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HERBICIDES, THEIR APPLICATION TIMINGS AND DIFFERENT SOIL TEMPERATURE REGIMES AFFECT WEED INFESTATION IN WHEAT

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ABSTRACT

Soil temperature, herbicides and their application timings were studied to determine their effect on weed infestation in wheat during 2012-13. A randomized complete block design (RCBD) with split plot arrangement was used to layout the experiment where herbicide application timings viz; T_1: 30 days after sowing (DAS) and 40 DAS (T_2) were randomized in main plot whereas weedy check (W_0), weed free (W_1), Affinity 50 WP (carfentrazone + isoproturan) (W_2) and Axial 0.50 EC (pinoxaden) + Buctril Super 60 EC (bromoxynil + MCPA) (W_3) were kept in sub-plots, respectively. Results showed that herbicides reduced weed density and its dry weight considerably in contrast to weedy check. Moreover, Axial 0.50 EC (pinoxaden) + Buctril Super 60 EC (bromoxynil + MCPA) was found most effective regarding weed control. Overall, chemical weed control led to substantial reduction in weed infestation in wheat. However, yield and yield related attributes like fertile tillers m^{-2}, spikelets per spike, grains per spike, 1000-grain weight, grain yield and harvest index were improved so far in weed control treatments as compared to weedy check whereas soil temperature pertaining to weed emergence rate was recorded as: 6-8 ºC > 8-10 ºC > 10-12ºC.

Key words: Herbicide, soil temperature, wheat, weeds, yield.

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INTRODUCTION

Weed infestation is the most important one amongst all the factors responsible for curtailing wheat yield in Pakistan (Riaz *et al.*, 2009; Khaliq *et al.,* 2011), resulted 48-52% loss in wheat yield. (Khan

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and Haq, 2002). Numerous weed species infesting wheat fields in Pakistan belongs to 28 different families approximately (Anjum and Bajwa, 2010). Global agricultural profitability is affected by weeds and it is the most important pest complex to the well-being of mankind with a major impact on ecosystem (Ashraf *et al.,* 2014). *Phalaris minor* and *Avena fatua* are considered noxious weeds of wheat that resuled 30% yield reduction in it (Hobbs *et al.,* 1998). Hassan *et al.* (2008) reported that high densities of *A. fatua* have adverse effect on wheat production and caused 20-30% yield reduction.

Weeds compete with crop plants for space, light, nutrients and moisture which may results in yield loss. (Gupta, 2004; Ashraf *et al.,* 2014). Crop yield losses associated with combined effect of insects and diseases are comparatively less than those resulting from the weeds (Young *et al.,* 1996). Besides reduction of wheat yield, quality deterioration of final produce is also crucial. Hence, weed control in wheat is prerequisite in order to increase its productivity. Weeds in wheat are usually controlled by physical, mechanical and chemical methods. Physical and mechanical methods are laborious, time consuming and costly. Consequently chemical method rests as the only option but the use of pesticides is being limited in many countries because they are harmful to users, contaminate the soil, water and foods and induced alterations in flora and fauna of the soil. However, for achieving the goal of self-sufficiency in wheat during the previous decades, use of herbicides has proved a valuable mean. In order to improve the efficacy of herbicide, the concept of critical period of weed control (CPWC) can be employed. This period refers to a fragment of growing spell in which weeds must be removed in order to avoid crop loss due to weed competition (Zimdahl, 1988; Hall *et al.,* 1992).

The critical period indicates the suitable timing of weed control and it also helps in understanding the impact of weed population on crop. Several factors such as time of weed emergence (Wilson and Westra, 1991; Mclachlan *et al.,* 1993a;), weed species composition (Swinton *et al.,* 1994), soil moisture and soil temperature (Mclachlan *et al.,* 1993b) affect the duration of the critical periods of weed control. Moreover, the timing of herbicide application, the dose used and weed growth stage are strongly related to herbicides efficacy and sensitivity of individual weed species to the active ingredient of an herbicide. Too early or late application may result in stunted crop growth and yield reduction. Advancement in weeds growth stage is related with the sensitivity of an individual species to the applied herbicides (Barros *et al.,* 2007; Faccini and Puwheatlli, 2007). Hence, on the basis of above discussion, the present research was planned to look into species composition of weeds, determine the efficacy of applied herbicides over manual weed control and to standardize the appropriate time for herbicide application in wheat.

