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Evaluation of Growth and Yield Attributes of Different Wheat Genotypes Sown under Various Planting Times

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Abstract
Late planting time caused drastic reduction in crop development, growth and yield attributes. Three-year field experiments were conducted at the Field Area of Agronomic Research Station Bahawalpur, Pakistan, to evaluate the performance of six wheat genotypes under different sowing dates starting form 1st Nov. to 21st Dec. with 10 days of intervals in each experimental year. Growth and yield components were determined at the time of physiological maturity. Late sowing of wheat crop drastically decreased the crop development attributes (days taken to booting, heading, anthesis, physiological maturity), growth attributes (germination count m^{-2}, No. of tillers m^{-2} and plant height) and yield attribute (number of grains $spike^{-1}$, 1000 grains weight, grain yield). Wheat sown at 11th Nov. followed by 1st Nov. and 21st Nov. reported maximum growth and yield attributes. Maximum reduction in growth and yield of wheat was observed by sowing on 21st Dec. and 11th Dec. Variations among genotypes were also observed. Genotype Aas-11 and Punjab-11 performed better in all the sowing dates while genotype Sehar-06 showed poor growth and yield attributes. Among the years, experimental season of 2012-13 and 2010-11 reported better growth and yield attributes. On overall basis, it may be concluded that wheat sown at 1st Nov. to 21st Nov. appeared to be most desirable sowing time to harvest maximum yield in all tested genotypes. However early as well as late planting of wheat favors for genotypes Aas-11 and Punjab-11.
Keywords: Sowing dates, wheat genotypes, late planting, crop development, germination count, anthesis, yield attributes

INTRODUCTION

Wheat is an important cereal crop grown in winter (Khan et al., 2007). In Pakistan, wheat grain production was 23.835 million tons from 9.129 million hectares during 2013-2014 (PAK-SCMS, 2014). High yield production of wheat is needed to feed the growing population of the world (Khakwani et al., 2012).

Among several causes of low wheat yield, sowing time and genotypic selection are of prime significance. Variation among the weather condition and within the season is also one of important constraints that effect the yield potential. Selection of proper sowing date is vital to obtain high yield due to variation among the weather conditions (Murungu and Madanzi, 2010). Wheat is grown in winter season and requires definite temperature and light for optimum growth (Dabre et al., 1993). Too early sowing, when temperature will be above the optimum could also produce poor plants. Whereas delay in crop sowing causes reduction in yield (Yajam and Madani, 2013). Sowing time in different locations provide differential growth conditions such as maximum and minimum temperature, daily sunshine, precipitation, growth period and genetic potential of wheat variety (Safdar et al., 2008). Neither too early nor too late sowing of wheat demonstrated better yield response by proposing prolonged growth period although excluding the probabilities of heat stress.

Mostly in Punjab, cultivation of wheat and cotton is the dominant cropping system. In this cropping system, sowing of wheat becoming late due to which maintaining high yield is much difficult. Low temperature in winter due to late planting could produce fewer tillers (Phadnawis and Saini, 1992). Number of kernels and spikes m^{-2} are most important yield component of wheat. Both early and late sowing of wheat causes reduction in numbers of kernel per spike (Refay, 2011). Temperature stress after anthesis cause drastic effect on grain yield production through reducing the kernel weight. Sowing at optimum time could enhance seed germination, plant height, number of spikelets, grains $spike^{-1}$ and 1000-grain weight (El-Mahdi et al., 2007).

Sial et al. (2005) conducted experiments and concluded that late sowing of wheat produce shorter plant height, reduction in days to heading, physiological maturity and grain yield. Sohail et al. (2014) also reported that late sowing of wheat reduced yield upto 29%. Ali et al. (2004) investigated the effect of planting dates on the yield of wheat genotypes and reported that wheat sown on 10th November gave highest grain yield. Delayed planting time from 20th November gradually reduced the wheat production (Ali et al., 2004). Iqbal et al., (2001) observed 50% reduction in yield with wheat sown after 15 December. Keeping in view the above facts, present study was conducted to evaluate the growth and yield performance of different wheat genotypes under different sowing dates.

