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EFFECT OF SOWING DATE ON EMERGENCE, TILLERING AND GRAIN YIELD OF DIFFERENT WHEAT VARIETIES UNDER BAHAWALPUR CONDITIONS

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An experiment was conducted to study the effect of germination percentage, seedling emergence and tillering on yield of different varieties of wheat viz. Punjab-96, MH-97, BWP-97, Panjnad-1, AS-2002, Inqlab-91, BWP-2000, Uqab-2000 and Bhakkar- 2002 sown at different planting dates. The study included six sowing dates starting from 1st November to 16th January of the year 2006-07 with equal intervals of fifteen days. The experiment was laid out in randomized complete block design with split plot arrangement having three replications, keeping sowing dates in main plots and wheat varieties in sub plots. The plot size was 2.4m x 8m. The collected data were analyzed using computer statistical program MSTATC. Significant difference was recorded among dates of sowing from 1st November to 16th January with highest mean grain yield of 6292 kg ha^{-1} followed by 16th November sowing (6059 kg ha^{-1}). After November, yield of all varieties decreased significantly. Lowest grain yield of 2020 kg ha^{-1} was recorded on 16th January sown. However, all the wheat varieties gave significantly higher yields in a wide range of sowing period i.e. 1st November to 1st December. In late sown crop due to increase in temperature (6-8°C) above normal from mid March to mid April crop reduced its life cycle, resulting in decreased grain yield. Crop emergence was impaired when sowing was delayed owing to low temperature prevailing during stand establishment, which resulted in poor stand and reduced the number of productive tillers which resulted in yield reduction. With delay in planting, high temperature (32-39ºC) at reproductive stage (March and April) reduced the patterns of dry matter accumulation as was evident from decrease in final yield.

Keywords: Date of sowing, wheat varieties, germination, tillering and grain yield

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world, In Pakistan 70-80% wheat is planted after 25th November as most of the wheat area comes after cotton, rice and sugarcane, which is late planting. Wheat is grown in almost all the provinces of Pakistan on an area of 9.04 million hectares with an annual production of 23.8 million tons and the national average grain yield of 2639 kg ha^{-1} (Anonymous, 2010). Sowing of wheat after 15th November decreased the number of fertile tillers and grain yield significantly (Akhtar *et al.,* 2002 and 2006). Maximum number of tillers m^{-2} and grain yield were recorded when wheat was sown on 30th November where as minimum tillers m^{-2} and grain yield were recorded on 15th December. Among different sowing dates maximum grain yield of wheat (5600 kg ha^{-1}) was recorded from 10th November sowing while minimum grain yield 4256 kg ha^{-1} was recorded from 25 December sowing in Dera Ismail Khan zone (Baloch *et al.,* 2010).

Early sowing of wheat significantly enhances the germination than late (December) sowing (Hussain, 2007). Late planting affects the growth, yield and quality of wheat, because early sowing produces higher yields than late sowing due to longer duration. Temperatures below or above normal alter plant functions and productivity. In late planted wheat, low temperature prevailing during germination substantially affects the germination and seedling emergence. Germination is a critical process and temperature below 12°C results in poor and uneven emergence (Timmermans *et al.,* 2007). Therefore, the rate of emergence and final emergence percentage are important factors in determining the crop potential in various temperature of wheat production cropping systems. In late planting season, temperature of soil can be expected to be below 10°C, which affects the seed germination and stand establishment. Poor crop establishment results in few tillers and finally decreased grain yield (Farooq *et al.,* 2008). Short period of high temperature stress, i.e. $\geq$ 35°C at reproductive stage can decrease the grain weight (Wardlaw and Wrigley, 1994), and reduce the grain quality in wheat (Randall and Moss, 1990; Savin *et al*., 1996). Late planting results in poor tillering, reduces the tillering period and more chances of winter injury (Joshi *et al*., 1992). Generally, wheat like other cool season crop is seeded early to take maximum period for growth and development toward maturity before the (prospective) heat stress. However, mid-season seeding of winter wheat for any locality is usually most favorable,

