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IMPACT OF VARIABLE SEEDING DATES ON CEREALS' PERFORMANCE UNDER AGRO-ECOLOGICAL CONDITIONS OF DERA ISMAIL KHAN

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ABSTRACT:- Performance of cereals was studied through a two factors field experiment under split-plot arrangements at Agricultural Research Institute, D.I.Khan during 2012-13. Four cereals (wheat, triticale, barley, oat) were assigned to main plots while six different sowing dates (October 15, November 1 & 15, December 1 & 15 and January 1) were kept in sub-plot. The experiment was replicated four times with a sub-plot size of 5 m × 1.8 m (9 m^2). Sowing of barley took minimum time to 50 % heading (99.08 days) which led the same towards earlier maturity (131.21 days) while oat crop showed prolonged maturity (147.67 days). Regarding yield, the four cereals showed non-significant results. Among different dates, January 1 sowing had the poorest performance in almost all parameters. However, the highest grain yield (3104 kg ha^{-1}) was produced by October 15 sowing while the results of November 15 and thereafter sowing were non-significant with each other. Data on lodging of these cereal crops was also observed during the study. Barley was the crop showing maximum lodging (35.83 %) which led the same to lowest grain yield. The minimum lodging (8.33 %) was noted in oat crop. It was also observed that earlier sowing showed more lodging due to longer growth period. The study concludes that cereals should be sown between mid-October to mid-November for their best performance in areas with similar agro-ecology.

Key Words: Wheat; Barley; Triticale; Oat; Sowing Dates; Crop Yield; Yield Components; Pakistan.

INTRODUCTION

Winter cereals may suffer severely from shortage of moisture at four critical stages of growth i.e., germination, tillering, flowering and grain-filling. Therefore, any practice to enhance the moisture holding capacity of rainfed fields would be beneficial to avoid severe moisture stress at these critical stages of growth. Such practices may include occasional deep plowing to minimize soil run-off, mulching of soil, intercropping with bushy crops to minimize field heat, evaporation rate and drought resistance. For producers of small grains, the goal is to select a planting date that gives an opportunity to develop as many fall tillers as possible while avoiding potentially severe damage associated with fall insect and disease infestations or an early spring freeze. The key advantage to planting early in fall is the opportunity to make use of warmer temperatures, warmer the weather the more tillers are produced. Cold

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temperatures impede growth, so it is important to plant small grains while there is still enough time and mild weather for tillers to form before winter. On the other hand, planting too early can result in increased risk of diseases such as barley yellow dwarf and powdery mildew, increased risk of Hessian fly infestations increased risk of spring freeze damage. Planting time has significant effect on grain yield and amount of forage that is available for grazing in fall. If winter wheat is to achieve high dry matter production followed by good grain recovery, it must be sown early. Late sowing results in slow growth, poor total production, although grain recovery can still be very good (Freebairn, 2005). Hossain et al. (2003) illustrated that delaying the planting date from September 10 to 30, resulted in 18% increase in expected grain yield while Gaylon et al. (2004) compared small grains for September planting and found that oats provided the most fall forage, followed by wheat. Similarly, wheat sowing between October 25 and November 10 produced more tillering with tallest plants, 1000-seed weight and grain yield which subsequently decreased with successive sowing dates (Baloch et al., 2010). Too early sowing produces weak plants with poor root system, which leads to irregular germination, frequent death of the embryo and decomposition of endosperm due to activities of bacteria or fungi (Paul, 1992). While, late planting affects germination, growth, grain development (Haq and Khan, 2002) and produces poor tillering due to winter injury in low temperatures (Tahir et al., 2009). Agriculture has been the major instrument of economic growth and development in KPK but it has only 53% of land irrigated from all sources of irrigation against 84% irrigated cropped area in Pakistan. Drought resistant cereals are expected to perform better under these conditions.

The aim of present study was to identify and promote suitable cereals under such conditions accordingly. For this purpose, four cereals viz., wheat, barley, triticale and oat were selected to test at different sowing times in the area.

