizers were applied @150: 120: 90 NPK kg ha^{-1} in the form of Urea, Di-Ammonium Phosphate and

Potassium Sulphate respectively. All the phosphorous, potash and ½ of the nitrogen were applied at the time of sowing and remaining ½ nitrogen was top dressed with first irrigation. Weedicide Buctril Super was applied @ 750 ml ha^{-1} after first irrigation to control weeds. The soil of site was silty clay, the pH = 7.78 and the organic matter content < 1 %. Meteorological data at the experimental site revealed the maximum temperature (37º C) in April and the minimum (5º C) in December and January/2010 (Table-1). The data were recorded on number of tillers m^{-2}, spike length (cm), plant height at maturity (cm), 1000-grain weight (g), grain yield (kg ha^{-1}) and analyzed statistically using MSTATC computer software.

RESULTS AND DISCUSSION

Number of tillers (m^{-2}): The economic yield of most of the cereals is determined by the number of tillers. It has the great agronomic importance as this may compensate the difference in number of plants, partially or totally after crop establishment and may allow crop recovery from early frost (Acevedo *et al*., 1998). It is evident from the data that sowing time had no significant effect on the number of tillers per unit area. However, sowing wheat on 25th October gave the maximum number of tillers (317.5 m^{-2}) as compared to the wheat sown on 25th December which showed the lowest value for number of tillers (Table-3). Different seed rates significantly increased the number of tillers, wherein, the use of 200 kg seed ha^{-1} produced higher number of tillers (311.8 m^{-2}) closely followed by 150 kg seed ha^{-1} with 306 number of tillers m^{-2}. The interaction of seed rate and planting time remained non-significant statistically (Table-2) because the process of tillering is mainly controlled by genetic and environmental factors (Longnecker *et al.,* 1993). Shahzad *et al*. (2007) also reported that sowing wheat on 15th December produced significantly more fertile tillers than the crop sown on 15th and 30th November.

Spike length (cm): The length of spike plays a vital role in wheat towards the grains $spike^{-1}$ and finally the yield (Shahzad *et al*., 2007). As far as the sowing time is concerned, significant observations were recorded for the spike length. Sowing wheat on October-25 and November-10 produced the longest and statistically at par spike length of 10.6 cm (Table-4). Further delay in sowing resulted in shorter spike length. Seed rate and its interaction with sowing time did not show significant effect on spike length (Table-2), however, longer spike length of 10.2 cm was noted on 25th October with 100 and 175 kg seed ha^{-1}. Waraich *et al.* (1981) reported that earlier planting resulted in better spike development due to longer growing period.

Plant height at maturity (cm): Height of the crop is mainly controlled by the genetic makeup of a genotype and it can also be affected by the environmental factors (Shahzad *et al*., 2007). The data showed that plant height differed significantly by planting time (Table-5). The wheat crop sown on November-10 and October- 25 produced the tallest plants of 103.3 and 98.8 cm respectively. In case of seeding rates, the maximum plant height (103.3 cm) was observed with seed rate of 150 kg ha^{-1} followed by 175 kg seed ha^{-1} which produced plants of 93.2 cm. These results, however, did not coincide with Sulieman (2010) who reported that increase in the seeding rate resulted in a slight increment in the heights of the plants. This could be because of variable environmental conditions and genetic makeup of the genotypes used in both these studies.

Table-1. Average monthly and seasonal meteorological data during 2009-2010.

Month	Temperature (^{0}C)		Relative Humidity		Rainfall (mm)
	Max	Min	0800 Hrs.	1400 Hrs.	
October	33	16	82	57	13
November	25	10	80	55	--
December	22	5	81	63	--
January	16	5	88	76	9.2
February	22	8	76	58	1.1
March	30	15	63	63	22
April	37	19	74	45	--

Table-2. Mean square of ANOVA's of number of tillers, spike length, plant height, 1000-grain weight and grain yield in wheat.

S. V.	D.F	Tillers m^{-2}	Spike length	Plant height	1000-grain weight	Grain yield
Replication	2	2366.44	0.28	104.03	9.60	195233.33
Factor A	4	4701.98^{NS}	6.77*	1206.08*	53.07*	6209083.33*
Error	8	3330.85	0.48	36.65	11.50	1435358.33
Factor B	4	4633.55*	0.33^{NS}	35.52*	2.80^{NS}	355000.00^{NS}
AB	16	1219.86^{NS}	0.28^{NS}	10.73^{NS}	8.66^{NS}	490645.83^{NS}
Error	40	1265.34	0.23	7.08	7.78	686416.66
Total	74	--	--	--	--	--

NS = Non-significant * = Significant at 5% level of probability.

1000-grain weight (g): Among different sowing dates, the maximum 1000-grain weight (40.1 and 40.0 g) was recorded on October-25 and November-10 respectively (Table-6). The minimum 1000-grain weight (36.1 g) was noted on December-25 sowing date. Among seeding rates, the maximum 1000-grain weight (38.7 g) was obtained when normal seed rate of 100 kg ha^{-1} was used. Further increase in seed rate did not show any positive effect on grain weight. This might be due to bulk planting density on account of higher seed rates used that eventually declined the seed weight. The results are in accordance with the findings of Shahzad *et al*. (2007) who also observed that earlier sowing resulted in better development of the grain due to longer growing period.

Table-3. Number of tillers (m^{-2}) as affected by seed rate and planting time in wheat.

