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Weed management in late-sown zero-till wheat (*Triticum aestivum*) with varying seed rate

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ABSTRACT

Excessive tillage and soil degradation are important factors limiting wheat [*Triticuam aestivum* (L.) emend. Fiori & Paol.) productivity, particularly in rice (*Oryza sativa* L.) – wheat cropping system. Therefore present field experiment was conducted during winter of 2007-08 and 2008-09 at Varanasi to study the effect of seed rate and weed management on weed growth and yield in late sown zero till wheat. Treatments comprised of three seed rates viz.,100,120 and 140 kg/ha in the main plots and five weed management treatments viz., weedy, 2,4-D Na salt 625 g/ha (POE), metsulfuron methyl 4 g/ha (POE) , sulfosulfuron 30 g/ha + metsulfuron methyl 2 g/ha (POE) and 2-hand weedings in sub-plots with three replications. Broad leaved weed population was found more in the experimental crop as compared to narrow leaved weeds. All the herbicidal treatments were effective in reducing weed density and dry weight in comparison to weedy check. Seed rate of 120 kg /ha recorded significantly higher grain yield in comparison to seed rate of 100 and 140 kg/ha. Amongst weed management treatments all the herbicidal weed control had significantly higher grain yield in comparison to weedy check. Sulfosulfuron 30 g/ha + metsulfuron methyl 2 g/ha had higher grain yield than alone application of 2, 4-D @ 625 g/ha and metsulfuron methyl 4 g/ha.

Key words: Seed rate, Weed management, Wheat, Zero-tillage

Wheat is most widely grown as winter cereal and is the backbone of food security in India. During last four decades, wheat production and productivity has increased almost 6-fold and it alone contributes about one-third of the total food grain production in India. In era of climate change and increasing biotic and abiotic stresses, maintaining yield up to required level is going to be formidable challenge in coming future. Excessive tillage and soil degradation are important factors limiting wheat productivity, particularly under rice wheat cropping system (Hobbs *et al*. 1997). Another important factor that reduces its productivity is severe weed infestation (Pandey *et al.* 2006).

Larson and Watson (2010) reported that more and more producers are growing wheat in no – tillage cropping systems because no till system has major ecological and economic benefits. The advancement of sowing by adopting zero-till can be useful mean to increase yield of late sown wheat. The sowing of wheat in India is generally delayed when sown after transplanted rice. Delay in sowing results in reduction of about 26.8 kg/ha/day in the grain yield of wheat (Tripathi *et al.,* 2005). Generally, wheat sowing gets delayed up to first week of January in certain areas of eastern Uttar Pradesh and western Bihar due to raising of long duration rice varieties and delayed transplanting in recent years. Farmers' in these areas can save time and sow wheat crop in December using zero-till seed drill.

For getting higher yield and net return maintenance of adequate plant density and fertile tillers are the most important agronomic factors. Late sowing of wheat tends to reduce germination count and number of tillers/ unit area because of sharp rise in temperature during tillering phase of the crop and ultimately decrease in yield (Soomro and Oad, 2002). To mitigate the deleterious effects of delayed sowing, increasing seed rate will be a viable and economic option to compensate the reduction in germination count and number of tillers/ unit area. Delayed sowing of wheat could be compensated by increasing seed rate, although number of grains/spike and 1000-grain weight was reduced (Shah *et al*., 2006).

Weed infestation is also a serious factor in rice – wheat cropping system. Besides the crop rotation (Anderson and Beck, 2007), tillage also influences the type of weed flora. Both grassy and broad leaved weeds infest wheat crop. Among grassy weeds *Phalaris minor* (L.) Retz. and among broad leaved weeds *Rumex dentatus* L. are of major concern in irrigated wheat under rice-wheat system in India (Balyan and Malik, 2000). Zero-till wheat in rice-

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wheat systems favours the infestation of *Rumex* spp. and *Malva parviflora* L., but reduces *Phalaris minor* (L.) Retz. infestation (Chhokar *et al*. 2007).The broad-leaf weeds in zero till system can, however, be controlled effectively with the application of 2,4-D, but leaf deformities in wheat is a major concern associated with its application. (Balyan *et al*., 1990). Metsulfuron methyl is very effective herbicide for controlling broad-leaved weed species (Saha and Rao, 2010).