MATERIALS AND METHODS

Field experiments were conducted at Research Area of Agronomic Research Station, Bahawalpur, in 2010-11, 2011-2012 and 2012-2013 to evaluate the performance of different wheat genotypes under different sowing times. Six commercially released wheat genotypes for the region (V_1-Aari-11, V_2-Aas-11, V_3-Meraj-08, V_4-Millat-11, V_5-Punjab-11, and V_6-Seher-06) were tested under different sowing time (D_1-1st Nov., D_2-11th Nov., D_3-21st Nov., D_4-1st Dec., D_5-11th Dec., and D_6-21st Dec.) with ten days interval for each experimental year. These sowing dates were selected on the base of sowing time usually adopted by growers in their fields. The experiments were laid out in factorial fashion having three replications. Crop was sown on a well prepared seedbed with seedling rate of approximately 120 kg ha^{-1} during three successive years. Seeds were sown in six row with 22.5 cm apart and 7 m in length with the help of single row hand drill.

Soil samples were taken prior to sowing and were analyzed in Soil and Water Testing Laboratory, Bahawalpur. Soil of field experiments was sandy clay loam having pH_s-7.92, EC_e-2.6 dS m^{-1} and SAR-8.7 (mmolL^{-1})$^{1/2}$. Recommended doses of NPK (160-120-60 kg ha^{-1}) were applied in the form of Urea, Diammonium Phosphate (DAP) and Sulphate of Potash (SOP). All the phosphorus and potash doses were applied at the time of sowing whereas, nitrogen was applied in two split doses, half dose at the time of sowing and remaining half dose at the time of 1st irrigation. Good quality canal water was used to irrigate the field through flood irrigation at critical growth stages (crown root development, booting, milking and grain formation) of crop. Insects and weeds were controlled through following the local recommendation standards. Other cultural practiced were done according to recommendation made by Department of Agriculture, Punjab, Pakistan.

Data regarding germination m^{-2} and number of days taken to heading, anthesis and physiological maturity was recorded by visiting the field daily. Crop was harvested at third week of April in each experimental year. At physiological maturity the data regarding number of fertile tiller m^{-2} and plant height. Plants of central four rows of each plot were hand harvested and number of grains spike^{-1} were counted. 1000 grains were manually separated and weighted to get 1000-grain weight. Grains obtained from each plot were weighted and grain yield was obtained in terms of t ha^{-1}.

The Collected data was analyzed statistically in each growing season for genotypes, sowing dates and years by using analysis of variance. The Least Significant Difference (LSD) test at 5% level of significance was used for comparison of means (Steel et al., 1997).

RESULTS

Weather data like average maximum and minimum temperature, total rainfall and average sun shine (Table 1) was collected from established station. Weather conditions were suitable for wheat growth and development during each experimental years. Field had shown no stress with good vigor and retention. During experimental season of 2011-12 maximum temperature during the month of March was 33 ^{o}C at grain filling stage which adversely affected the grain yield while during season of 2012-13 the maximum temperature was 29.6 ^{o}C in March which had positive effect on grain yield of wheat.

Table 1: Average monthly and seasonal meteorological data

	Maximum temperature (^{o}C)			Minimum temperature (^{o}C)			Relative Humidity (%)			Rainfall (mm)		
Months	**2010-11**	**2011-12**	**2012-13**	**2010-11**	**2011-12**	**2012-13**	**2010-11**	**2011-12**	**2012-13**	**2010-11**	**2011-12**	**2012-13**
November	31.0	31.0	27.5	12.0	15.4	8.9	75.0	65.0	86.1	-	-	-
December	22.0	22.0	25.9	5.0	5.0	4.8	70.0	58.9	85.8	-	-	7.2
January	18.7	18.0	24.8	4.7	3.0	2.2	69.9	63.8	85.6	-	5.08	-
February	23.6	21.0	23.1	10.0	5.0	6.6	68.3	70.0	85.4	5.33	51.56	49.44
March	30.5	33.0	29.6	14.5	8.8	11.1	55.8	75.0	85.0	0.76	-	6.3
April	35.1	38.4	46.0	19.2	17.6	17.3	44.2	70.1	85.3	13.21	17.02	-

Difference in wheat attributes among sowing dates, genotypes and year are presented in Table 2, Table 3 and Table 4. The main effects associated with planting date and genotypes were significant with respect to days taken to booting, heading, anthesis, physiological maturity, germination count m^{-2}, number of tiller m^{-2}, plant height, 1000 grain weight, number of grains spike^{-1} and grain yield during three experimental years. However, their interaction (planting dates × genotypes) was not significant.

