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Effect of Sowing Date and Plant Population on Biomass, Grain Yield and Yield Components of Wheat

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ABSTRACT

This study was conducted to investigate the effect of sowing date and plant population on biomass, grain yield and components of yield. The early sowing (10 Nov.) gave higher grain yield over late sowing (10 Dec.) by 60.6%. Differences in grain yield between 10 Nov. and 25 Dec. sowing were also significant (45%). Increasing plant population from 200 plant m^{-2} to 300- and 400 plant m^{-2} also enhanced grain yield but the response was quadratic. The higher grain yield in early sowing was due to higher number of ears m^{-2} and mean grain weight than late sowing. Early sowings also enhanced biomass accumulation over late sowing. The study confirmed that optimum planting time of wheat is early November for obtaining higher grain yield under agro-ecological conditions of Faisalabad.

Key Words: Biomass; Grain yield; Yield components; Sowing date; Plant population; Wheat

INTRODUCTION

There are many components of production technology which significantly affect grain yield of wheat in a region, for example sowing date, seeding rate, etc. Sowing date affects the growth and yield of wheat by affecting its environment. Early sowing always produces higher yield than late sowing mainly due to longer duration of growth. Each day delay in sowing from 20 November onward decreases grain yield @ 39 kg ha^{-1} d^{-1} (Singh & Uttam, 1994). Similarly, seeding rate affects yield when crop is sown late in the season. Increasing seeding rate usually gives good yield (Nanaenko & Loktionv, 1991).

This paper reports the effects of sowing date and plant population on biomass, grain yield and components of yield in wheat under semi arid conditions.

MATERIALS AND METHODS

The study was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad, during 1998-1999 and 1999-2000. The experiment was laid out in a randomized complete block design with split plot arrangement with sowing date in main plots and seeding rate in sub-plots. There were three replications having a plot size of 1.6m x 10m. The treatments were three sowing dates (10 November, 25 November and 10 December) and three planting densities (200-, 300- and 400 plants m^{-2}). The crop was sown with the help of a single row hand drill. Nitrogen and phosphorus @ 120 and 100 kg ha^{-1}, respectively, were applied in both the seasons. Half of the nitrogen and full phosphorus was applied at sowing and remaining half of nitrogen was top dressed with first irrigation. All other practices such as hoeing, irrigation, weeding, etc. were kept uniform in both seasons for all the treatments.

At maturity an area of one meter square was harvested from each plot. Spikes were threshed and grains were separated and weighed. Then the grain yield was converted into kilograms per hectare.

RESULTS AND DISCUSSION

Biomass. Early (10 Nov. or 25 Nov.) sowings significantly increased final biomass than the late (10 Dec.) sowing in 1999-2000, but not during 1998-99 season (Table I) and it ranged from 11.15 to 12.7 t ha^{-1} among different sowing dates. Increasing plant population from 200 plants m^{-2} to 300- or 400 plants m^{-2} also showed significant effect on final biomass production than the low (200 plants m^{-2}) population only in 1999-2000. On an average, final biomass yields were 11.4 t ha^{-1} in 200 plants m^{-2}, 12.19 t ha^{-1} in 300 plants and 12.15 t ha^{-1} in 400 plants m^{-2}. Overall, biomass yields were higher (5.6%) in 1999-2000 (12.24 t ha^{-1}) than the 1998-99 (11.59 t ha^{-1}). The average biomass yield (11.59 t ha^{-1} to 12.24 t ha^{-1}) obtained in this study are similar to the average values of TDM (10.6-13.5 t ha^{-1}) reported by others under similar agro-ecological conditions (Hussain *et al*., 1997; Khan, 2000).

Grain yield. Table I shows the effect of treatments on grain yield in both seasons. In 1989-99 differences in grain yield among sowing dates were non-significant. However, in 1999-2000, significant differences in grain yield among sowing dates were found. Early sowings enhanced grain yield over late sowing by 60.6%. The 10 November sowing also significantly increased grain yield over 25 November sowing by 44.9%. Increasing plant population at 400 plants m^{-2} significantly increased grain yield over 300- or 200 plants m^{-2}. Similarly differences in grain yield between 200 plants m^{-2} and 300 plants m^{-2} were also significant. Interaction between sowing date and plant population

Table I. Effect of sowing date and plant population on biomass, grain yield and yield components of wheat