Keeping in view the above facts, an investigation was planned to study the influence of weed management practices in late sown zero till wheat with varying seed rate in eastern Uttar Pradesh.

MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) of 2007-08 and 2008-09 at the Agricultural Research Farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The eastern Indo-Gangetic soil was sandy clay loam in texture having pH 7.4 and moderately fertile, organic carbon 0.32% and available N, P_2O_5, K_2O was 174, 22.71 and 201 kg/ha, respectively. The treatment comprised of three seed rates (100, 120 and 140 kg/ha) in main plots and five weed control treatments, *viz.* weedy , 2,4-D 625 g/ha, metsulfuron methyl 4 g/ha, sulfosulfuron 30 g/ha+ metsulfuron methyl 2 g/ha and 2-hand weeding (30 and 60 DAS) in subplots. The experiment was laid out in split plot design with three replications. A promising wheat cultivar HUW 234 recommended for normal as well as late conditions in eastern Uttar Pradesh was sown with the help of zero-till seed cum ferti-drill on 17 and 19 December during 2007 and 2008, respectively. A uniform fertilizer dose of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha was applied in the form of urea, single super phosphate and muriate of potash in all the plots. One-third nitrogen and full dose of phosphorus and potassium was applied as basal and remaining two-thirds was applied in two equal splits at crown root initiation and panicle initiation stages.

Existing weed species were destroyed by application of glyphosate at 2 kg/ha (3 days before sowing). Herbicides were applied as post-emergence i.e. 32 DAS with the help of hand- operated knapsack sprayer, fitted with flat fan nozzle with water as a carrier at 600 litres/ha .Weed density and weed dry weight data were recorded at 60 days stage of crop growth .Weed count was recoded randomly from two places in each plot using $0.25m^2$ quadrate. Weeds were cut at ground level, washed with tap water, sun dried and thereafter oven dried at 75^0C for 48 hr and then weighed. Weed control index was calculated at maximum weed growth stage using weed dry weight recorded at 60 days after sowing. Grain yield and its attributes were also recorded during the course of investigation. The data recorded on weeds were subjected to square root transformation $(\ddot{o}+0.5)^{1/2}$. The curve estimation of seed rate and grain yield data was done with the statistical software SPSS.

RESULTS AND DISCUSSION

Effect on weed

Important weed flora infesting the crop fields were *Chenopodium album* L. (26.79%), *Phalaris minor* (L.) Retz (19.17%), *Rumex dentatus* L. (13.79%) *Avena ludoviciana* L. (8.79%), *Melilotus alba* L. (6.39%), *Melilotus indica* L. (4.79%), *Anagallis arvensis* L. (4.15%), *Solanum nigrum* L. (4.15%), *Cynodon dactylon* L. (3.36%) *Lauenea splenifolia* L. (1.60%) *and Vicia sativa* L. (1.60%), other weed species consisted of 5.43%. Relative composition of narrow and broad leaved weed in weedy check recorded at 30 days stage of crop growth revealed that average weed population of broad leaved species was more in comparison to narrow leaved weed species in both the years. Relatively more number of broad leaved weeds under zero till system has been also reported by Chhokar *et al.,* (2007). Seed rate caused significant variations in weed density in first year and weed dry weight in second year. Seed rate of 120 kg/ha significantly reduced weed population and dry weight in comparison to 100 kg/ha and it was at par with 140 kg/ha (Table 1). Among the varying seed rates, seed rate of 120kg/ha had the maximum weed control index followed by 100 and 140 kg/ha in both years (Table 3).

All the weed control treatments registered significantly lower number of weeds and weed dry matter than weedy at 60 days stage. (Table 1) Further inspection of the data revealed that there was significant reduction in both narrow and broad leaved population due to all the weed control treatments. Combined application of metsulfuron methyl 2 g/ha and sulfosulfuron 30 g/ha and alone application of metsulfuron methyl 4g/ha significantly reduced weed population and weed dry weight as compared to weedy. Hand-weeding twice was found superior to other weed control treatments with 100% control of weeds. The results also revealed that among the herbicides, 2, 4-D 625 g/ha application had highest weed control index followed by metsulfuron methyl 2 g/ha + sulfosulfuron 30 g/ha and alone application of metsulfuron methyl 4g/ha in first year, whereas in second year, metsulfuron methyl 2 g/ha + sulfosulfuron 30 g/ha had the highest weed control index followed by metsulfuron methyl 4 g/ha and 2, 4-D (Table 3).