Crop developmental attributes

The results indicated that wheat development was influenced by time of planting as reducing trend was found in days taken to heading, anthesis and maturity with delayed in planting dates (Table 2). Maximum days taken to heading, anthesis and physiological maturity were reported by planting wheat at 1st Nov. followed by 11th Nov. and 21st Nov. during three experimental years. Wheat sowing at 21st Dec. followed by 11th Dec. showed minimum days taken to these attributes. Genotypic variation was found with respect to days taken to heading, anthesis and maturity (Table 2). Genotype Aas-11 followed by Punjab-11 showed maximum days taken to heading, anthesis and maturity. Minimum days taken to these attributes were reported by genotype Sehar-06.

Experiment conducted during season 2012-13 showed maximum days taken to heading, anthesis, maturity and minimum days taken to these attributes were reported by experiment of season of 2011-12 (Table 2).

Table 2: Effect of different sowing dates and genotypes on average days taken to booting, heading, anthesis and maturity during three experimental seasons

	Days to heading	Days to anthesis	Days to maturity
	Sowing dates		
1st November	97.0 a	110.6 a	142.0 a
11th November	96.1 b	108.9 b	141.2 b
21st November	93.7 c	104.4 c	134.9 c
1st December	87.5 d	99.9 d	129.9 d
11th December	84.0 e	94.0 e	123.9 e
21st December	79.0 f	88.4 f	117.3 f
	Wheat genotypes		
Aari-11	90.0 b	101.6 b	131.8 bc
Aas-11	90.4 a	102.3 a	132.4 a
Meraj-08	89.0 e	100.3 c	131.5 c
Millat-11	89.5 cd	100.3 c	130.8 d
Punjab-11	90.0 b	101.4 b	132.0 ab
Sehar-06	89.4 d	100.3 c	130.7 d
	Year		
2010-11	94.1 a	101.8 a	130.5 b
2011-12	80.5 b	99.6 b	130.5 b
2012-13	94.1 a	101.8 a	133.6 a

Growth Attributes

Results revealed that delay in planting time caused reduction in plant height, germination count m^{-2} and No. of tillers m^{-2} during three experimental years (Table 3). Wheat sown at 1st Nov. and 11th Nov. showed better plant height and germination count m^{-2} and did not differ significantly to each other. Maximum No. of tillers m^{-2} were reported by crop sown at 11th Nov. followed by 1st Nov. in each experimental year. Wheat sowing at 21st Dec. followed by 11th Dec. showed minimum values of these attributes. In case of genotypic variation, genotype Aas-11, Punjab-11 and Aari-11 did not different significantly to each other and showed better germination count m^{-2} and plant height (Table 3). Maximum No. of tillers m^{-2} were reported by genotype Aas-11 following by Punjab-11 and Aari-11. Minimum germination count m^{-2} and number of tillers m^{-2} were reported by genotype Sehar-06 while genotype Millat-11 showed shortest plant height. Maximum and minimum plant height, germination count and No. of tillers were reported by experiment conducted in season 2012-13 and 2011-12 respectively (Table 3).

Table 3: Effect of different sowing dates and genotypes on average growth of wheat during three experimental year

	Germination count m^{-2}	Number of tillers m^{-2}	Plant height (cm)
	Sowing dates		
1st November	198.5 a	404.0 b	102.0 a
11th November	199.2 a	416.1 a	102.5 a
21st November	195.7 b	386.2 c	94.0 b
1st December	186.5 c	376.8 d	93.5 c
11th December	182.3 d	354.5 e	89.7 d
21st December	178.2 e	326.0 f	82.9 e
	Wheat genotypes		
Aari-11	190.1 a	381.5 c	95.3 ab
Aas-11	191.8 a	390.1 a	96.3 a
Meraj-08	188.5 b	371.6 e	92.4 c
Millat-11	189.0 b	377.8 d	90.3 d
Punjab-11	190.5 a	386.9 b	95.3 ab
Sehar-06	186.4 c	369.8 f	93.1 c
	Year		
2010-11	196.8 b	377.4 b	93.5 b
2011-12	168.4 c	359.6 c	92.3 b
2012-13	205.0 a	394.8 a	95.5 a