Treatments	Biomass (t ha^{-1})		Grain yield (t ha^{-1})		Harvest index (%)		Tillers m^{-2}		Spikelets spike^{-1}		Grain spike^{-1}		1000-Grain weight (g)	
Sowing date	1998-99	1999-00	1998-99	1999-00	1998-99	1999-00	1998-99	1999-00	1998-99	1999-00	1998-99	1999-00	1998-99	1999-00
S1= 10 Nov.	11.7^{NS}	13.7a	3.2^{NS}	5.3	27.1^{NS}	38.8a	293a	348a	14.2^{NS}	16.1a	37.4a	44.8a	39.3a	46.1a
S2= 25 Nov.	11.2	12.6a	3.0	4.8	26.7	38.3a	274b	359a	13.1	14.6b	34.6b	42.6b	40.4a	40.6b
S3= 10 Dec.	11.8	10.5b	3.0	3.3	25.8	31.9b	232c	277b	12.8	14.0c	35.5b	41.4c	32.7b	33.5c
LSD 5%	0.8	1.1	0.2	0.3	2.9	3.5	10	41	0.8	0.3	1.2	0.5	2.5	0.8
Contrast														
(S1+S2) VS S3	NS	**	NS	**	NS	**	**	**	NS	**	NS	*	**	**
Plant population														
P1	11.1^{NS}	11.7b	3.0^{NS}	4.2c	27.3^{NS}	36.4	238c	343^{NS}	14.1^{NS}	15.2^{NS}	37.1a	43.2^{NS}	36.9b	40.0^{NS}
P2	11.9	12.5a	3.2	4.5b	27.3	35.8	273b	317	13.3	15.7	35.2b	43.3	37.0b	40.7
P3	11.7	12.6a	2.9	4.7a	25.0	36.9	288a	323	13.4	15.5	35.4b	43.3	38.4a	39.7
LSD 5%	1.2	0.4	0.5	0.1	4.1	1.6	7	27	0.8	0.5	1.8	0.5	1.3	0.9
Linear	NS	**	NS	**	NS	**	**	NS	NS	NS	NS	NS	NS	NS
Mean	11.6	12.2	3.1	4.5	26.5	36.3	267	328	13.4	14.9	35.8	42.9	37.5	40.1

Means sharing different letters differ significantly at $P < (0.05)$; *, ** = significant at 5 % and 1 % level; NS = Non-significant; P1=200 Plants m^{-2}; P2= =300 Plants m^{-2}; P3==400 Plants m^{-2}

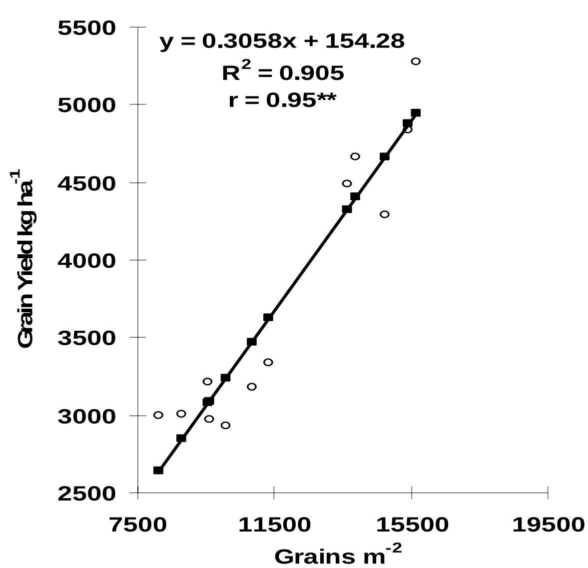
affecting grain yield was significant during 1999-2000 (Table II). The interaction showed that 10 Nov. sowing increased grain yield over 25 Nov. or 10 Dec. sowings but this response was higher at 300 plants m^{-2} than at 200 plants m^{-2}. Over the two seasons, average grain yield ranged from 3.05 t ha^{-1} in 1998-99 and 4.48 t ha^{-1} in 1999-2000, respectively (Table I). There was a strong correlation (r = 0.80**) between grain yield and TDM at final harvest for the pooled data. Grain yield was linearly related to the number of grains per unit area, and the regression accounted for 90.5% variance in grain yield for the pooled data (Fig. 1). Results showed lower grain yield at about 3.0 t ha^{-1} during 1998-99 season, probably caused by typical dull, cold and dry weather. In 1999-2000, average grain yield was, however, ranged from 3.3 t ha^{-1} to 5.3 t ha^{-1} among various sowing dates. Similar grain yields of wheat were reported by others (Khan, 2000; Naeem, 2001) under normal weather conditions.

Harvest index. In 1998-99, Harvest index (HI) did not differ among treatments and it ranged from 24.95% to 27.26% among various treatments. In 1999-2000, early sown crops (15 Nov., 25 Nov.) significantly enhanced HI by 20.7% (38.55 vs 31.94) over late (10 Dec.) sowing. Both 10 Nov. and 25 Nov. sowing did not, however, vary in HI. Plant population effects on HI were also non-significant in both the seasons. The average values of HI were 26.51% in 1998-99 and 36.34% in 1999-2000 (Table I). Many workers have reported variable values of HI in wheat ranging from 33.9% to 38.6% under normal growing conditions for various genotypes (Naeem, 2001).