MATERIALS AND METHOD

The present research was carried out at the Agricultural Research Institute, Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan during the Rabi 2012-13. Geographical coordinates of the experimental site were 31° N, 70° E having clay-loam soil of pH 7.6 and 0.68% organic matter. Soil fertility status showed 0.042% nitrogen, 10.11 ppm phosphorus and 400 ppm exchangeable potassium. The trial was laid out in randomized complete block design with split-plot arrangements having four replications. The sub-plot size was 1.8 m × 5 m (9 m^2) with 6, 5 m long and 30 cm apart rows. Main plot consisted four cereals (wheat, triticale, barley, oat) while six sowing times (October 15, November 1 & 15, December 1 & 15 and January 1) were assigned to sub-plots.

Fertilizers were applied @ 120-60-60 kg NPK ha^{-1} in the form of urea, diammonium phosphate and potassium sulphate. Half of nitrogen and full dose of phosphorus and potash were applied at sowing while remaining half nitrogen was applied with first irrigation. Sowing was done by hand drill using seed rate of 100 kg ha-1 (wheat), 90 kg ha^{-1} (barley), 100

kg ha^{-1} (triticale) and 90 kg ha^{-1} (oat). High yielding, well adopted varieties of each cereal viz., Pirsabak-05 (wheat), Bajour-2000 (barley) and Advanced NARC lines of triticale and oat were used in the experiment. Irrigations were applied to whole experiment at respective times according to sowing dates. Herbicides Buctril Super @ 750 ml ha^{-1} and Puma Super @ 625 ml ha^{-1} were used to control weed flora in the trial. Data on number of days to 50% heading, number of days to maturity, plant height (cm), grain yield (t ha^{-1}) and lodging (%) were recorded and analyzed statistically using analysis of variance techniques (Steel et al., 1997) and subsequently the individual treatment means were compared by Tukey HSD Test (Black, 2011). The analysis was performed by using "Statistix" software program

.RESULTS AND DISCUSSION

Number of Days to 50% Heading

Data revealed that four cereals showed significant variations in days to 50% heading (Table 1). Among different cereals, oat took the maximum time (111.08 days) to 50% heading while the other three cereals remained non-significant with each other. Sowing of triticale and barley had minimum days (99.08) to 50% heading. On the other hand, significant variations were observed with different sowing times. Maximum time (109.38 days) to 50% heading was noted for November 1 sowing which was statistically at par with November 15 (108.75 days) sowing. Sowing on December 1 took minimum days (86.81) to 50% heading. It was followed by 97.75 days taken by December 15 sowing. Late sowing resulted in earlier heading due to the shortage of growth period. It is obvious that crops had short time to produce in late sowing. The interaction between cereals and date of sowing also had significant results. Sowing of oat on October 15 took the maximum (129.75 days) to produce 50% heading. It was followed by November 1 sowing of the same crop with 121.00 days to 50% heading. Wheat crop sown on October 15 took the minimum (81.50 days) to 50% heading.

Number of Days to Maturity

It was observed that different sowing times significantly affected the maturity of four cereals (Table 2).

Table 1. Number of days to 50% heading of four cereals as affected by different sowing dates

Cereals	Sowing dates						Means
	Oct. 15	Nov. 1	Nov. 15	Dec. 1	Dec. 15	Jan. 1	
Wheat	81.50 ^{l}	105.25 $^{d-h}$	111.00 ^{cd}	109.50 $^{c-f}$	99.50 ^{hi}	88.25 ^{jkl}	99.17 ^{b}
Triticale	88.75 ^{jk}	107.75 $^{c-g}$	109.25 $^{c-f}$	104.00 $^{e-i}$	98.00 ^{i}	86.75 ^{jkl}	99.08 ^{b}
Barley	114.25 ^{bc}	103.50 $^{f-i}$	102.00 ^{ghi}	101.50 ^{ghi}	90.50 ^{j}	82.75 ^{kl}	99.08 ^{b}
Oat	129.75 ^{a}	121.00 ^{b}	112.75 ^{c}	110.50 ^{cde}	103.00 $^{f-i}$	89.50 ^{jk}	111.08 ^{a}
Mean	103.56 ^{c}	109.38 ^{a}	108.75 ^{ab}	106.38 ^{b}	97.75 ^{d}	86.81 ^{e}	

$LSD_{0.05}$ Cereals = 1.76; Sowing dates = 2.71; Cereals × Sowing dates = 7.01
Means followed by same letter(s) do not differ significantly at P<0.05