whereas late sown wheat suffers from winter injury, which produces fewer tillers and may result in lower grain weight (Razzaq *et al.,* 1986). Sowing dates (Dec. 1, 15 and 30) and varieties both significantly affected the number of fertile tillers (Tahir *et al.,* 2009). The genotypic response of wheat to planting dates varies for yield contributing characters due to different genetic potential. The decline becomes prominent in the cultivars requiring more vernalization period under normal planting. Increase in temperature causes shortening of heading period (Tashiro and Wardlaw, 1999). Similarly, cultivars matured earlier when planted late, indicating the forced maturity due to high temperature at grain filling. When optimum condition was provided to the wheat cultivar, grain filling period was higher as compared to late sown condition under high temperature stress at maturity. Many high yielding wheat cultivars had been suggested for general cultivation in the past but these cultivars are losing their yield potential owing to segregation and climate change. Hence the performance of wheat genotypes was evaluated under late sowing condition to identify the best-suited variety for late sowing. In Pakistan, 70-80% wheat is planted after 25th November as most of the wheat area comes after cotton, rice and sugarcane, which is late planting.

MATERIALS AND METHODS

The experiment was laid out in randomized complete block design with split plot arrangement having three replications, keeping sowing dates in main plots and wheat varieties in sub plots. Plot size was 2.4m x 8m. The experiment comprised of three replications, with row to row distance of 30 cm. The land was mechanically ploughed. Irrigation channels in 1 m wide were in between the replications to ensure irrigation of individual plots independently, until crop grew up to the maturity stage. The study included six sowing dates starting from 1st November to 16th January during 2006–07 with equal interval of fifteen days. Nine wheat genotypes were used in the study viz., Punjab-96, MH-97, BWP-97, Panjnad-1, AS-2002, Inqlab-91, BWP-2000, Uqab-2000 and Bhakkar- 2002.

Standard dose of NPK fertilizer (120-80-60 kg ha^{-1}) was applied as blank application. Nitrogen was applied to the plants in splits i.e. ½ at sowing and ½ at first irrigation. The whole phosphorous and potassium was applied at sowing .The nitrogen, phosphorous and potassium were used in the form of Urea, Diammonium phosphate (DAP) and Sulphate of potash (SOP). Irrigation was applied as and when required. Weedicide (Puma super) @ 1250ml ha^{-1} was applied to control the weeds after first irrigation.. The crop was sown with single row hand drill in 30 cm apart rows using seed rate @ 125 kg ha^{-1}. All other agronomic practices were kept uniform for all the treatments. The following observations were recorded during the course of study, germination percentage, days to emergence, number of fertile tillers and grain yield. After emergence germination was evaluated m^{-2}. Daily count of emerged seedlings from three central rows of each plot with one meter length was counted until the number of plants emerged reached to a constant level. This data is converted into per square meter. From each plot, numbers of productive tillers were determined by counting number of productive tillers in an area of 1m^2.

For grain yield an area of 14.4 m^2 was harvested from each plot at random avoiding the border effects. Then sun-dried wheat was threshed and grain yield was recorded from each plot. The grain yield was expressed in kg ha^{-1}. Data regarding various yield parameters were collected using standard procedure and were analyzed statistically by Tukey's method. Three replicates for each treatment were maintained in each experiment. The treatment means were compared using Tukey's Honestly least difference test at 5% probability level (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