Yield and yield attributes

Crop growth attributes data (Table 2) revealed that plant height and dry matter accumulation g/m row in 120 kg/ha

Table 1. Effect of seed rate and weed management on weed density and weed dry weight in late-sown zero-till wheat

Treatment	Weed density (No./m^2)						Weed dry weight (g/m^2)	
	60 DAS (2007-08)			60 DAS (2008-09)			60 DAS	
	BLW	NLW	Total	BLW	NLW	Total	2007-08	2008-09
Seed rate (kg/ ha)								
100	3.6	2.6	4.44	5.6	3.4	6.4	5.1	5.8
	(16.2)	(8.1)	(24.23)	(46.02)	(16.42)	(61.04)	(37.03)	(41.52)
120	3.8	2.7	4.68	5.5	3.2	6.2	4.9	5.5
	(17.9)	(8.9)	(26.80)	(43.54)	(15.27)	(58.28)	(35.65)	(39.07)
140	4.3	3.1	5.29	5.7	3.4	6.6	5.2	5.9
	(22.7)	(11.3)	(34.00)	(47.28)	(17.50)	(64.78)	(38.32)	(42.87)
SEm ±	0.07	0.11	0.01	0.23	0.20	0.34	0.64	0.11
CD(P=0.05)	0.31	0.47	0.037	NS	NS	NS	NS	.41
Weed control								
Weedy	6.4	4.6	7.93	9.4	6.6	11.4	7.1	9.1
	(41.7)	(20.9)	(62.60)	(87.54)	(43.39)	(128.7)	(50.63)	(82.37)
2,4-D Na salt (625 g/ha)	4.7	3.3	5.85	6.0	3.6	6.9	5.5	6.6
	(22.6)	(11.3)	(33.93)	(36.13)	(13.32)	(48.4)	(29.84)	(41.07)
Metsulfuron methyl (4 g/ha)	4.0	2.8	4.97	5.8	2.9	6.5	5.8	6.4
	(16.4)	(8.2)	(24.60)	(33.91)	(8.13)	(42.04)	(33.42)	(39.07)
Sulfosulfuron (30 g/ha) +	3.7	2.6	4.56	5.9	2.9	6.6	5.8	5.8
Metsulfuron methyl (2 g/ha)	(13.7)	(6.9)	(20.60)	(35.69)	(8.13)	(43.83)	(33.30)	(33.23)
Two hand weeding (30	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
and 60 DAS)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SEm ±	0.07	0.16	0.09	0.22	0.23	0.24	0.07	0.11
CD (P=0.05)	0.22	0.47	0.27	0.66	0.69	0.74	0.23	0.33

DAS, Days after sowing; BLW: Broad leaved weeds; NLW- Narrow leaved weeds, Figures in parentheses indicate original values

seed rate was highest and significantly different from seed rate of 100 and 140 kg/ha in both the years, however, both these later treatments were statistically at par with each other. Among the weed control, 2-hand weeding and weedy recorded the highest and lowest plant height and dry matter, respectively, in comparison to herbicidal treatment in both the years, except in 2007-08, where non-significant variations in these characters were observed due to weed control treatments. Metsulfuron methyl 4g/ha alone and combination of sulfosulfuron 30 g/ha and metsulfuron methyl 2g/ha had significantly more plant dry matter than 2,4-D 625g/ha which had the lowest dry matter amongst herbicidal treatments.

Seed rate of 120 kg/ha had better performance of yield attributes *viz.,* number of ear head/m^2 and test weight and grain yield when compared to 100 and 140 kg/ha (Table 2). The yield attributing characters viz., number of ear head/m^2 and test weight were significantly more in 120 kg/ha than seed rate of 140 kg/ha. Grain and straw yields as affected by seed rates revealed that seed rate of 120 kg/ha had significantly higher grain and straw yields when compared with 140 kg/ha and it was at par with 100 kg/ha. The better performance of yield and yield attributing characters was also reflected in the performance of harvest index, where seed rate of 120 kg/ha recorded the highest harvest index and it was significantly superior than 140 kg/ha and statistically similar to 100 kg/ha in both the years. The poor performance of yield attributing characters in higher seed rates may be due to more intra specific competition and delayed showing. Shah *et al.* (2006) also reported reduction in grains/spike and 1,000 grains weight under delayed sowing.