MATERIALS AND METHODS

The planned study was conducted at the Agronomic Research Area, Department of Agronomy, University of Agriculture Faisalabad (31.25°N latitude, 73.09°E longitude, altitude 184 m), during 2012-13. Treatments were arranged in randomized complete block design (RCBD) with split plot arrangement in triplicate. Herbicide application timings *viz;* T_1: 30 days after sowing (DAS) and T_2: 40 DAS were randomized in main plots while herbicide treatments W_0: weedy check; W_1: weed free; W_2: Affinity 50 WP (isoproutran+ carfentrazone) at 1000 g a.i ha^{-1}; W_3: Buctril Super 60 EC (bromoxynil +MCPA) at 445 g a.i ha^{-1} + Axial 0.50 EC (pinoxaden) at 37 g a.i. ha^{-1} were assigned to sub-plots.

Seedbed was prepared by cultivating the soil with a disk plow and then cultivating two times with a tractor-mounted cultivator followed by planking. Wheat (cv Millet-2011) was sown with seed rate of 120 kg ha^{-1} in 22.5 cm spaced crop rows at a depth of 3-4 cm. NPK were applied at 150, 100 and 70 kg ha^{-1}. Whole of the phosphorus and one third of the N were applied as a starter basal dose while remaining N was equally applied at tillering and booting stage. The first irrigation was applied 14 days after crop emergence, and subsequent irrigations were applied at tillering, jointing, booting, anthesis, and grain filling period. No serious incidence of insect or disease was observed, hence no pesticide or fungicide was applied. Crop was harvested manually with sickle at physiological maturity on 20 April. The harvested total produce (in net plots) of the crop was threshed, the seeds were cleaned , grian yield was recorded and expressed in tons per hectare (t ha^{-1}).

Three different temperature regimes were established to see the response of different weed seeds for germination at varying soil temperature. Soil temperature of experimental site was recorded daily using ordinary ethanol thermometer at three different places from two depths 3 cm and 6 cm respectively up to 30 DAS. Emergence % of weeds was recorded from a marked area of 1 m × 1 m plot in each treatment and then average was calculated. All herbicides were applied using flat-fan type nozzle fitted to a manual knap sack sprayer. Affinity 50 WP (isoproutran+ carfentrazone) and Buctril Super 60 EC (bromoxynil + MCPA) + Axial 0.50 EC (pinoxaden) were applied alone and tank mixture, respectively as post emergence (30 DAS) and later on 40 DAS. Data pertaining to weed density were obtained at 60 and 90 DAS from randomly placed quadrates (1 m^2) from each plot. Weeds were clipped off above the soil surface placed in an oven at 70°C till constant weight after sun drying.

Statistical analysis

The data regarding weed density, dry biomass and crop yield was statistically analyzed by Statistix version 8 (Analytical, Tallahassee, Florida, USA). Differences among treatment means were measured by using Tuckey's HSD test at 0.05 probability level.

RESULTS AND DISCUSSION

Weed flora of the experimental site

Experimental site was comprised of following weeds: *Anagallis arvensis* L. (Primulaceae), *Avena fatua* L. (Poaceae),*Chenopodium album* L. (Chenopodiaceae),*Convolvulus arvensis* L. (Convolvulaceae), *Rumex dentatus* L. (Polygonaceae), Phalaris *minor* (Retz.) (Poaceae) and *Coronopus didymus* L. (Sm.) (Brassicaceae). These weeds were found dominant all over the growing season.