Oats took the maximum (147.67 days) for maturity. It was followed by wheat crop which took 132.71 days to maturity. Statistically, the time of maturity of three cereals viz., wheat, triticale and barley was at par with each other however, barley was the earliest maturing (131.21 days) crop. In different sowing times, maximum (143.94 days) was taken by November 1 sowing which was statistically at par (142.31 days) with November 15 sowing. Early sowing produced a longer growth period that resulted in more time of maturity. The shortest time (121.81 days) to maturity was taken by sowing on January 1 which was followed by December 15 (132.19 days) sowing. Imranullah et al. (2007) reported that late sowing resulted in earliest maturity in different cereals. Cereal crops under this study were significantly interacted with different sowing times. Oat crop sown on October 15 took the maximum (159.75 days) to mature which was statistically similar to November 1 sowing (159.25 days) of the same crop. As discussed earlier, maximum number of days taken to heading and maturity might be due to longer crop cycle of oat crop. The shortest time (114.50 days) to maturity was taken by wheat crop sown on January 1. This might be due to the limited growth period to produce crop yield as after March temperature is raised causing maturity.

Plant Height (cm)

This attribute of four cereals was significantly affected by the time of sowing (Table 3). The tallest plants (124.54 cm) were produced by oat crop while triticale showed statistically similar results with 124.04 cm tall plant. It is obvious that oat crop has comparatively more height than other cereals. The minimum plant height (101.71 cm) was noted in wheat crop which was at par with barley (103.38 cm). On the other hand, plant height was significantly affected by different times of sowing. Among various dates, the tallest plants (125.75 cm) were produced with October 15 sowing which was statistically at par with 122.56 cm height recorded in November 1 sowing. This might be due to the longer growth period and plants took enough time during their vegetative growth. It is obvious from the data that late sowing resulted in shorter plants. Sowing on January 1 gave shortest plants (100.19 cm). It was followed by December 15 sowing which produced 106.56 cm tall

Table 2. Number of days to maturity of four cereals as affected by different sowing dates

Cereals	Sowing Dates						Means
	Oct. 15	Nov. 1	Nov. 15	Dec. 1	Dec. 15	Jan. 1	
Wheat	114.50 ^{k}	139.75 ^{cde}	142.75 c	142.25 ^{c}	134.75 ^{def}	122.25 ^{hij}	132.71 ^{b}
Triticale	120.25 ^{ijk}	138.00 ^{cde}	142.50 c	138.25 ^{cde}	129.00 ^{fgh}	123.75 ^{hi}	131.96 ^{b}
Barley	141.75 ^{cd}	138.75 ^{cde}	133.25 ef	133.00 ^{efg}	124.75 ^{hi}	115.75 ^{jk}	131.21 ^{b}
Oat	159.75 ^{a}	159.25 ^{a}	150.75 b	150.50 ^{b}	140.25 ^{cde}	125.50 ^{ghi}	147.67 ^{a}
Means	134.06 ^{c}	143.94 ^{a}	142.31 ab	141.00 ^{b}	132.19 ^{c}	121.81 ^{d}	

$LSD_{0.05}$ Cereals = 2.79; Sowing dates = 2.68; Cereals × Sowing dates = 6.94
Means followed by same letter(s) do not differ significantly at P<0.05

plants. These results are in line with the findings of Imranullah et al. (2007) who observed detrimental effect on plant height as the sowing time delayed. The two factors (cereal crop and sowing dates) significantly interacted with each other. Oat crop sown on October 15 gave maximum plant height (158.75 cm) which was followed by November 1 sowing (140.00 cm) of the same cereal crop. The possible reason for this is the longer time span taken by the said crop as well as genetically longer plant height. In accordance, wheat crop sown on January 1 gave the minimum plant height (95.50 cm) which was statistically similar (98.50 cm) to that of barley crop sown at the same date.

Grain Yield (kg ha^{-1})