***Germination percentage*:** The effect of treatments on germination percentage is presented in Table 1. The data revealed significant effect of sowing date on germination percentage as November sown crop gain more germination percentage than the January sowing. Germination percentage decreased in late sowing crop. In 1st and 16th November sowing, germination was 88.78% whereas significantly a lowest value of 80.67% was recorded on 16th January. The wheat variety BWP-2000 significantly gained more mean germination percentage (86.56), whereas lowest germination percentage (83.94) was found in wheat variety Punjab-96. Interaction between sowing date and wheat varieties affecting germination percentage was also significant, reflecting optimum sowing time for all the varieties included in the experiment. This parameter significantly decreased in January sowing as decreasing temperature at sowing effects germination in late sown crop. Early sowing of wheat significantly enhanced the germination then late (December) sowing. Germination is a critical process, as temperature below 12°C resulted in poor and uneven emergence In late planting season, temperature of soil can be expected to be below 10°C, which affects the seed germination and stand establishment. These results are supported by the findings of Farooq *et al.* (2008) who reported that in late planting, temperature of soil may be below 10°C, which affects the seed germination.

***Days to emergence*:** The data revealed significant effects of sowing date on emergence, as November sown crop resulted in early emergence in minimum 5 days, whereas, late emergence was recorded for late sowing with 11 days to emergence during January sowing (Table 2). Regardless of the sowing time, all the wheat genotypes had non-significant

Table 1. Germination %age as affected by planting dates of different wheat varieties during the year 2006-07

Varieties	1st Nov.	16th Nov.	1st Dec.	16th Dec.	1st Jan.	16th Jan.	Mean
P.96	88.0bc	88.0bc	85.33cd	83.0d	79.67e	79.67e	83.94d
MH-97	89.67abc	90.0 ab	87.67bc	86.0cd	79.0e	78.33ef	85.11bcd
BWP-97	88.0bc	88.0bc	87.0bc	85.0cd	82 .0de	81.0de	85.17bcd
Pnd-1	93.0a	91.0ab	89.33abc	85.33cd	80.0e	78.33ef	86.17ab
As-2002	87.0bc	88.0bc	86.67cd	86.0bcd	83.0d	82.0de	85.44abc
Inqlab-91	87.0bc	87.0bc	85.67cd	85.0cd	82.67d	82.00de	84.89bcd
Bwp-2000	90.33ab	90.67ab	88.33bc	86.33cd	82.33d	81.33de	86.56a
Uqab-2000	88.0bc	88.0bc	86.00cd	84.33cd	82.67d	82.33d	85.22bcd
Bhakkar-2002	88.0bc	88.33bc	85.67cd	84.33d	81.67cd	81.0de	84.83cd
Mean	88.78a	88.78a	86.85b	85.04c	81.44d	80.67d	

Any two means not sharing the common letters differ significantly from each other at p 0.05
HSD at 0.05 for sowing date (S) = 0.75; HSD at 0.05 varieties (V) = 0.84; HSD at 0.05 for interaction (S x V) = 2.07

Table 2. Days to emergence as affected by planting dates of different wheat varieties during the year 2006-07

Varieties	1st Nov.	16th Nov.	1st Dec.	16th Dec.	1st Jan.	16th Jan.	Mean
P.96	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
MH-97	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
BWP-97	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
Pnd-1	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
As-2002	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
Inqlab-91	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
Bwp-2000	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
Uqab-2000	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
Bhakkar-2002	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66
Mean	5.00d	5.00d	6.00c	8.00b	11.00a	11.00a	7.66

Any two means not sharing the common letters differ significantly from each other at p 0.05
HSD at 0.05 for sowing date (S) = 0.07; HSD at 0.05 for interaction (SxV) = 0.16

effect for mean days to emergence. Interaction between planting date and wheat genotypes was also significant, in 1st and 16th November sowing all wheat varieties emerged in minimum 5 days followed by 1st December (6 days). This parameter significantly increase in 1st and 16th January sowing (11days for emergence), as decreasing temperature at sowing effects emergence period in late sown crop. Timmermans *et al*. (2007) also reported similar results that in late planted wheat, low temperature prevailing during germination substantially affects the seedling emergence. Joshi *et al.* (1992) also found late planting to result in poor tillering, reduces the tillering period and more chances of winter injury

***Number of fertile tillers m^{-2}*:** Data regarding number of fertile tiller m^{-2} are presented in Table 3 showed that the November sown wheat significantly increased number of tillers m^{-2} as compared to late sowing. The maximum number of fertile tillers 398.5 m$^{-2,}$ were recorded on 1st November sowing followed significantly by 16th November (382.7), whereas lowest number of tillers m^{-2} were recorded in 16th January sowing (298 m^{-2}).This showed that fertile tiller decreased significantly in January sowing, as temperature gradually increased in late sowing and sensitivity to high temperature increased. Joshi *et al.* (1992) reported that late planting results in poor tillering, reduces the tillering period and more chances of winter injury.