Soil temperature and weed emergence

Soil temperature greatly affected weed emergence rate in wheat. *C. album* showed maximum emergence 83% at 6-8 °C temperature followed by *Phalaris minor* (50%), *A. fatua* (50%), *R. dentatus* (47%), *C. didymus* (41%), *C. arvensis* (38%) and *A. arvensis* (36%). While at 8-10 °C emergence % age of all the weeds decreased as compared to 6-8 °C (Fig. 1). The environmental conditions and micro-climate of experimental site was favorable to various kinds of weed growth and development. The alteration in weed pressure encounter in terms of density and dry matter of weeds and also in relative proportion of different kind of weeds might be due to different rates of canopy closure and, partially due to intrinsic weed flora of the experimental site. Soil macro and micro-climate affects not only crop but also weed emergence as reported by (Vleeshouwers, 1997) while modelling the soil temperature effect on weed emergence that 10–25 ºC temperature range did not affect weed emergence. They further reported that weed emergence rate was increased with increasing soil temperature. Summer weeds do not readily germinate during cool weather conditions.

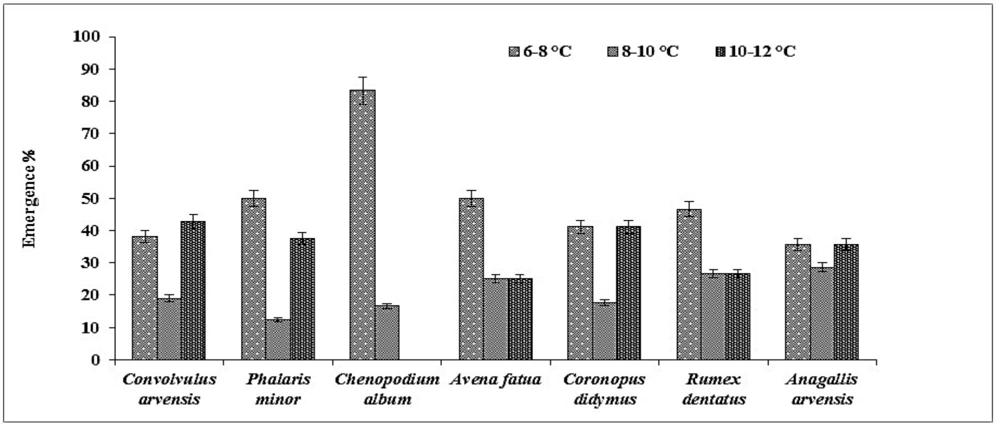

Figure 1. Emergence percentage of weed flora in wheat at different soil temperature regimes

Weeds density and dry weight

Anagallis arvensis

Data regarding *A. arvensis* density and dry biomass (Table-1 & 2) revealed that it was significantly affected by various herbicide treatments whereas timing of herbicides application was found non-significant. Among various herbicide treatments, higher weed population at 60 and 90 DAS was observed in weedy check, followed by carfentrazone + isoproturan and mixture of pinoxaden + bromoxynill + MCPA and caused 79-80% and 86-88% reduction in weed density, respectively. Moreover, highest weed dry biomass at 60 and 90 DAS was observed in weedy check, followed by carfentrazone + isoproturan and mixture of bromoxynil + MCPA and pinoxaden and reduced up to 77-81% and 84-85% weed dry biomass, respectively.

Avena fatua

Avena fatua density and dry weight considerably affected by different herbicide treatments (Table 1 & 2). Higher weed population at 60 and 90 DAS was recorded in weedy check, persuaded by carfentrazone + isoproturan and mixture of bromoxynil + MCPA and pinoxaden and reduced weed density about 79-80% and 85-86%, respectively whereas an interactive effect of herbicide application timings with various herbicides was found non-significant. Moreover, dry biomass of *A. fatua* noticeably reduced by various herbicide treatments. Same trend was observed regarding dry weight of *A. fatua* and resulted in 76-81% and 83-86% reduction in W_2 and W_3, respectively when compared with control.

Chenopodium album

Tank mixtures of various herbicides reduced density of *Chenopodium album* remarkably. Highest population of *Chenopodium* *album* at 60 and 90 DAS was observed in weedy check plots, pursued by carfentrazone + isoproturan and pinoxaden + bromoxynill + MCPA whereas carfentrazone + isoproturan and mixture of bromoxynil + MCPA and pinoxaden caused 72-85% and 85-90% reduction in weed density, respectively. Moreover, a significant effect of herbicides on *C. album* dry biomass was recorded while herbicide application timing was found non-significant in this case. Similar trend was observed regarding weed dry biomass having up to 82% and 87% reduced dry weight of *Chenopodium album* while herbicide application timing and its interaction with herbicides treatments was found non-significant.

