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IMPACT OF SOWING TIME AND SEEDING DENSITY ON GRAIN YIELD OF WHEAT VARIETY GOMAL-08

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ABSTRACT

The research was performed, at Agronomic Research Area, Faculty of Agriculture, Gomal University Dera Ismail Khan, to assess the impact of sowing time and seeding density on grain yield of wheat variety Gomal-08. Treatments included three dates of sowing as D_1 (Oct-25), D_2 (Nov-20), D_3 (Dec-15) and three seeding rates (kg ha^{-1}) of S_1-100, S_2-120, S_3-150. Almost all yield parameters showed significant variability among treatments means. Maximum grain $spike^{-1}$(g), number of fertile tillers m^{-2}, spike length (cm), economic yield (t ha^{-1}) and thousand grain weight (g) were recorded in D_1(Oct-25) and D_2 (Nov-20) with S_1 and S_2 as compared to late planted wheat with higher seed rate applied.
Keywords: Wheat, Plant Density, Sowing Date, Production

INTRODUCTION

Wheat (*Triticum aestivum* L.), a member of Gramineae family, is the most important staple food of the world including Pakistan. It was originated from Asia and then was spread to other parts of the globe i.e. Africa, America and Europe. It is consumed by major portion of Pakistan's population thus it occupies first position among the cereal crops growing in the country. Our country is the 7th largest wheat producer in the globe (FAO, 2008). But its average yield is less as compared to other countries due to several factors including less choice of varieties, improper seed rate and sowing time. Average yield in Khyber Pakhtunkhwa is 1286 kg ha^{-1} during five years 2001-05 (Anonymous, 2008) quite less than, 3210 kg ha^{-1}, the average economic yield of the world (Brown, 2011).

Factors like improper grain rate, late sowing, methods of sowing, soil nutrients deficiencies with inadequate population of tillers and lack of irrigation water at critical period of plant growth initiate the decrease of wheat grain yield. Selection of variety and grain rate are believed the most important yield reducing factors. Amongst these, seed rate and sowing time are very important which determine the appropriate crop establishment through pairing struggle and finally influence yield of wheat crop (Nakano and Morita, 2009; Kabesh et al., 2009). Early planting of wheat gives the highest yield than delay in planting due to long planting duration (Tanveer et al., 2003) and better growth development due to rapid seedling and uniform emergence (Kirby, 1993) with more combination of leaf area and fertile tillers (Regan et al., 1992; Kristo et al., 2007). By increasing seed rate, decreased root-shoot ratio and increased leaf growth $unit^{-1}$ area, more production is channelled into increasing total dry matter and shoot growth.

The impact of seeding density on plant size and crops effectively has received concentration (Harper, 1977). Different researchers suggested different seeding rate from 70 to 100 kg ha^{-1} (Chila, 1993; Shah, 1994; Khan, 1993; Singh and Singh 1984). Delayed sowing is manipulated normally with high seed rate because late sowing decreases the growth of plants and number of tillers (Gooding and Davies 1917), (Satorr, 1999). The influence of late sowing of wheat crop at the gap of 10 days (Byerlee et al., 1984) showed that late sowing of wheat crop increased the hazards of hot weather and reduced time of tillering specially at grain filling stage which decreases the grain yield (Soomro et al., 2009). The sowing of crop from (early November to early December) produced higher grain yield as compared to late sowing. Late wheat crop sown from mid to end of December produced reduced yield from 27-59% (Iqbal et al., 2001) as it depended on

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obtainable food energy to produce wheat Grain yield (Stoskopit, 1981). Such mechanism sketch on food energy and photosynthesis to enhance the grain yield of crop must be increased. If crop production practices considered how they will affect the photosynthesis then grain yield must be increased effectively. The present research was conducted to optimize the proper seed rate and best sowing time for wheat variety Gomal-8 under the agro-climatic condition of D.I. Khan.

MATERIALS AND METHODS:

The research was conducted to see the impact of seeding density and sowing time on grain yield of wheat variety Gomal-08 at Research Area of Faculty of Agriculture Gomal University D. I. Khan. The experiment was laid out with split plot arrangement in RCB-design having 4-replications. Three sowing date D_1 (Oct-25), D_2 (Nov-20), D_3 (Dec-15) were kept in main plots with three seeding densities 100 (kg ha^{-1}), 120 (kg ha^{-1}), 150 (kg ha^{-1}) in sub plots. The net plot size was kept $9m^2$ with row-row distance of 0.3m. Land was well prepared by ploughing 3-4 time in order to make suitable seedbed for better germination. NPK fertilizers were applied to soil in form of Urea, DAP and MOP with recommended doses i.e., 100:120:150. At the time of sowing, all the phosphate and potassium was applied with nitrogen in split dozes i.e., half at first irrigation and remaining at second irrigation.
Following observations were recorded during the experiment.