Crop productivity is the rate at which a crop accumulates organic matter which depends primarily on the rate of photosynthesis and conversion of light energy to chemical energy by green plants (Nadim et al., 2012). Data showed that different cereals had non-significant effect on grain yield whereas it was significantly affected by various sowing dates (Table 4). However, maximum grain yield (2581.3 kg ha^{-1}) was produced by triticale, while with a lesser difference, wheat and oat produced 2484.9 and 2432.2 kg ha^{-1} yield. Grain yield of different cereals was significantly affected by various sowing times. The highest yield (3104.2 kg ha^{-1}) was recorded in October 15 sowing which was statistically at par with November 1 sowing by producing 2555.2 kg ha^{-1}. The results with sowing thereafter were statistically at par with each other; however, January 1 sowing gave the lowest grain yield (2005.2 kg ha-1). It is obvious that late sown crop matured in shorter time compared with normal sowing as the hot summer season approached. Thus, late sown crop took less number of Growing Degree Days (GDD) due to which yield components decreased and hence the economic yield of the crop suffers negatively (Lone et al., 1999). Non-significant interaction was observed between cereal crops and sowing dates. However, wheat sown on October 15 gave maximum yield (3937.5 kg ha^{-1}) while triticale produced 3518.5 kg ha^{-1} when sown at the same date.

Table 3. Plant height (cm) of four cereals as affected by different sowing dates

Cereals	Sowing Dates						Means
	Oct. 15	Nov. 1	Nov. 15	Dec. 1	Dec. 15	Jan. 1	
Wheat	101.75 ^{efg}	101.25 ^{efg}	107.50 $^{d-g}$	105.25 $^{d-g}$	99.00 ^{efg}	95.50 ^{g}	101.71 ^{b}
Triticale	137.50 ^{b}	139.75 ^{b}	132.00 ^{b}	113.00 ^{de}	116.00 ^{cd}	106.00 $^{d-g}$	124.04 ^{a}
Barley	105.00 $^{d-g}$	109.25 $^{d-g}$	101.50 ^{efg}	101.75 ^{efg}	104.25 $^{d-g}$	98.50 ^{fg}	103.38 ^{b}
Oat	158.75 ^{a}	140.00 ^{b}	128.50 ^{bc}	112.25 ^{def}	107.00 ^{dg}	100.75 ^{efg}	124.54 ^{a}
Means	125.75 ^{a}	122.56 ^{a}	117.38 ^{b}	108.06 ^{c}	106.56 ^{c}	100.19 ^{d}	

$LSD_{0.05}$ Cereals = 5.79; Sowing dates = 4.68; Cereals × Sowing dates = 12.12
Means followed by same letter(s) do not differ significantly at P<0.05

Lodging (%)

Lodging in cereal crops occurs mainly due to adverse climatic conditions including high velocity winds, thunderstorm, hailstorm and heavy rainfall etc. However, sometimes lodging occurs with heavy doses of nitrogenous fertilizers under moist conditions. Data depicted maximum lodging (35.83%) in barley (Table 5). It was statistically at par with triticale which showed 26.67% lodging. Oat crop had the minimum lodging (8.33%) while wheat crop showed 13.12% lodging. The results further indicated that different sowing times also significantly affected lodging percentage. Highest lodging (33.43%) was observed in November 15 sowing. It was statistically similar with sowing on November 1 and December 1 by producing 29.06% and 25.93% lodging. The minimum lodging (2.81%) was obviously shown by January 1 sowing. This might be due to short growth period and the plants can tolerate winds and rainfall, etc. These significantly interacted with each other for lodging. Sowing of triticale at three different times showed higher lodging i.e., 51.25% (November 15), 47.50% (December 1) and 43.75% (November 1). It was also observed that sowing of wheat and oat on December 15 and January 1 had 0% lodging. The possible reason is the short statured plants which tolerated more towards climatic hazards.

It is thus concluded that all

Table 4. Grain yield of four cereals as affected by different sowing dates

(t ha^{-1})

Cereals	Sowing Dates						Means
	Oct. 15	Nov. 1	Nov. 15	Dec. 1	Dec. 15	Jan. 1	
Wheat	3937.5 ^{NS}	2445.8	2083.5	2421.8	1931.3	2089.5	2484.9 ^{NS}
Triticale	3518.5	2935.5	2206.3	2206.3	2346.0	2275.3	2581.3
Barley	2271.0	2218.5	2264.8	1741.8	2054.3	1170.8	1953.5
Oat	2689.8	2621.0	2389.8	2208.3	2199.0	2485.3	2432.2
Means	3104.2 ^{a}	2555.2 ^{ab}	2236.1 ^{b}	2144.5 ^{b}	2132.6 ^{b}	2005.2 ^{b}	

$LSD_{0.05}$ Sowing dates = 796.60
Means followed by same letter(s) do not differ significantly at P<0.05

Table 5. Lodging of four cereals as affected by different sowing dates

(%)