Regardless of planting time, the wheat variety Bhakhar-2002 significantly showed higher number of fertile tillers 359.9 m^{-2} followed by wheat variety Punjnad-1 which produced fertile tillers (357 m^{-2}). The lowest number of mean fertile tillers m^{-2} was produced by AS-2002 (336.1 m^{-2}). The interaction between sowing time and wheat genotypes was also significant. Highest no of fertile tillers 420.7 m^{-2} were obtained by wheat variety Punjnad-1 in 1st November sowing, whereas lowest fertile tillers (386.4 m^{-2}) were recorded by wheat genotype AS-2002 on same planting time. This parameter significantly decreased in late sowing time, i.e. December and January. These results are in conformity with the findings of Akhtar *et al.* (2006) who stated that sowing of wheat after 15th November decreased the number of fertile tillers significantly. Malik *et al.* (2009) also reported that maximum number of tillers m^{-2} was recorded when wheat was sown on 30th November where as minimum tillers m^{-2} was recorded on 15th December. Farooq

Table 3. Number of fertile tillers m^{-2} as affected by planting dates of different wheat varieties during the year 2006-07.

Varieties	1st Nov.	16th Nov.	1st Dec.	16th Dec.	1st Jan.	16th Jan.	Mean
P.96	392.3 abc	390.3 bcd	356.9 cde	339.4 def	303.3 gh	295.5 gh	346.3 ab
MH-97	390.0 bcd	399.7 ab	362.7 cde	345.8 def	310.5 fgh	299.5 gh	351.4 ab
BWP-97	392.7 abc	379.1 cd	355.7 cde	345.6 b-h	306.0 fgh	296.0 gh	345.8 ab
Pnd-1	420.7 a	390.0 bcd	364.8 cde	344.3 def	315.7 fgh	306.3 gh	357.0 ab
As-2002	386.4 bcd	347.4 cdf	350.7 cde	338.2 def	302.3 gh	291.7 gh	336.1 b
Inqlab-91	398.7 abc	378.5 cde	354.6 cde	342.3 cde	310.7 fgh	301.0 gh	347.6 ab
Bwp-2000	389.0 bcd	362.0 bcd	348.0 cde	332.0 def	306.3 fgh	290.0 h	337.9 ab
Uqab-2000	411.3 ab	386.0 a-e	352.3 cde	332.9 def	299.5 gh	291.1 gh	345.5 ab
Bhakkar-2002	405.0 ab	411.6 ab	365.0 cde	353.3 cde	313.3 fgh	311.3 gh	359.9 a
Mean	398.5 a	382.7 a	356.8 b	341.5 b	307.5 c	298 c	

Any two means not sharing the common letters differ significantly from each other at p 0.05
HSD at 0.05 for sowing date (S) = 16.21; HSD at 0.05 varieties (V) = 16.08; HSD at 0.05 for interaction (SxV) = 34.45

Table 4. Grain Yield Kg ha^{-1} as affected by sowing dates of different wheat varieties during the year 2006-07