Plant height (cm)
Data were recorded by selecting 5 plants randomly from each plot. Their height was measured from the soil surface to the tip of spike with the help of a meter rod and average height was calculated.

Number of tiller (m^{-2})
Number of tillers (m^{-2}) was counted randomly at three places from each plot.

Spike length (cm), grains $spike^{-1}$
Twenty spikes were selected from each plot and their length was measured to calculate grains $spike^{-1}$.

1000-grain weight (g), Grain yield (t ha^{-1})
Thousand grain samples were taken randomly from each plot and weighed using digital electronic balance and converted to grain yield (t ha^{-1}).

Biological yield (t ha^{-1})
The crop was harvested and bundles left in respective plots for sun-drying. After that weighed and converted into t ha^{1}.

Harvest index (%)
By using the following formula the harvest index of each plot was calculated;

$$H.I\ (\%) = \frac{\text{Economic yield}}{\text{Biological Yield}} \times 100$$

RESULTS AND DISCUSSION

Plant height (cm)
Maximum plant height (109.20) cm was on D_1 (October-25) with S_1 (100 kg ha^{-1}) followed by (106.55cm) (October-25) S_2 (120 kg ha^{-1}) seed rate and plant height of 105.19 cm was measured on October-25 sowing with the higher seed rate (S_3) (150 kg ha^{-1}). The lowest plant height (96.45cm) was observed on D_3 (December-15) with S_3 (150 kg ha^{-1}) seed rate followed by similar values (96.78) and (97.16) cm in seeding densities S_1-100 (kg ha^{-1}) and S_2-120 (kg ha^{-1}) on same date (Table 1). Minimum plant height in late sowing may be due to short growing period as observed previously that wheat planted on 25-October produce maximum plant height (Baloch et al., 2010).

Table 1: Effect of sowing time and seeding density on plant height (cm) of spring wheat

Seed Rate	Date of Sowing			Mean
	Oct-25	Nov-20	Dec-15	
S_1 (100 kg ha^{-1})	109.20 a	102.00 c	96.78 d	102.16 a
S_2 (120 kg ha^{-1})	106.55 b	102.31 c	97.16 d	102.01 a
S_3 (150 kg ha^{-1})	105.19 b	101.85 c	96.45 d	101.16 b
Mean	106.98 a	102.05 b	96.80 c	

Various characters (S) are likely to be followed by the level of statistical significance of 5%
LSD..
$LSD_{0.05}$ for
Date of sowing = 1.607
Seed rate = 0.78
Interaction = 1.36

Number of tiller (m^{-2})
More fertile tillers (407.7) (m-2) were obtained on D1 (October-25) planted with seeding density S3-150 (kg ha-1) followed by statistically insignificant with 404.5 tiller m-2 with seeding density S_2-120 (kg ha^{-1}) on same planting time. The lower number of fertile tillers 278.75 (m^{-2}) were noted on D_3 (December-15) where S_1-100 (kg ha^{-1}) seed was used (Table 2). Maximum fertile tillers (m^{-2}) in early sowing might due to favourable temperature for germination while in delay sowing the numbers of tillers (m^{-2}) decreased due to low temperature as previously observed by Razzaq et al. (1986).

Table 2: Effect of sowing time and seeding density on number of tillers (m^{-2}) of spring wheat

Seed Rate	Date of Sowing			Mean
	25-Oct	20-Nov	15-Dec	
S_1 (100 kg ha^{-1})	399.75 b	371.25 d	278.75 g	349.92 c
S_2 (120 kg ha^{-1})	404.50 ab	379.00 c	320.50 f	368.00 b
S_3 (150 kg ha^{-1})	407.75 a	375.25 cd	341.25 e	374.75 a
Mean	404.00 a	375.17 b	313.50 c	

Various characters (S) are likely to be followed by the level of statistical significance of 5%
LSD.
Date of sowing = 4.303
Seed rate = 4.201
Interaction = 7.276

Spike length (cm)
The highest spike length (8.92 cm) was recorded on D_1 (October-25) followed by (8.80 cm) D_2 (November-20) for the same seed rate S_1 (100 kg ha^{1}) while minimum spike length (7.02 cm) was obtained on D_3 (December-15). It was followed by statistically similar value (7.05 cm) for the seed rate S_2 (120 kg ha^{-1}) and (7.1 cm) for the S_3 (150 kg ha^{-1}) on the same date (Table 3). In early planting spike length increases due to longer time available for spike to develop. Our results are in agreement with Ahmad et al. (2000) who reported that spike length, grain $spike^{-1}$ and harvest index decreases when seed rate increases.

