INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 9, No. 2, p. 162-170, 2016

RESEARCH PAPER

OPEN ACCESS

Effect of Brassinolide on the yield and yield related traits of wheat

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Article published on August 25, 2016

Key words: *Triticum aestivum*, Sowing date, Brassinolide, Grain yield.

Abstract

Wheat (*Triticum aestivum*) is the most widely used cereal in the world. Wheat contributes 14.4 % to the value addition and 3 % to GDP in Pakistan. The objective of the present study was to evaluate two wheat varieties (Janbaz and AUP-4008) for sowing date and Brassinolide. Results showed that sowing dates significantly affected days to emergence, emergence m^{-2}, days to 50 % heading, days to 50 % anthesis, plant height, number of grains per spike, grain weight per spike, thousand grain weight and grain yield in both varieties. The influence of Brassinolide was not significant for most of the parameters. Interaction of sowing dates and varieties was significant for almost all parameters except days to emergence, 50% heading and grain yield. Plants sown on 20th November resulted in lower days to emergence, higher 50% heading and 50% anthsis. Likewise, higher number of grains $spike^{-1}$, plant height, grain weight $spike^{-1}$, thousand grain weight and grain yield were recorded for 20th November sowing. Results about days to 50% heading and 50% anthsis were higher for Jehanbaz. Similarly higher number of grains $spike^{-1}$, grain weight $spike^{-1}$ and grain yield were recorded for wheat variety Janbaz. Whereas, higher plant height and 1000 grain weight were recorded for wheat variety AUP-4008. It is concluded that cultivation of wheat variety Jehanbaz on 20th November will produce higher yield in KPK province of Pakistan.

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Introduction

Wheat (*Triticum aestivum*) is the most widely used cereal in the world. Wheat contributes 14.4 % to the value addition and 3 % to GDP. In Pakistan during 2008-09 wheat was grown on an area of 9046 thousand hectares with an annual production of 24032.9 thousand tons with national average yield 2657 kg ha^{-1} while the average yield of Khyber Pakhtunkhwa was 769.5 thousand tons (MINFA, 2009). Sowing dates is one of the most important factors that affect the growth and yield of wheat. Date of sowing influence maturity, seed filling duration and seed weight. Late sowning wheat is generally affected by winter injury, produces fewer tillers and ripens later (Ouda *et al*. 2005). Normally wheat is grown in winter that requires optimal temperature and light for emergence, growth and flowering (Dabre *et al*., 1993).

High temperature leads to poor germination, irregular seedling stand, embryo death and endosperm becomes inactive because of the activities of bacteria and fungi. Late sowing generally produces fewer tillers and dwarf plants because of the low temperature at the time of sowing. So wheat variety should match the temperature requirement to produce high yield that is attained by proper grain filling at late maturity stage (Phadnawis and Sani, 1992). Brasssinolide is a brassinosteroid hormone which plays an important role in cell division and elongation. Brasssinolide positively affects the metabolic activities which enhance the translocation of water and minerals to produce optimal yield (Shen *et al*. 1990).

Brasssinolide increases source to sink translocation by increasing number of tillers, grains per spike and 1000 grain weight (Fujii *et al*., 1991). The application of brassinolide at sowing time, tillering stage and anthesis stage promotes cell expansion and cell elongation (Nemhauser, 2004).Hossain *et al*. (2003) evaluated wheat (*Triticum aestivum* L.) for planting dates, grain yield and 1000 grain weight and concluded that delaying the sowing time from 10 to 30 days results in an increase of grain yield up to 18%. Pullman *et al*. (2003) concluded that brassinolide is an important plant stimulant for the initiation and development of embryonic tissues. Nemhauser *et al*. (2004) studied that brassinolide works with auxin to promote cell expansion and cell elongation that accelerates the growth of new meristamatic tissues of the plant. Shafiq (2004) reported that early sowing of wheat improves germination, plant height, spikelets per spike, 1000 grain weight, grain per spike and overall yield.