All the weed control treatments significantly out performed the weedy in respect of yield attributes *viz.,* earhead/m^2, test weight and yield. An increase of 86.47 and 80.04% in seed yield with 2-hand weeding over the weedy check was observed mainly owing to manual removal of associated weed flora and keeping the plots weed free in first and second year, respectively. Metsulfuron methyl 2 g/ha in combination with sulfosulfuron 30 g/ha recorded better performance of yield attributes in comparison to 2, 4-D 625 g/ha alone with respect to yield attributing characters *viz.,* number of ear head/m^2 in first year, ear head length, number of grains/ear head and test weight, and grain yield in both the years. Chhokar and Malik (2002) reported that metsulfuron methyl controls mostly broad leaved weed species, whereas sulfosulfuron controls grasses and some broad leaved species. In the present investigation, application of metsulfuron methyl and sulfosulfuron provided broad

Table 2. Effect of seed rate and weed control measures on yield attributes, yield, harvest index and weed control efficiency in late-sown zero-till wheat.

Treatment	Harvest Index (%) 2007-08	Harvest Index (%) 2008-09	Plant height at 60 DAS (cm) 2007-08	Plant height at 60 DAS (cm) 2008-09	Plant dry matter at 60 DAS (g/m row) 2007-08	Plant dry matter at 60 DAS (g/m row) 2008-09	No. of ear head/ m^2 2007-08	No. of ear head/ m^2 2008-09	Ear head length (cm) 2007-08	Ear head length (cm) 2008-09	No. of grains /ear head 2007-08	No. of grains /ear head 2008-09	Test weight (g) 2007-08	Test weight (g) 2008-09	Grain yield (t/ha) 2007-08	Grain yield (t/ha) 2008-09	Grain yield (t/ha) Pooled analysis	Straw yield (t/ha) 2007-08	Straw yield (t/ha) 2008-09
Seed rate (kg/ha)																			
100	45.2	46.1	63.2	62.7	64.9	61.9	322.6	317.8	8.1	7.9	40.1	39.3	40.0	39.4	4.17	4.11	4.15	4.86	4.85
120	47.8	46.8	66.4	64.4	64.6	63.3	338.4	337.4	8.1	8.0	41.2	39.8	41.4	39.8	4.49	4.25	4.37	5.07	4.83
140	40.0	42.4	61.9	61.7	66.2	64.9	312.4	318.7	8.0	7.9	40.0	40.5	39.6	38.2	3.84	3.75	3.80	5.75	5.08
SEm ±	0.97	0.61	0.67	0.42	0.37	0.44	4.92	4.10	0.01	0.07	0.21	0.34	0.34	0.14	0.11	0.12	0.10	0.10	0.08
CD(P=0.05)	3.81	2.40	2.66	1.66	1.48	1.75	19.3	16.11	0.06	NS	0.83	NS	1.37	0.58	0.46	0.32	0.39	0.39	0.31
Weed control																			
Weedy	42.4	46.2	63.3	60.1	53.2	51.4	304.2	284.7	5.4	4.8	33.6	32.5	36.5	35.2	3.77	3.56	3.67	4.55	4.21
2,4-D Na salt (625 g/ha)	43.5	44.5	63.6	63.8	62.9	61.7	309.2	329.8	8.0	8.0	36.2	35.4	38.9	37.4	4.22	4.03	4.13	5.25	5.02
Metsulfuron methyl (4 g/ha)	47.9	44.9	63.9	63.6	65.7	64.2	333.0	332.2	8.5	8.4	40.8	40.0	40.2	40.2	4.23	4.05	4.14	5.33	4.98
Sulfosulfuron (30 g/ha) + Metsulfuron methyl (2 g/ha)	42.9	44.6	64.1	63.2	68.3	65.7	333.5	337.8	9.1	9.1	43.9	43.3	42.8	40.7	4.27	4.08	4.18	5.41	5.08
Two hand weeding (30 and 60 DAS)	44.9	45.6	64.3	63.7	75.1	73.8	342.5	338.8	9.3	9.5	47.5	48.0	43.1	42.2	4.36	4.45	4.41	5.59	5.31
SEm ±	1.45	1.21	.52	.56	.61	.65	6.94	7.24	0.02	0.08	0.33	0.49	0.49	0.27	0.08	0.08	0.11	0.20	0.19
CD(P=0.05)	NS	NS	NS	1.69	1.82	1.94	20.7	21.6	0.07	0.25	0.99	1.48	1.48	0.81	0.36	0.26	0.30	0.62	0.59