Table 3: Effect of seeding density and sowing time on Spike length (cm) of spring wheat

Seed Rate	Date of Sowing			Mean
	25-Oct	20-Nov	15-Dec	
S_1 (100 kg ha^{-1})	8.92 a	8.80 a	7.14 e	8.28 a
S_2 (120 kg ha^{-1})	8.38 b	8.09 c	7.05 e	7.84 b
S_3 (150 kg ha^{-1})	8.51 b	7.67 d	7.02 e	7.73 b
Mean	8.60 a	8.19 b	7.07 c	

Various characters (S) are likely to be followed by the level of statistical significance of 5%
LSD.
$LSD_{0.05}$ for
Date of sowing = 0.120
Seed rate = 0.113
Interaction = 0.195

Grains per spike (g)
Grains $spike^{-1}$ depicted that sowing date D_1 (October-25) and D_2 (November-20) gave the highest (41.25) number grains at all the seeding rate of S_1-100 kg ha^{-1}, S_2-120 kg ha^{-1} and S_3-150 kg ha^{-1} and all were statistically insignificant (Table 4). In last date of sowing D_3 (December-15) minimum grains $spike^{-1}$ (31.75) were recorded with highest seeding density S_3 (150 kg ha^{-1}), followed (34.50) with

S_2 (120 kg ha^{-1}) and 35.25 in S_1 100 (kg ha^{-1}). The higher grains spike^{-1} in early planting might be due lengthy growing period in which more photosynthesis energy converted into grains as compared to shorter period available for grain development. Shafiq (2004) revealed that early planted wheat enhanced grains spike^{-1} over then delayed planting.

Table 4: Effect of sowing time and seeding density on number of grain (g) spike^{-1} of spring wheat

Seed Rate	Date of Sowing			Mean
	25-Oct	20-Nov	15-Dec	
S_1 (100 kg ha^{-1})	40.50 a	40.75 a	35.25 b	38.83 a
S_2 (120 kg ha^{-1})	41.25 a	40.75 a	34.50 b	38.83 a
S_3 (150 kg ha^{-1})	40.25 a	41.25 a	31.75 c	37.75 b
Mean	40.66 a	40.91 a	33.83 b	

Various characters (S) are likely to be followed by the level of statistical significance of 5%
LSD.
LSD $_{0.05}$ for
Date of sowing = 1.552
Seed rate = 0.774
Interaction = 1.341

Thousand-grain weight (g)

Maximum (47.22 g) 1000-grain weight was obtained in D_2 (November-20) sowing date with lowest seed rate S_1 (100 kg ha^{-1}) followed by (46.74 g) with S_2 (120 kg ha^{-1}) (Table 5). The lowest (41.06 g) 1000-grain weight was noted in delayed sowing date D_3 (December-15) with highest seed rate used S_3 (150 kg ha^{-1}) followed by (43.95 g) with S_2 (120 kg ha^{-1}) on D_3 (December-15). Shahazad et al. (2002) revealed that 1000-grain weight reduced with delay in planting.

Table 5: Effect of sowing time and seeding density on 1000-grain weight (gm) of spring wheat

Seed Rate	Date of Sowing			Mean
	25-Oct	20-Nov	15-Dec	
S_1 (100 kg ha^{-1})	45.96 bc	47.22 a	45.12 cd	46.10 a
S_2 (120 kg ha^{-1})	46.61 ab	46.74 ab	43.95 e	45.77 a
S_3 (150 kg ha^{-1})	44.82 de	44.21 de	41.06 f	43.63 b
Mean	45.80 a	46.06 a	43.37 b	

Various characters (S) are likely to be followed by the level of statistical significance of 5%.
$LSD_{0.05}$ for
Date of sowing = 0.625
Seed rate = 0.577
Interaction = 1.000

Grain yield (t ha^{-1})

Higher Grain yield of 7.42 (t ha^{-1}) on D_1 (October-25) sowing date with seeding density S_2 (120 kg ha^{-1}) was statistically at par with that on D_1 (Ocotober-25) with S_1 (100 kg ha^{-1}) producing 7.39 (t ha^{-1}) followed by 7.14 (t ha^{-1}) with S_3=150 (kg ha^{-1}) (Table 6). The lowest of 4.21 (t ha^{-1}) was obtained on D_3 (December-15) with recommended seeding density S_1= 100 (kg ha^{-1}) followed by D_3 (December-15) with S_2 120 (kg ha^{-1}) gave 5.21 (t ha^{-1}) grain yield. Early planted wheat on D_1 (October-25) gave the highest grain yield may be due to more growth duration which resulted longer spikes filled with heavier grain and higher number of fertile tillers. While in late planting, the higher seed rate increased the grain yield as compared to lowest seed rate might be attributed to highest tiller m^{-2} in highest seed rate. The decreasing trend in economic yield with delayed in sowing due to shorter growing period which resulted in low tiller m^{-2} plant height and grains spike^{-1}. Our results also confirmed the finding of Shahazad (2007) who reported that in late sowing the grain yield t ha^{-1} reduced due to short growing period.