Yield attributes

Delayed in planting time caused drastic reduction in yield attributes such as No. of grains spike^{-1}, 1000 grains weight and grain yield during consecutive three years (Table 4). Crop sown on 11th Nov. followed by 1st Nov. and 21st Nov. reported maximum yield attributes such as No. of grains spike^{-1}, 1000 grains weight and grain yield as compared to other sowing dates. Late sowing of wheat on 21st Dec. and 11th Dec. showed minimum values of No. of grains spike^{-1}, 1000 grains weight and grain yield. Experiment conducted in season 2012-13 showed comparatively better yield attributes than the remaining seasons (Table 4). Comparisons of genotypes revealed that genotype Aas-11 followed by Punjab-11 reported maximum No. of grains spike^{-1}, 1000 grains weight and grain yield during consecutive three years (Table 4). Minimum No. of grains spikes^{-1}, 1000 grains weight and grain yield was shown by genotype Sehar-11.

Table 4: Effect of different sowing dates on average yield and yield components of different wheat genotypes during three experimental year

	Number of grains spike^{-1}	1000 grains weight (g)	Grain yield (t ha^{-1})
	Sowing dates		
1st November	50.18 a	44.53 a	5.781 a
11th November	51.25 a	44.57 a	5.815 a
21st November	48.25 b	42.02 b	4.799 c
1st December	43.09 c	37.97 c	3.814 d
11th December	41.37 d	35.06 d	3.066 e
21st December	38.66 e	32.02 e	2.532 f
	Wheat genotypes		
Aari-11	45.75 b	39.55 b	4.359 ab
Aas-11	47.88 a	40.63 a	4.487 a
Meraj-08	44.40 bc	38.63 c	4.299 bc
Millat-11	43.20 c	39.12 bc	4.021 d
Punjab-11	47.56 a	39.61 b	4.369 ab
Sehar-06	44.02 c	38.43 c	4.163 cd
	Year		
2010-11	48.50 b	39.90 b	4.626 b
2011-12	36.41 c	36.46 c	3.292 c
2012-13	51.50 a	41.73 a	4.916 a

DISCUSSION

Late planting of wheat crop caused drastic decrease in growth and yield attributes. Planting times play its critical role in performance of genotypes. Three-year field experiments were conducted at the Field Area of Agronomic Research Station Bahawalpur, Pakistan, for the purpose to check out the performance of six wheat genotypes under different sowing dates. Commercially released six wheat genotypes for the region were tested under different sowing time with ten days of interval for each experimental year. Planting dates were selected on the bases of sowing time usually adopted by growers in their fields. In this study, It was concluded that late sowing of wheat crop caused significant reduction in crop developmental attributes (days taken to heading, anthesis and physiological attributes) as compared to early sowing. Wheat sown on 11th Nov. followed by 1st Nov. and 21st Nov. showed maximum No. of days taken to heading, anthesis and physiological maturity whereas wheat sown on 21st Dec. and 11th Dec. reported lowest values for crop development characters. Difference in crop development was also attributed to genotypic variations. Genotype Aas-11 and Punjab-11 showed better results while genotypes Sehar-06 showed lowest number of days taken to heading, anthesis and physiological maturity. Among the experimental years, wheat season 2012-13 showed better crop development while season 2010-11 showed poor crop development. Similar results were also reported by Sial et al. (2005), Khan et al. (2007), Tahir et al. (2009), Nahar et al. (2010) and Refay (2011). Reduction in crop developmental attributes could be due to fluctuation in temperature during crop growth that reduces the crop growing period.