spectrum weed control. Therefore, after two hand weeding, minimum weed density and dry weight, and maximum grain yield was observed in this treatment. Similar findings have been also reported by Chhokar *et al.* (2007). Relative composition of weed species showed that number of broad leaved population was more when compared with narrow leaf weed species; therefore, all the herbicidal weed control was effective in weed control and enhanced yield attributing character and yield.

Nitrogen use efficiency

Nitrogen use efficiency of crop (Table 3) due to seed rates revealed that, the treatment having the highest grain yield resulted in better nitrogen use efficiency. Seed rate of 120 kg/ha had the highest N–use efficiency when compared with 100 and 140 kg/ha. Similar trend was also observed in weed control treatment. Treatments showing the highest grain yield *viz.,* metsulfuron methyl 2 g/ha + sulfosulfuron 30 g/ha had better N-use efficiency when compared with maximum weed competition plots *i.e.* weedy. Minimum nitrogen (N) depletion was observed in metsulfuron-methyl 2 g/ha + sulfosulfuron 30 g/ha which had better weed control index when compared with rest of the herbicidal treatment.

Curve fitting and correlation studies

Quadratic relationship between seed rate and

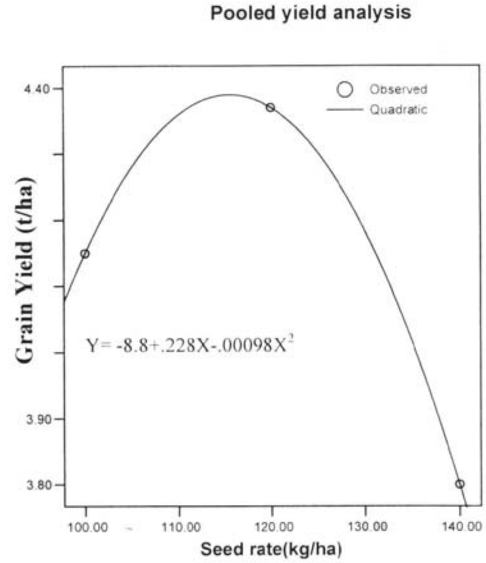

Fig. 1. Quadratic relationship between seed rate and grain yield.

Table 3. Effect of seed rate and weed control on, weed control efficiency, nitrogen use efficiency, and uptake by grain and depletion by weeds, net returns and B : C ratio in late sown zero till wheat.

Treatment	Weed control index		N-use efficiency (kg grain/kg N applied)		N uptake by grain (kg/ha)		N depletion by weeds (kg/ha)		Net returns (₹/ha)		B:C ratio	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Seed rate (kg/ha)												
100	39.9	39.9	34.7	34.3	71.3	69.1	7.1	7.8	42,257	40,733	3.8	3.7
120	49.5	44.0	37.4	35.4	74.6	71.4	6.7	7.2	45,501	42,228	3.9	3.8
140	34.7	39.4	32.0	31.2	65.5	63.0	7.2	8.4	38,815	35,598	3.5	3.3
SEm ±					1.4	1.39	0.24	0.22				
CD (P=0.05)					5.72	5.46	NS	0.9				
Weed control												
Weedy	0	0	31.4	29.7	61.5	59.9	9.6	15.6	39,636	35,132	3.8	3.63
2,4-D Na salt 625 g/ ha	40.3	43.5	35.1	33.5	68.9	67.8	5.6	7.8	44,359	41,076	4.1	3.96
Metsulfuron methyl 4 g/ ha	33.0	49.4	35.2	33.8	69.6	68.1	6.3	7.4	43,096	41,150	3.9	3.92
Sulfosulfuron 30 g/ ha+ Metsulfuron methyl 2 g /ha	33.0	59.2	35.5	34.0	75.0	68.6	6.3	6.3	44,448	40,795	3.9	3.75
Two hand weedings (30 & 60 DAS)	100	100	36.3	37.4	77.2	74.9	0.0	0.0	38,664	39,445	2.7	2.86
SEm ±					1.67	1.48	0.25	0.24				
CD (P=0.05)					4.99	4.43	0.81	0.74				