Convolvulus arvensis

Density and dry weight of *Convolvulus arvensis* reduced drastically when mixtures of herbicides were sprayed. Weedy check was loaded with the population of *C. arvensis* therefore provided the maximum dry weight of it but mixture of herbicides significantly ($p \leq 0.05$) inhibited the growth of *Convolvulus arvensis* where sprayed. Combination of bromoxynil + MCPA and pinoxaden proved most efficient mixture regarding weed control followed by carfentrazone + isoproturan and recorded 86-87% and 79-80% reduction in weed density and 79-81% and 82-85% in weed dry biomass, correspondingly. Furthermore, interaction between herbicide application timings and different herbicides treatments was found non-significant.

Coronopus didymus

Table-1 and 2 indicated that *C. didymus* density and dry weight was reduced significantly ($p \leq 0.05$) by herbicide application. Paramount weed population and increased dry weight was recorded in weedy check at 60 and 90 DAS followed by carfentrazone + isoproturan and mixture of bromoxynil + MCPA and pinoxaden while a non-significant interaction was observed between various herbicide treatments and herbicide application timing. Furthermore, carfentrazone + isoproturan and mixture of pinoxaden + bromoxynil + MCPA caused up to 79-83% and 85-87% reduction in weed dry biomass, respectively at both intervals after sowing of wheat.

Phalaris minor

Results so far indicated that *P. minor* infestation and dry mass was recorded maximum in weedy check after 60 and 90 DAS while minimum was observed where bromoxynil + MCPA and pinoxadenwas applied followed by Carfentrazone + isoproturan which reduced the density and dry weight of *P. minor* up to 78-83%, 87-90%, 79-80% and 84-85%, respectively. Furthermore a non-significant interaction between herbicides and their application timings was recorded.

Rumex dentatus

Population and dry weight of *R. dentatus* affected significantly ($p \leq 0.05$) by various herbicide treatments (Table 1& 2). Weedy check resulted in highest weed density and dry weight at 60 and 90 DAS. 87% reduction in the density of *R. dentatus* was recorded where Carfentrazone + isoproturan was sprayed whereas mixture of bromoxynil + MCPA and pinoxaden reduced up to 78-81% as for dry biomass of *R. dentatus*is concerned, separate application of both mixtures reduced dry weight of *R. dentatus* about 76-77% and 82-83%, respectively. No significant difference was observed in interaction of herbicides and their application timings.

Chemical weed control is an easy, quick and economical strategy of weed control and reduced the weed density and biomass significantly over unweeded check (Rao and Ratnam 2010; Ehsanullah *et al.,* 2014). We have found an effective weed control where mixtures of herbicides were applied. Mixture of bromoxynil + MCPA and pinoxaden provided maximum reduction in weed types, weed numbers and dry weight persuaded by isoproturon + carfentrazone. Post emergence herbicides in mixtures was found effective regarding weed suppression as reported by (Rahman *et al.,* 2012). Carfentrazone + isoproturan significantly reduced the weed fresh and dry weight and keep the weed density lowered as compared to control (Khalil *et al.*, 2013). Reduced weed infestation and dry weight was also reported by Siddiqui *et al.* (2010) who stated that *C. album* caused up to 23% reduction in weed density and Hussain *et al.* (2013) who concluded that sole application of bromoxynill + MCPA and its mixture with coldinafop-propargyl resulted up to 90% weeds mortality. No doubt, herbicide application timing is a crucial factor regarding efficacy, ease of application and their phyto-toxic effect but in our findings application timings were found non-significant in most of the treatments but in some (*Convolvulus arvensis* L., *Rumex dentatus* L.) weeds, when their dry weight were recorded, application timings were found significant. Auskalnis and Kadzys (2006) observed that higher weed control efficacy on weed biomass was achieved when herbicide was applied at 3-leaf stage and at tillering stage and biomass reduced up to 84-96% in both years.