Dokuyucu *et al*. (2004) observed the influence of sowing dates on yield and growth of wheat in the East Mediterranean region of Turkey and concluded that days to anthesis, days to physiological maturity, number of plant/m^{-2}, 1000 grain weight and yield are significantly affected by sowing dates. The grain yield obtained from the first five sowing date were significantly enhanced. Ferrie *et al*. (2005) reported that BRs- 24 and BL increased the yield of MDES. Brassinolide produces signaling which protect the plant cells from further damage under temperature stress. Brassinolide produce absesic acid which close stomata of leaves and reduce transpirational loss and enhance tolerance.

Ozturk *et al*. (2006) reported that wheat grown at optimum time significantly affected leaf area index, leaf area duration, spikes per square meter, kernel weight and grain yield as compare to spring wheat. Facultive cv. *Kirik* was sown in winter. While grains yield was recorded low in spring and freezing sown wheat because the conditions for the vegetative and reproductive growth were not favorable. Sowing times influence spikes $meter^{-2}$ which is the major factor of the grain yield, lower the number of spike will be lower the grain yield. Bajguz (2009) examined that brassinolide (BL) accelerates metabolic activities of plant cells. Xiao Jian Xia *et al*. (2009) observed that the effects of brassinosteroids in metabolism of pesticides. McRae *et al*. (2010) conducted an experiment to different sowing dates in New South Wales. Tillers m^{-2}, spikes m^{-2}, 1000 grain weight and grain yield drastically decreased when crop sown delayed.

The yield decreased 4-7 % for each week that wheat sown delayed after the optimum time. So keeping in view, the role of sowing dates and brassinolide (PGR), the present study was designed to evaluate the effect of sowing dates and brassinolide on growth, yield and yield components of advanced wheat varieties.

Material and methods

The experiment was conducted in New Developmental Farm of Khyber Pakhtunkhwa, Agricultural University Peshawar, Pakistan during normal wheat season. Field is located at latitude 30° and 47° North and longitude 69°and 74°East.

Wheat varieties Janbaz and AUP-4008 were sown following randomized complete design (RCBD) with split plot arrangement with triplicate arrangement having plot size of 14m^2. Row to row distance was maintained 30 cm. Four sowing dates (Nov 20th, Nov 30th, Dec 10th and Dec 20th) were allotted to main plot while Brassinolide concentrations were assigned to sup plots. All the plant production measure were followed normally. Brassionolide was applied at tillering stage in each sub plot.

Material layout

V1																*V2*															
Sowing dates																Sowing dates															
20 Nov				30 Nov				10 Dec				20 Dec				20 Nov				30 Nov				10 Dec				20 Dec			
B0	B1	B2	B3	BO	B1	B2	B3	BO	B1	B2	B3	BO	B1	B2	B3	BO	B1	B2	B3	BO	B1	B2	B3	BO	B1	B2	B3	BO	B1	B2	B3

Statistical analysis

The data were analyzed statistically using analysis of variance technique appropriate for RCB design with split plot arrangement. Means were compared using LSD test at 0.05 levels of probability, when the F value were significant (Steel and Torri, 1980).

Results and discussion

Days to emergence

Data regarding emergence are presented in Table 1. Statistical analysis of the data showed that sowing date significantly affected days to emergence whereas the effect of varieties was not significant. Interaction between sowing date and varieties was non-significant. Higher number of days (16) to emergence was recorded for 20th December sowing, while the lower days to emergence (09) was recorded for sowing on 20th November. Both the varieties took same number of days for emergence.

Emergence m^{-2}

Data on emergence m^{-2} are reported in Table 2. Mean data revealed that sowing dates had significant effect on emergence m^{-2}, while the varieties effect was not significant on emergence m^{-2}. The interaction of sowing date and varieties was significant for emergence m^{-2}. Higher numbers of plants (206) were emerged from the sowing date of 20th November. Lower numbers of plants were noted (143) for sowing of the 20th December. The results partially concide with those of Razzaq *et al*. (1986) who explained that late sowing of wheat caused less number of plants m^{-2}.

Days to 50 % heading

Data pertaining days to 50 % heading are given in Table 3. Mean data exhibited that sowing dates and varieties had significantly influenced days to 50% heading whereas brassinolide showed not significant effect on days to 50% heading. The interactive response of sowing dates, varieties and brassinolide was not significant for days to 50% heading. Maximum days to 50 % heading (119) were recorded when sowing was done on 20th December, while minimum numbers of days (88) to 50 % heading were noted for sowing on 20th November. Higher numbers of days (104) to 50 % heading were taken by Janbaz variety whereas the lower numbers of days (103) to 50 % heading were counted for AUP-4008 variety. These results are an agreement with those of Augilar and Hunt (1991) who explained that delay in sowing decreased number of days to heading.