Yield components. It is now well established that grain yield in wheat should be considered as being made up of various components and that they in turn are influenced by cultivar, agronomic practices and weather acting through physiological processes (Langer & Dougherty, 1976).

Tillers m^{-2}. In both the seasons, early sowing significantly increased the number of tillers m^{-2} as compared to Dec. sowing (Table I). The average number of tillers m^{-2} was 320, 316 and 255 in 10 Nov., 25 Nov. and 10 Dec. sowings, respectively. Increasing plant population significantly increased the number of tillers m^{-2} during 1998-99, and this response to plant population was quadratic in nature (Table I). In 1999-2000, plant population showed non-significant effect on the number of tillers m^{-2}. Overall, average number

Fig. 1. Relationship between grain yield and grains m-2 for pooled data



of tillers was 267 m^{-2} in 1998-99 and 328 m^{-2} in 1999-2000.

Interaction between sowing date and plant population was significant in both the season (Tables II). Early sowing (10 Nov.) enhanced the number of tillers m^{-2} with increase in population at 300 or 400 plants m^{-2}. Lowest number of tillers m^{-2} was produced in Dec. sowing, irrespect of plant population. The average value of tillers m^{-2} (267-328) obtained in this study is similar to average values of (279-333) among different management treatments for wheat reported by others (Hussain *et al*., 1997; Khan, 2000).

Spikelets spike^{-1}. Early sowings significantly enhanced the number of spikelets per spike over late sowing (Table I). In 1998-99, the average number of spikelets spike^{-1} was 14.2 in 10 Nov., 13.1 in 25 Nov. and 12.8 in 10 Dec. sowings. Equivalent values in 1999-2000 were 16.1, 14.6 and 14.0 respectively. In both the seasons, non-significant differences in the number of spikelets spike^{-1} were found among different plant populations. Overall, the average number of spikelets spike^{-1} was 13.4 in 1998-99 and 14.9 in 1999-2000. Similar number of spikelets spike^{-1} was reported by Khan (2000) working on wheat under Faisalabad conditions.

Grains spike^{-1}. The 10 Nov. sowing significantly enhanced the number of grains spike^{-1} in both the seasons. In 1998-99, the average number of grains spike^{-1} was 37.4, 34.6 and 35.5 in 10 Nov., 25 Nov. and 10 Dec. sowings, respectively. In 1999-2000, equivalent values were 44.8, 42.6 and 41.4, respectively (Table I).

In 1998-99, a population of 200 plants m^{-2} gave significantly higher number of grains than 300- or 400 plants $m^{-2.}$ The effect of plant population on number of grains was however, non-significant in 1999-2000. Overall, average number of grains spike^{-1} was 35.8 in 1998-99 and 42.9 in 1999-2000.

1000–grain weight. Data in Table I showed that early sowing significantly increased 1000-grain weight over late sowing in both the seasons. Differences in thousand grain weight between 10 Nov. and 25 Nov. sowings were also significant in 1999-2000. In 1998-99 average grain weight was 39.3 g, 40.4 g, 32.7 g per1000-grains in 10 Nov., 25 Nov. and 10 Dec. sowings, respectively. Equivalent values in 1999-2000 were 46.1 g, 40.6 g and 33.5 g per 1000-grains, respectively. Many workers have reported a decrease in grain weight in wheat due to late sowing (Baker & Darroch, 1995; Khan 2000).

Increasing plant population from 200 plants m^{-2} to 400 plants m^{-2} also increased mean grain weight in 1998-99, but not in 1999-2000. Overall mean grain weight was 37.5 per 1000 grains and 40.0 per 1000 grains in 1998-99 and 1999-2000, respectively.

Interaction between sowing date and plant population affecting mean grain weight showed that early sowing gave maximum average grain weight at 48.0 g with 300 plants m^{-2}. Late sowing (10 Dec.) caused significant reduction in average grain weight, irrespective of plant population. Khan (2000) reported an average value of 39.46 g per 1000 grain weight for wheat under similar ecological conditions.

Results showed that higher grain yield of early sowing over late sowing may be attributed to its higher number of ear m^{-2}, number of grains ear^{-1} and mean grain weight. This response was higher at 300 plants m^{-2} as compared to 200- or 400 plants m^{-2}. The yield components seem to compensate as ear population and grain set are inversely related. Many workers have reported higher grain yield with Nov. sowing than Dec. sowing working under similar agro-ecological conditions (Hussain *et al*., 1998; Khan *et al*., 2001).

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