Table 6: Effect of sowing time and seeding density on grain yield (t ha^{-1})of spring wheat

Seed Rate	Date of Sowing			Mean
	25-Oct	20-Nov	15-Dec	
S_1 (100 kg ha^{-1})	7.39 a	6.95 b	4.21 e	6.18 b
S_2 (120 kg ha^{-1})	7.42 a	7.04 b	5.21 d	6.56 a
S_3 (150 kg ha^{-1})	7.14 b	6.92 b	5.77 c	6.61 a
Mean	7.32 a	6.97 b	5.07 c	

Various characters (S) are likely to be followed by the level of statistical significance of 5%
LSD
$LSD_{0.05}$ for
Date of sowing = 0.183
Seed rate = 0.128
Interaction = 0.22

Biological yield (t ha^{-1})

Biological yield (t ha^{-1}) was significantly affected by sowing date, seed rate and their interaction. The data showed that on date of sowing D_1 (October-25) with S_2 120 (kg ha^{-1}), highest biological yield of 19.58 t ha^{-1} was recorded followed by S_3-150 (kg ha^{-1}) and S_1-100 (kg ha^{-1}) seeding density by producing statistically at par biological yield of 19.51(t ha^{-1}) and 19.40 (t ha^{-1}) (Table 7). Minimum biological yield of 8.45 (t ha^{-1}) was found in delayed planting D_3 (December-15) with seed rate S_1 100 (kg ha^{-1}) followed by S_2-120 (kg ha^{-1}), S_3-150 (kg ha^{-1}) by producing biological yield of 9.68 (t ha^{-1}) and 9.46 (t ha^{-1}) respectively. The result supported the finding of Iqbal (2012) who stated that the highest biological yield was produced by using grain rate 150 kg ha^{-1}.

Table 7: Effect of sowing time and seeding density on biological yield (t ha^{-1}) of spring wheat

Seed Rate	Date of Sowing			Mean
	25-Oct	20-Nov	15-Dec	
S_1 (100 kg ha^{-1})	19.40 a	15.15 b	8.45 d	14.33 b
S_2 (120 kg ha^{-1})	19.58 a	15.51 b	9.68 c	14.93 a
S_3 (150 kg ha^{-1})	19.51 a	15.53 b	9.46 c	14.83 a
Mean	19.49 a	15.40 b	9.20 c	

Various characters (S) are likely to be followed by the level of statistical significance of 5% LSD.
$LSD_{0.05}$ for
Date of sowing = 0.362
Seed rate = 0.234
Interaction = 0.405

Harvest Index % (H.I)

Highest H.I (%) 61.10% was noted on D_3 (December-15) S_3 (150 kg ha^{-1}), followed by 53 (%) in S_2 (120 kg ha^{-1}) on same date D_3 (December-15) while minimum 38.10 (%) in S_1 (100 kg ha^{-1}) followed by 37.93(%) and 36.63(%) in S_2-120 (kg ha^{-1}), S_3-150 (kg ha^{-1}) on date D_1 (October-25) (Table 8). The lowest H.I in early planting might be due to higher biomass resulting from tall plants, more tillers m^{-2} and dense population which decreased the ratio of economic yield comparatively.

Table 8: Effect of sowing time and seeding density on harvest index (%) of spring wheat.

Seed Rate	Date of Sowing			Mean
	25-Oct	20-Nov	15-Dec	
S_1 (100 kg ha^{-1})	38.10 e	48.89 d	49.87 c	44.62 c
S_2 (120 kg ha^{-1})	37.93 e	45.38 d	53.88 b	45.73 b
S_3 (150 kg ha^{-1})	36.63 e	45.58 d	61.09 a	47.67 a
Mean	37.55 c	45.28 b	54.95 a	

Various characters (S) are likely to be followed by the level of statistical significance of 5% LSD.

$LSD_{0.05}$ for

Date of sowing = 1.69
Seed rate = 0.97
Interaction = 1.68

Early planting of wheat on (Oct-25) produced the highest economic yield of 7.39 and 7.42 t ha^{-1} with seed rates 100 kg ha^{-1} and 125 kg ha^{-1} indicating its suitability under the ecological environment of Dera Ismail Khan. It is suggested that in case of early planted of wheat (Oct-25 to Nov-10), the seed rate should be used from 100-120 kg ha^{-1} while in late planting, use the higher S_3 (150 kg ha^{-1}) for obtaining the reasonable grain yield.

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