Present study indicated that late sowing of wheat crop caused reduction in growth attributes like germination count, No. of tillers m^{-2} and plant height. Wheat sown on 1st Nov. and 11th Nov. do not differ significantly to each other with respect to plant height and germination count m^{-2}. Maximum germination count m^{-2}, No. of tillers m^{-2} and plant height were reported by crop sown on 11th Nov. followed by 1st Nov. During these sowing times, wheat crop enjoyed better environmental conditions like solar radiation and temperature. Due to delay sowing, temperature was not according to crop requirement. Fall in temperature do not fulfill the temperature requirement of seed germination and tillering resulted in less germinated seed, No. of tillers and shorter plant. Minimum growth attributes were obtained with sowing of wheat on 21st Dec. followed by 11th Dec. Direct relation was found between germination count and No. of tillers. Late sowing of crop reduces the germination count that resulted in less No. of tillers due to fluctuation in temperature. Differences in growth attributes among

genotypes was attributed to their genetic potential. Genotypes Aas-11, Punjab-11 and Aari-11 do not different significantly to each other and showed better germination count m^{-2} and plant height whereas genotype Aas-11 and Punjab-11 produced maximum No. of tillers m^{-2}. Genotype Sehar-06 produced minimum germination count m^{-2} and number of tillers m^{-2}. Experimental season 2012-13 produced better crop growth while 2010-11 reported poor crop growth. These results are in line with Shah et al. (2006), Shahzad et al. (2007), Tahir et al. (2009), Baloch et al. (2010), Yajam and Madani (2013), and Mumtaz et al. (2014).

Present work demonstrated that grain yield were greatly influenced by different sowing times. Yield components were correlated to progressive vegetative growth. Among sowing dates, 11th Nov. followed by 1st Nov. and 21st Nov. reported maximum No. of grains spike^{-1}, 1000 grains weight and grain yield. The early sowing provided longer growing period to wheat crop that resulted in better development of grains. Delay in planting time (21st Dec. and 11th Dec.) caused drastic reduction in yield attributes and showed minimum values of these attributes. Grain yield was mainly associated with decreased in germination count m^{-2}, No. of tillers m^{-2}, No. of grains spike^{-1} and 1000 grain weight. Yield attributes were significantly affected by genotypic potential. Genotype Aas-11 and Punjab-11 reported better No. of grains spike^{-1}, 1000 grains weight and grain yield. Genotype Sehar-11 showed poor yield component in all the sowing dates. Experimental season 2012-13 showed comparatively better yield attributes than the seasons 2010-11 and 2011-12. Similar results are strongly supported by Shahzad et al. (2007), Tahir et al. (2009), Baloch et al. (2010) and Yajam and Madani (2013). Reduction in grain yield due to late sowing was attributed to grain mortality due to increase in temperature in the month of March that shortens the grain filling stage and induced early physiological maturity (Wardlaw, 2002; Guilioni et al., 2003).

CONCLUSION

The following conclusions can be drawn from the present study: Delay in sowing of wheat can cause severe reduction in crop growth, development and yield attributes. Wheat sown on 1st Nov. to 21st Nov. appeared to be most desirable sowing time to harvest maximum yield in all tested genotypes. However genotypes Aas-11 and Punjab-11 have potential to produced high yield under early as well as late planting time.

REFERENCES

Ali, M. A., M. Ali, and Q. Mohy-Ud-Din. 2004. Determination of grain yield of different wheat genotypes as influenced by planting dates in agro-ecological conditions of Vehari. Pakistan Journal of Life and Social Science, 2(1): 5-8.

Baloch, M. S., I. T. H. Shah, M. A. Nadim, M. I. Khan and A. A. Khakwani. 2010. Effect of seeding density and planting time on growth and yield attributes of wheat. Journal of Animal and Plant Science, 20(4): 239-240.

Dabre, W. M., S. B. Lall and G. L. Lngole. 1993. Effects of sowing dates on yield, ear number, stomatal frequency and stomatal index in wheat. Journal of Maharashatra Agricultural University, 18: 64-66.

El-Mahdi, A. R. A., S. E. M. EI-Amin and F. G. Ahmed. 2007. Effect of sowing date on the performance of sesame (*Sesamum indicum* L.) genotypes under irrigation conditions in northern Sudan. African Crop Science Conference Proceeding, 8: 1943-1946.

Guilioni L., J. Wery and J. Lecoeur. 2003. High temperature and water deficit may reduce seed number in field pea purely by decreasing plant growth rate. Functional Plant Biology, 30: 1151-1164.