Varieties	1st Nov.	16th Nov.	1st Dec.	16th Dec.	1st Jan.	16th Jan.	Mean
P.96	6273ab	6219ab	5794abc	4115de	2489hij	2083j	4496 a
MH-97	6278ab	6482ab	5764abc	4053de	2427hij	1793j	4466 a
BWP-97	6110abc	5810abc	5549abc	4269de	2572hij	2037j	4391 ab
Pnd-1	6389ab	5910abc	5486bc	3539fgh	2716hij	1991j	4338 ab
As-2002	6157abc	5671abc	5049cd	3950def	2572hij	2037j	4239 ab
Inqlab-91	6482ab	6294ab	5498bc	3897efg	2901ghi	2176ij	4541 a
Bwp-2000	5880abc	5648abc	5046cd	3230fgh	2624hij	1968j	4065 b
Uqab-2000	6697a	6156abc	5694abc	3520fgh	2695hij	1967j	4455 a
Bhakkar-2002	6359ab	6342ab	5555abc	4322de	2757hij	2129ij	4577 a
Mean	6292 a	6059 a	5493 b	3877 c	2639 d	2020 e	

Any two means not sharing the common letters differ significantly from each other at p 0.05
HSD at 0.05 for sowing date (S) = 238.5; HSD at 0.05 varieties (V) = 247.89; HSD at 0.05 for interaction (SxV) = 533.3

et al. (2008) also confirmed that by late planting season, temperature of soil may be below 10°C, which affects the stand establishment results in few tillers.

***Grain yield kg ha^{-1}*:** Analysis of variance showed significant differences among wheat genotypes for this parameter at different planting dates (Table 4) Among sowing dates, 1st November sowing gave highest mean grain yield (6292 kg ha^{-1}) (Table 4), followed non significantly by16th November sowing (6059 kg ha^{-1}) , sowing after November, yield of all varieties included in the experiment decreased significantly. The lowest mean grain weight (2020 kg ha^{-1}) was recorded on 16th January sowing.

The data showed significant differences for all wheat genotypes at different sowing dates. The thorough scrutiny of the data revealed superiority of Bhakar-2002 over others wheat varieties, which gave mean yield of 4578 kg ha^{-1}, whereas lowest mean weights (4239 kg ha^{-1}) were obtained from variety AS-2002.

The interaction between sowing dates and varieties was also significant. 1st and 16th November sowing gave significantly more grain yield than late sowing. This response was greater in Uqaab-2000 which gave 6697 kg ha^{-1} grain yield when sown on 1st November whereas, wheat variety BWP-2000 produced 5880 kg ha^{-1} grain yield when sown on same date of sowing.

Actually in November sowing, temperature is reasonably normal for anthesis and grain filling. But in late sowing i.e. after 16th December and in January, temperature shoot up and it rose above normal at anthesis and grain filling period. These results are in conformity with the findings of Akhtar *et al.* (2006) who stated that normal (November) sowing increased the grain yield of wheat than late sowing (December and January). The results of Baloch *et al.* (2010) also support the present findings who stated that among different planting date of wheat, maximum grain yield of 5600 kg ha^{-1} was recorded from 10th November sowing while minimum grain yield of 4256 $kgha^{-1}$ was recorded from 25th December sowing.

***Conclusions*:** In late planting season, temperature of soil can be expected to be below 10°C, which affects the seed germination and stand establishment. Poor crop establishment results in few tillers and finally decreased grain yield. Wheat varieties matured in short period when

planted late, indicating the forced maturity due to high temperature at grain filling. When optimum condition was provided to the wheat varieties, grain filling period was higher as compared to late sown condition under high temperature stress at maturity. 1st November sown crop gave highest mean grain yield 6292 kg ha^{-1}.followed by 16th November sowing 6059 kg ha^{-1} after that dates yield of all varieties included in the experiment decreased significantly. The lowest grain yield 2020 kg ha^{-1} was obtained from 16th January sowing. Late planting of wheat crop in December and January decreased the grain yield significantly as best growth occur when temperature ranges between 9 -27 ºC and in late planting crop temperature rises above normal due to which rapid growth occur, which adversely effect the anthesis and grain filling of crop resulted in grain shrivelage in late sown crop, so in order to avoid this, sowing should be done during the month of November.

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