grain yield was observed during course of investigation (Fig.1). It can be concluded from the Fig. 1 that the grain yield was maximum between seed rate of 110 and 120 kg/ha, after that there is sharp decline in grain yield. The correlation studies($r = 0.65$ in 2007-08 and $r=0.92$ in 2008-09) performed between weed control index and grain yield showed that it was highly correlated in second year whereas poorly correlated in first year.

Economics

The highest net return and benefit cost ratio (Table 3) was observed in seed rate of 120 kg/ha followed by 100 and 140 kg/ha. Amongst the weed control treatment, though hand weeding recorded the highest grain yield it proved to be costly because of cost incurred in hiring manual labour, however, herbicidal weed control had more net return and benefit cost ratio in comparison to weedy. Application of 2, 4-D 625 g/ha resulted in more B: C ratio because of lesser price of 2, 4-D when compared with metsulfuron methyl 4g/ha alone and combination of metsulfuron methyl 2 g/ha and sulfosulfuron 30 g/ha.

It is concluded that for high productivity of wheat use 120 kg seed/ha and control weed through application of sulfosulfuron @ 30 g/ha and metsulfuron 2 g/ha.

REFERENCES

Anderson, R.L. and Beck, D.L. 2007. Characterizing in central South Dakota. *Weed Technology* **21**: 76–79.

Balyan, R.S., and Malik, R.K. 2000. New herbicides for Jungali Palak (*Rumex retroflexus* L.). *Indian Journal of Weed Science* **32**(1 and 2): 86–88.

Balyan, R.S., Malik, R.K. and Bhan, V.M. 1990. Sensitivity of wheat cultivars to fluroxypyr and 2, 4-D combination. *Indian Journal of Agronomy* **35**: 408–409.

Chhokar, R.S. and Malik. R.K. 2002. Isoproturon resistant *Phalaris minor* and its response to alternate herbicides. *Weed Technology* **16**:116–123.

Chhokar, R.S., Sharma, R.K., Jat, G.R., Pundir, A.K. and Gathala, M.K. 2007. Effect of tillage and herbicides on weeds and productivity of wheat under rice-wheat growing systems. *Crop Protection* **26**: 1689–1696.

Hobbs, D.R., Giri, G.S. and Grace, P. 1997.Reduced and zero tillage option for the establishment of wheat after rice in South Asia. RCW paper No.**2** Mexico, D.F.: Rice-wheat consortium for the Indo-Gangetic plains and C1MMYT.

Larson, E. and Watson, R. 2010. Planting methods and seeding rates for small grain crops. Publication 2401 Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. From *ttp://msucares.com/pubs/publications/p2401.pdf.*

Pandey, A.K, Gopinath, K.A. and Gupta, H.S. 2006.Evaluation of sulfosulfuron and metribuzin for weed control in irrigated wheat. *Indian Journal of Agronomy* **51**:135–138.

Saha, Sanjoy and Rao, K.S. 2010. Efficacy of metsulfuron methyl for controlling broad leaved weeds in transplanted rice (*Oryza sativa)* under rainfed shallow lowland. *The Indian Journal of Agricultural Sciences* **80**(6): 522–526

Shah, W.A, Bakht. J., Ullah, T., Khan, A.W., Zubair, M and Khakwani, A.A. 2006. Effect of sowing dates on the yield and yield components of different wheat varieties. *Journal of Agronomy* **5**(1): 106–110.

Soomro, A. and Oad, F.C. 2002. Yield potentials of wheat genotypes under different planting times. *Journal of Applied Sciences* **2**(7): 713–714.

Tripathi, S., Mongia, C., Sharma, A.D., Kharub, R.K. and Chhokar, R.S. 2005. Wheat productivity at different sowing time in various agro-climatic zones of India. South Asian Association for Regional Cooperation (SAARC). *Journal of Agriculture* **3:** 191–201.