Wheat growth and yield response

Different herbicide treatments altered the wheat growth and development and other yield contributing factors. Fertile tillers m^{-2}, spikelets per spike, grains per spike, 1000-grain weight significantly ($p \leq 0.05$) by various herbicide treatments whereas herbicide application timings were found non-significant in this regard except grain yield (Table-1).

All growth and yield contributing traits were found highest where weeds were controlled manually followed by chemical weed control (Table-3). Mixture of bromoxynil + MCPA and pinoxaden was found at par with all other treatments where weeds were controlled manually except fertile tillers m^{-2}. Moreover, isoproturon + carfentrazonewere also found effective regarding weed control and ultimately contributed in better wheat phenology. Overall, poor performance regarding growth and yield of wheat was observed in weedy check where weeds were allowed to grow freely. Minimum fertile tillers m^{-2} (298.7), spikelets per spike (12.6), grains per spike (37.4) and 1000-grain weight (41.9 g) were recorded in weedy check. However, herbicide application timings and their interaction with various combinations of herbicides used were found non-significant ($p \leq 0.05$). A complete cleanup of weeds in W_0 resulted in grain yield of 4.1 t ha^{-1} but found statistically similar ($p \leq 0.05$) where mixture of bromoxynill + MCPA and pinoxaden was applied followed by isoproturon + carfentrazone. Moreover, lowest grain yield (3.3 t ha^{-1}) was recorded in weedy check. Further perusal of data revealed that herbicide application timings also affected wheat grain yield appreciably while highest grain yield was recorded where herbicides were applied 30 DAS (T_1) followed by T_2.

On the other hand, maximum harvest index (29.6 %) was recorded in manual weed control treatment and found statistically similar with W_2 and W_3 whereas minimum (25.1%) harvest index was recorded in weedy check. Furthermore, herbicide application timings were found non-significant while an interactive effect of both factors was also found non-significant regarding grain yield and harvest index. Manual weed control provided maximum yield and encouraged wheat growth and development which might be due to weed free conditions throughout the season. Khatam *et al.* (2013) showed that maximum grain yield was obtained in weed free plots followed by herbicide treatments. Furthermore, chemical weed control also provided the satisfactory results regarding wheat growth and yield and found statistically at par with hand weeded plots. These findings are in accordance with the results of Hasanuzzaman *at el.* (2008) and Ehsanullah *et al.* (2014) who found higher yields and its contributing traits in rice where weeds were controlled by herbicides.

CONCLUSION

Conclusively, weeds being a cause of yield reduction are necessary to control in time to avoid yield and economic losses. No doubt, manual weeding is the most reliable method to get rid of weed infestation and other off types but it is most labourious and time consuming method. Other approaches like chemical weed control should be adopted to effective and quick weed control. Results of our experiment indicated that weeds reduced the wheat yield while combination of bromoxynil + MCPA and pinoxaden endowed better weed control than the mixture of carfentrazone + isoproturan. Application of herbicides not only reduced the weed density but also improved yield by discouraging weed competition with wheat.

Table-1. Individual weed density (m^{-2}) at 60 and 90 days after sowing (DAS) in wheat.