Table 1. Days to emergence of wheat varieties as affected by sowing dates and brassinolide concentrations.

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L^{-1})				SD x V
		00	0.5	1.0	1.5	
20th Nov, 2009	Janbaz	9	8	8	9	9
	AUP-4008	8	7	10	8	8
30th Nov, 2009	Janbaz	11	12	12	12	12
	AUP-4008	12	12	12	12	12
10th Dec, 2009	Janbaz	13	14	13	14	13
	AUP-4008	14	14	14	15	14
20th Dec, 2009	Janbaz	16	16	16	16	16
	AUP-4008	16	17	17	16	16
		SD x B				
Nov 20th		9	8	9	8	8 a
Nov 30th		12	12	12	12	12 b
Dec 10th		14	14	13	14	14 c
Dec 20th		16	16	16	16	16 d
		V x B				
	Janbaz	12	13	12	13	12
	AUP-2008	13	13	13	13	13
Mean		12	13	13	13	

LSD value (P≤0.05) for sowing dates= 1.007.

Table 2. Emergence m^{-2} of wheat varieties as affected by sowing dates and brassinolide concentrations.

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L^{-1})				SD x V
		00	0.5	1.0	1.5	
20th Nov, 2009	Janbaz	200	213	193	188	199
	AUP-4008	214	218	193	196	206
30th Nov, 2009	Janbaz	153	156	167	162	160
	AUP-4008	157	170	164	171	165
10th Dec, 2009	Janbaz	155	148	140	144	147
	AUP-4008	141	142	142	139	141
20th Dec, 2009	Janbaz	139	142	143	150	144
	AUP-4008	136	140	137	142	139
		SD x B				
Nov 20th		207	216	193	192	202 a
Nov 30th		155	163	165	167	162 b
Dec 10th		148	145	141	142	144 c
Dec 20th		138	141	140	146	141 c
		V x B				
	Janbaz	187	190	186	186	187
	AUP-4008	187	193	184	187	188
Mean		187	187	191	185	

LSD value (P≤0.05) for sowing date = 17.41.

Table 3. Days to heading of wheat varieties as affected by sowing dates and brassinolide concentrations.

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L^{-1})				SD x V
		00	0.5	1.0	1.5	
20th Nov, 2009	Janbaz	119	118	120	120	119
	AUP-4008	119	118	119	119	119
30th Nov, 2009	Janbaz	108	107	110	110	109
	AUP-4008	107	106	109	108	108
10th Dec, 2009	Janbaz	101	102	99	99	100
	AUP-4008	100	96	98	99	98
20th Dec, 2009	Janbaz	88	87	90	89	88
	AUP-4008	88	87	89	88	88
		SD x B				
Nov 20th		119	118	120	119	119 a
Nov 30th		108	107	110	109	108 b
Dec 10th		101	99	98	99	99 c
Dec 20th		88	87	89	88	88 d
		V x B				
	Janbaz	104	104	105	104	104 a
	AUP-4008	104	102	104	103	103 b
Mean		104	103	104	104	

LSD value (P≤0.05) for sowing dates = 1.514.

Days to 50 % anthesis

Data on days to 50% anthesis are shown in Table 4. Analysis of the data revealed that sowing dates and varieties had significantly affected days to 50 % anthesis. Brassinolide was not significant affected days to 50% anthesis. The interaction of sowing dates and varieties was significant for days to 50 % anthesis whereas all the other interactions were not significant. Higher numbers of days to 50 % anthesis (134) was counted for sowing on 20th December, while lower numbers of days (103) to 50 % anthesis was recorded for the sowing date of 20th November. Janbaz variety took higher days to 50 % anthesis (119) while AUP-4008 variety took minimum days to 50 % anthesis (118). These results are similar to those of Aslam *et al.* (2003) who concluded that days to heading decreased with delaying sowing of crops. Differences in both of varieties were found significant because it might be attributed to their genetic variability. These results supported by Shahzad *et al.* (2002).