Iqbal, M. S., A. Yar, A. Ali, M. R. Anser, J. Iqbal and H. M. Akram, 2001. Effect of sowing date and seed rate on grain yield of wheat (cv. 93-BT- 022). Journal of Agriculture Research, 39(4): 217-220.

Khakwani, A. A., M. D. Dennett, M. Munir and M. Abid. 2012. Growth and yield response of wheat genotypes to water stress at booting and anthesis stages of development. Pakistan Journal of Botany, 44: 879-886.

Khan, M. I., M. Tila, F. Subhan, M. Amin and S. T. Shah. 2007. Agronomic evaluation of different bread wheat (*Triticum aestivum* L.) genotypes for terminal heat stress. Pakistan Journal of Botany, 39(7): 2415-2425.

Mumtaz, M. Z., M. Aslam, M. Jamil, M. Ahmad. 2014. Effect of different phosphorus levels on growth and yield of wheat under water stress conditions. Journal of Environment and Earth Science, 4(19): 23-30.

Murungu, F. S. and T. Madanzi. 2010. Seed priming, genotype and sowing date effects on emergence, growth and yield in a tropical low altitude area of Zimbabwe. African Journal of Agricultural Research, 5(17): 2341-2349.

Nahar, K., K. Ahmad and M. Fujita. 2010. Phenological variation and its relation with yield in several wheat (*Triticum aestivum* L.) cultivars under normal and late sowing mediated heat stress conditions. Not. Sci. Biol. 2(3): 51-56.

PAK-SCMS. 2014. Pakistan: Satellite Based Crop Monitoring System 4(2): 1-31.

Phadnawis, B. N. and A. D. Saini. 1992. Yield models in wheat based on sowing time and phenological developments. Annual. Plant Physiology, 6: 52-59.

Refay, Y. A. 2011. Yield and yield component parameters of bread wheat genotypes as affected by sowing dates. Middle-East Journal of Science and Research, 7(4): 484-489.

Safdar, M. E., A. Ali, S. Muhammad, G. Sarwar and T. H. Awan 2008). Effect of transplanting dates on paddy

yield of fine grain rice genotypes. Pakistan Journal of Botany 40(6): 2403-2411.
Shah, W. A., J. Bakht, T. Ullah, A. W. Khan, M. Zubair and A. Khakwani. 2006. Effect of sowing dates on yield and yield components of different wheat varieties. Journal of Agronomy, 5(1): 106-110.
Shahzad, M. A., Wasi-ud-Din, S. T. Sahi, M. M. Khan, Ehsanullah and M. Ahmad. 2007. Effect of sowing dates and seed treatment on grain yield and quality of wheat. Pakistan Journal of Agricultural Sciences, 44(4): 581-583.
Sial, M. A., M. A. Arain, S. K. Mazhar, H. Naqvi, M. U. Dahot and N. A. Nizamani. 2005. Yield and quality parameters of wheat genotypes as affected by sowing dates and high temperature stress. Pakistan Journal of Botany, 37(3): 575-584.
Sohail, M., I. Hussain, Riaz-ud-Din, S. K. Tanveer, M. Qamar and S. H. Abbas. 2014. Evaluation of advance wheat lines for agronomic traits in rainfed environment. Pakistan Journal of Agricultural Research, 27(2): 79-88.
Steel, R. G. D., J. H. Torrie and D. A. Dickey. 1997. Principles and Procedures of Statistics: A Biometrical Approach. 3rd ed. McGraw Hill Co., New York, USA.
Tahir, M., A. Ali, M. A. Nadeem, A. Hussain and F. Khalid. 2009. Effect of different sowing dates on growth and yield of wheat (*Triticum aestivum* L.) genotypes in District Jhang, Pakistan. Pakistan Journal of Life and Social Sciences, 7(1): 66-69.
Wardlaw, I. F. 2002. Interaction between drought and chronic high temperature during kernel filling in wheat in a controlled environment. Annual Botany, 90: 469-476.
Yajam, S. and H. Madani. 2013. Delay sowing date and its effect on Iranian winter wheat cultivars yield and yield components. Annals of Biological Research, 4(6): 270-275.