Planting Time	Seed rate (kg ha^{-1})					Means
	100	125	150	175	200	
Oct-25	273.3^{NS}	316.0	323.6	303.0	371.6	317.5 ^{NS}
Nov-10	294.3	316.0	323.3	315.3	286.6	307.1
Nov-25	235.6	275.0	302.0	295.6	304.0	282.4
Dec-10	279.3	262.6	296.0	310.0	311.3	291.8
Dec-25	268.6	242.0	285.0	290.0	285.3	274.2
Means	270.2c	282.3bc	306.0ab	302.8ab	311.8a	

$LSD_{0.05}$ (Seed rate) = 26.25
NS = Non-significant
Means followed by different letter(s) in a row are significant at 5% level of probability.

Table-4. Spike length (cm) as affected by seed rate and planting time in wheat.

Planting Time	Seed rate (kg ha^{-1})					Means
	100	125	150	175	200	
Oct-25	11.2^{NS}	10.9	10.3	10.4	10.3	10.6^{a}
Nov-10	10.7	10.2	10.6	11.1	10.4	10.6^{a}
Nov-25	10.5	10.1	9.8	10.6	10.2	10.2^{ab}
Dec-10	10.1	9.9	9.9	10.0	9.4	9.9^{b}
Dec-25	8.6	8.8	9.3	9.2	9.1	9.0^{c}
Means	10.2^{NS}	10.0	10.0	10.2	9.9	

$LSD_{0.05}$ (Planting time) = 0.58
Means followed by different letter(s) in a column are significant at 5% level of probability.

Grain yield (kg ha^{-1}): The data showed significant effects ($P<0.05$) of different sowing time, whereas, the seed rate differed non-significantly for the grain yield. The highest grain yield was obtained from October-25 and November-10 planting date (5650 and 5600 kg ha^{-1} respectively) while December-25 produced the lowest grain yield of 4257 kg ha^{-1} (Table-7). Shahzad *et al*. (2007) also obtained lower grain yield with delay in sowing due to shorter duration of growth and development. The use of 150 kg seed ha^{-1} produced higher grain yield of 5103.3 kg ha^{-1} than other seeding rates used. Further increase in seed rate did not improve grain yield because the dense wheat population creates keen competition between plants for nutrients, moisture etc, which leads to the decrease in grain yield (Ragasits, 1998). The interaction of seed rate and planting time was non-significant statistically (Table-2)

Table-5. Plant height (cm) as affected by seed rate and planting time in wheat.

Planting Time	Seed rate (kg ha^{-1})					Means
	100	125	150	175	200	
Oct-25	95.7 ^{NS}	97.4	10.3.3	100.8	101.6	99.8 a
Nov-10	102.2	103.3	103.3	103.8	103.8	103.3 a
Nov-25	93.3	90.5	96.1	94.4	88.8	92.6 b
Dec-10	84.4	86.6	89.9	87.2	88.3	87.3 c
Dec-25	78.8	82.7	82.7	79.9	82.2	81.3 d
Means	90.9 c	92.1 bc	95.1 a	93.2 ab	93.0 b	

$LSD_{0.05}$ (Seed rate) = 1.96
$LSD_{0.05}$ (Planting time) = 5.09
NS = Non-significant
Means followed by different letter(s) in a column and rows are significant at 5% level of probability.

Table-6. 1000-grain weight (g) as affected by seed rate and planting time in wheat.

Planting Time	Seed rate (kg ha^{-1})					Means
	100	125	150	175	200	
Oct-25	40.5^{NS}	40.0	40.7	40.3	38.9	40.1^{a}
Nov-10	41.5	39.4	43.1	37.4	38.4	40.0^{a}
Nov-25	38.4	37.9	35.6	35.4	39.7	37.4^{ab}
Dec-10	36.3	35.1	36.2	38.1	37.0	36.5^{b}
Dec-25	36.8	35.6	35.4	38.2	34.7	36.1^{b}
Means	38.7^{NS}	37.6	38.2	37.9	37.7	

$LSD_{0.05}$ (Planting time) = 2.85
Means followed by different letter(s) in a column are significant at 5% level of probability.

Table-7. Grain yield (kg ha^{-1}) as affected by seed rate and planting time in wheat.

Planting Time	Seed rate (kg ha^{-1})					Means
	100	125	150	175	200	
Oct-25	5366.6^{NS}	6016.6	5933.3	5283.3	5650.0	5650.0^{a}
Nov-10	5133.3	5350.0	5750.0	6150.0	5616.6	5600.0^{a}
Nov-25	4866.6	4100.0	4533.3	4333.3	4466.6	4460.0^{b}
Dec-10	4850.0	4416.6	4950.0	5333.3	4550.0	4800.0^{ab}
Dec-25	3533.3	4266.6	4350.0	4100.0	5033.3	4257.0^{b}
Means	4750.0^{NS}	4830.0	5103.3	5040.0	5043.3	

$LSD_{0.05}$ (Planting time) = 1009.0 Means followed by different letter(s) in a column are significant at 5% level of probability.

Conclusion: In the present research, wheat variety Hashim-8 produced higher number of tillers, spike length, plant height, 1000-grain weight and the grain yield when sown on October-25 and November-10 (15 days interval) with seed rate of 150 kg ha^{-1}. Therefore, sowing time October-25 to November-10 with 150 kg seed ha^{-1} is recommended to obtain higher yield of wheat var. Hashim-8.

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