Cereals	Sowing Dates						Means
	Oct. 15	Nov. 1	Nov. 15	Dec. 1	Dec. 15	Jan. 1	
Wheat	13.75 $^{c-g}$	41.25 $^{a-d}$	22.50 a-g	1.250 ^{fg}	0.00 ^{g}	0.00 g	13.12 ^{b}
Triticale	40.00 $^{a-d}$	43.75 ^{abc}	51.25 a	47.50 ^{ab}	25.00 $^{a-g}$	7.50 ^{efg}	26.67 ^{a}
Barley	33.75 $^{a-f}$	27.50 ^{ag}	35.00 a-e	42.50 ^{abc}	17.50 $^{b-g}$	3.75 ^{efg}	35.83 ^{a}
Oat	8.75 $^{d-g}$	3.75 ^{efg}	25.00 a-g	12.50 $^{c-g}$	0.00 ^{g}	0.00 ^{g}	8.33 ^{b}
Means	24.06 ^{a}	29.06 ^{a}	33.43 a	25.93 ^{a}	10.62 ^{b}	2.81 ^{b}	

$LSD_{0.05}$ Cereals = 10.45; Sowing dates = 12.13; Cereals × Sowing dates = 31.38
Means followed by same letter(s) do not differ significantly at P<0.05

cereals performed well in the area. However, their performance was differentiated with various sowing times. Sowing during October 15 and November 1 is best suited for cereals under the agro-ecology of D.I.Khan.

LITERATURE CITED

Baloch, M. S., I. 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. J. Anim. Plant Sci. 20 (4): 239-24

Black, K. 2011. Business Statistics: Contemporary Decision Making. 7th edn., John Wiley & Sons. p. 424.

Freebairn, B. 2005. Productive dual purpose winter wheat. Available online at www.agric.nsw.gov.au.

Gaylon, M., J. Shaffer and T. Baughman. 2004. Identifying the impact of planting date and seeding rate on dual-purpose and grain only wheat yields. Available online at http://varietytesting.tamu.edu/wheat/ongoingresearch/2005/Morgan.

Haq, N. U. and M. Khan. 2002. Effect of planting date, chlortoluran + MCPA and wheat varieties on weed control and wheat yield. Sarhad J. Agric. 18 (2): 443-447.

Hossain, I., F. M. Epplin and E. G. Krenzer. 2003. Planting date influence on dual purpose winter wheat forage yield, grain yield, and test weight. Agron. J. 1179-1188.

Imranullah, N. H. Shah, Z. Haq and F. U.Khan. 2007. An analysis of the planting dates effect on yield and yield attributes of spring wheat. Sarhad J. Agric. 23 (2): 269-275.

Lone, A. H., M. H. Shah and A. S. Bali. 1999. Yield and economic analysis of different wheat varieties grown on different sowing dates. Applied Biol. Res. 1: 155-157.

Nadim, M. A., I. U. Awan, M. S. Baloch, E. A. Khan, K. Naveed and M. A. Khan. 2012. Response of wheat (*Triticum aestivum* L.) to different micronutrients and their application methods. J. Anim. Plant Sci. 22 (1): 113-119.

Paul, S. R. 1992. Effects of pre-sowing treatments, seed rates, fertility levels and surface soil competition on growth and yield at late sown rainfed wheat in Assam. Agric. Res. 13: 410-411.

Steel, R., J. H. Torrie and D. Dickey 1997. Principles and procedures of statistics. A biometric approach, 3rd edn. McGraw Hill book C. Inc. New York.

Tahir, M., A. Ali, M. A. Nadeem, A. Hussain and F. Khalid. 2009. Effect of different sowing dates on growth and yield of wheat varieties in district Jhang, Pakistan. Pakistan J. Life Soc. Sci. 7 (1): 66-69.

AUTHORSHIP AND CONTRIBUTION DECLARATION

S.No	Author Name	Contribution to the paper
1.	Mr. Shahid Iqbal Khattak	Conceived the idea, Wrote abstract, Methodology
2.	Dr. Muhammad Amjad Nadim	Did SPSS analysis, Data entry in SPSS and analysis
3.	Dr. Mohammad Safdar Baloch	Conclusion, Technical input at every step
4.	Dr. Kashif Waseem	Data collection
5.	Dr. Muhammad Sohail	Overall management of the article

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