Plant height (cm)

Data relating to plant height are reported in Table 5. Perusal of the data explained that sowing date and varieties was significantly influenced plant height. The effect of brassionolide was not significant on plant height. The interaction of sowing date and varieties was significant for plant height, whereas all the remaining interactions were not significant. Higher plants (90 cm) were measured for sowing on 20th November, while lower height (78 cm) of the plant was measured for sowing on 20th December. AUP-4008 variety produced the taller plants (83 cm) while smaller plants (80 cm) were measured for Janbaz. These results supported by those of Shahzad *et al.* (2002) who reported that plant height decreased with delaying in sowing because the plants gets minimum period for the growth and remained dwarf. The significant differences among the wheat varieties were found might be attributed to the genetic makeup of the varieties. These results are supported by those of Ahmad *et al.* (1997).

Table 4. Days to anthesis of wheat varieties as affected by sowing dates and brassinolide concentrations.

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L^{-1})				SD x V
		00	0.5	1.0	1.5	
20th Nov, 2009	Janbaz	134	133	135	135	134 a
	AUP-4008	134	134	134	134	134 a
30th Nov, 2009	Janbaz	123	122	125	125	124 b
	AUP-4008	122	119	124	123	122 b
10th Dec, 2009	Janbaz	117	120	114	114	116 c
	AUP-4008	115	111	112	113	113 d
20th Dec, 2009	Janbaz	103	101	105	104	103 e
	AUP-4008	103	102	104	103	103 e
		SD x B				
Nov 20th		134	133	135	135	134 a
Nov 30th		123	121	125	124	123 b
Dec 10th		116	116	113	113	114 c
Dec 20th		103	101	104	104	103 d
		V x B				
	Janbaz	119	119	120	119	119 a
	AUP-4008	119	116	119	118	118 b
Mean		119	118	119	119	

LSD value (P≤0.05) for interaction of (SXV) = 2.462.

Table 5. Plant height (cm) of wheat varieties as affected by sowing dates and brassinolide concentrations.

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L^{-1})				SD x V
		00	0.5	1.0	1.5	
20th Nov, 2009	Janbaz	88	89	87	88	88 a
	AUP-4008	91	94	90	88	91 a
30th Nov, 2009	Janbaz	83	82	84	81	82bc
	AUP-4008	84	83	84	82	83 b
10th Dec, 2009	Janbaz	78	77	81	83	79cd
	AUP-4008	78	78	78	79	78 d
20th Dec, 2009	Janbaz	75	78	79	81	78 d
	AUP-4008	76	78	79	77	78 d
	SD x B					
Nov 20th		89	92	89	88	90 a
Nov 30th		84	82	84	82	83 b
Dec 10th		78	77	80	81	79 c
Dec 20th		76	78	79	79	78 c
	V x B					
	Janbaz	81	81	83	83	82 a
	AUP-4008	82	83	83	82	83 b
Mean		82	82	83	82	

LSD value (P≤0.05) for sowing dates = 0.67.

Number of grains per spike

Data concerning number of grains per spike are given in **Table 8**. Data showed that the effect of sowing dates and varieties was significant on number of grains per spike. Brassinolide effect was not significant on number of grains per spike. All the interactions were found not significant except the interaction of sowing dates and varieties. Higher number of grains (43) was counted for sowing date of 20th November, whereas lower number of grains (39) was counted for sowing on 20th December. Higher number of grains (43) was produced by Janbaz variety, whereas lower numbers of grains (40) were recorded for AUP-4008. These results are agreements to those of Hossain *et al.* (1993). Difference among the varieties might be attributed to their genetic diversity. These results are similar with those of Haider (2004).

Grain weight per spike (g)

Data pertaining grains per spike are presented in Table 9. Perusal of the data of grain weight per spike exhibited that sowing dates and varieties had significantly (P≤0.05) influenced grain weight per spike while the effect of brassinolide was found not significant. Interaction between sowing date and varieties was significant for grains weight per spike while the other interactions were not significant. Heavier grain (1.78 g) per spike was recorded for sowing date of 20th November, whereas lighter grain (1.28 g) was produced when sowing was done on 20th December. Janbaz variety produced heaver grains (1.51 g), while lower grains weight (1.47 g) was recorded for AUP-4008. These statements are an agreement to those of Spink *et al.* (2000) who reported that late sown crops produced lighter grains per spike. Differences in grain weight per spike might be attributed among the varieties due to their genetic variability. These results are in line with those of Shahzad *et al.* (2002).

Table 6. Number of grains per spike of wheat varieties as affected by sowing dates and brassinolide concentrations.

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L^{-1})				SD x V
		00	0.5	1.0	1.5	
20th Nov, 2009	Janbaz	41	47	48	47	46 a
	AUP-4008	42	40	39	41	41bc
30th Nov, 2009	Janbaz	46	40	43	48	44ab
	AUP-4008	47	41	37	42	42abc
10th Dec, 2009	Janbaz	43	37	40	42	40 bc
	AUP-4008	41	41	41	41	41 bc
20th Dec, 2009	Janbaz	43	38	40	40	40 bc

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L⁻¹)				SD x V
		00	0.5	1.0	1.5	
	AUP-4008	38	38	39	36	38 c
		SD x B				
Nov 20th		42	44	44	44	43 a
Nov 30th		47	41	40	45	43 a
Dec 10th		42	39	40	42	41ab
Dec 20th		41	38	39	38	39 b
		V x B				
	Janbaz	43	41	43	45	43 a
	AUP-4008	42	40	39	40	40 b
Mean		43	40	41	42	

LSD value (P≤0.05) for sowing dates =2.831.

1000 grain weight (g)

Data on thousand grain weight as influenced by sowing dates, varieties and brassinolide is given in **Table 10.** Analysis of the data revealed that the influence of sowing dates and varieties was significant on thousand grains weight. The effect of brassinolide concentrations was not significant on 1000 grain weight. The interaction of sowing dates and varieties for 1000 grain weight was significant, while the rest of interactions were not significant. Heavier 1000 grains (39 g) were recorded when sowing was done on 20th November, while lighter 1000 grain weight (35 g) was noted for the sowing date of 20th December. Higher 1000 grain weight (38 g) was recorded for Janbaz, whereas lower 1000 grain weight (35 g) was noted for AUP-4008. These results are similar to those of Shahzad *et al.* (2002).

Grain yield (kg ha⁻¹)

Data regarding grain yield are reported in **Table 12.** Mean data exhibited that sowing dates and varieties significantly influenced grain yield. The effect of brassinolide concentrations was not significant on grain yield. All the interactions were not significant for grain yield. Higher grain yield (3510 kg ha⁻¹) was recorded for the sowing date of 20th November whereas lower grain yield (2840 kg ha⁻¹) was recorded for sowing date of 20th December. Janbaz variety produced higher grain yield (3226 kg ha⁻¹), while lower grain yield (3173 kg ha⁻¹) was produced by the AUP-4008 variety. Findings are in link with those of (Fisher and Maurer, 1976).

Table 7. Thousand grain weight (g) of wheat varieties as affected by sowing dates and brassinolide concentrations.

Sowing dates (SD)	Varieties (V)	Brassinolide (B) (mg L⁻¹)				SD x V
		00	0.5	1.0	1.5	
20th Nov, 2009	Janbaz	44	43	41	42	43 a
	AUP-4008	38	35	36	36	36 b
30th Nov, 2009	Janbaz	37	38	38	36	37b
	AUP-4008	36	37	37	36	37b
10th Dec, 2009	Janbaz	34	36	37	36	36 b
	AUP-4008	34	34	35	36	35bc
20th Dec, 2009	Janbaz	34	36	37	39	36b
	AUP-4008	33	32	33	34	33 c
		SD x B				
Nov 20th		41	39	38	39	39 a
Nov 30th		36	37	38	36	37 b
Dec 10th		34	35	36	36	35 c
Dec 20th		34	34	35	36	35 c
		V x B				
	Janbaz	37	38	38	38	38 a
	AUP-4008	35	34	35	36	35 b
Mean		36	36	37	37	

LSD value (P≤0.05) for sowing dates = 1.567.

Conclusion

It was concluded that 20th November may be called the best sowing date as it resulted in higher yield and yield related traits of wheat. Moreover wheat variety Janbaz produced higher 1000 grain weight and grain yield.

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