Treat.	60 DAS							90 DAS						
	A. arvensis	*A. fatua*	*C. album*	*C. arvensis*	*C. didymus*	*P. minor*	*R. dentatus*	*A. arvensis*	*A. fatua*	*C. album*	*C. arvensis*	*C. didymus*	*P. minor*	*R. dentatus*
T_1	10.2	10.9	6.5	10.8	11.5	11.1	10.6	11.7	10.4	4.2	11.1	12.8	13.1	11.85
T_2	9.7	10.3	6.4	11.0	11.3	11.4	10.6	11.7	10.7	4.3	11.5	12.8	13.2	11.85
HSD ($p \leq 0.05$)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
W_1	22.2 A	23.3A	15.5 A	24.2 A	25.2 A	25 A	23.6 A	26.4 A	23.6 A	8.9 A	25.6 A	29.3 A	31.3 A	27.1 A
W_3	4.6 B	4.8 B	2.3 B	5.2 B	5.5 B	5.5 B	5.1 B	5.3 B	4.9 B	2.5 B	4.9 B	5.6 B	5.1 B	5.1 B
W_4	3.2 C	3.6 B	1.6 B	3.3 C	3.6 C	3.2 C	3.1 C	3.3 C	3.2 C	1.3 C	3.4 C	3.5 C	3.4 C	3.5 C
HSD ($p \leq 0.05$)	0.46	2.14	1.44	0.72	1.54	0.67	0.80	1.29	0.78	0.48	1.02	1.22	1.54	0.75
T_1W_1	22.8	24.1	15.4	24.2	25.8	25.0	23.7	26.8	23.2	8.6	25.2	29.5	31.1	27.0
T_1W_3	4.7	4.8	2.5	5.0	5.3	5.2	5.0	5.2	4.8	2.5	4.8	5.5	5.0	5.2
T_1W_4	3.2	3.7	1.7	3.2	3.3	3.0	3.2	3.0	3.2	1.3	3.2	3.5	3.3	3.5
T_2W_1	29.2	22.5	15.7	24.2	24.5	25.0	23.5	26.0	24.0	9.1	33.93	29.2	31.5	27.2
T_2W_3	4.5	4.8	2.0	5.3	5.7	5.8	5.2	5.5	4.8	2.5	5.0	5.7	5.2	5.0
T_2W_4	3.2	3.5	1.5	3.5	3.8	3.3	3.0	3.7	3.2	1.3	3.3	3.5	3.0	3.5
HSD ($p \leq 0.05$)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means not sharing the same letters in columns differ significantly according to Tukey's HSD test ($p < 0.05$).
NS= Non-Significant. T_1: Herbicide application 30 days after sowing (DAS) and T_2: 40 DAS;
W_0: weedy check; W_1: weed free; W_2: Affinity 50WP (isoproutran+ carfentrazone) at 1000 g a.i ha^{-1};
W_3: Buctril Super 60EC (bromoxynil +MCPA) at 445 g a.i ha^{-1} + Axial 0.50EC (pinoxaden) at 37 g a.i. ha^{-1}.

Table-2. Individual weed dry weight (g m^{-2}) 60 and 90 days after sowing (DAS) in wheat.

	60 DAS							90 DAS						
Treat.	*A. arvensis*	*A. fatua*	*C. album*	*C. arvensis*	*C. didymus*	*P. minor*	*R. dentatus*	*A. arvensis*	*A. fatua*	*C. album*	*C. arvensis*	*C. didymus*	*P. minor*	*R. dentatus*
T_1	2.1	2.2	1.1	2.4 B	2.8	2.2	2.2	7.3	7.7	2.6	8.4 B	9.3	7.7	7.8 B
T_2	2.2	2.3	1.3	2.5 A	2.8	2.3	2.3	7.5	8.0	2.6	9.1 A	9.5	7.9	8.5 A
HSD ($p \le 0.05$)	NS	NS	NS	0.02	NS	NS	NS	NS	NS	NS	0.37	NS	NS	0.34
W_0	4.8 A	5.1 A	2.7 A	5.6 A	6.4 A	5.0 A	4.8 A	15.9 A	16.8 A	5.6 A	19.6 A	20.9 A	17.2 A	17.4 A
W_2	0.9 B	0.9 B	0.5 B	1.0 B	1.1 B	1.0 B	1.1 B	3.7 B	3.9 B	1.4 B	4.0 B	4.3 B	3.5 B	4.2 B
W_3	0.7 C	0.7 B	0.4 B	0.8 C	0.8 C	0.8 C	0.8 C	2.6 C	2.7 C	0.9 C	2.6 C	3.1 C	2.6 C	2.9 C
HSD ($p \le 0.05$)	0.18	0.30	0.22	0.11	0.07	0.10	0.12	0.63	0.45	0.26	0.60	0.62	0.77	0.70
T_1W_0	4.6	5.1	2.6	2.0	6.3	5.0	5.0	15.7	16.6	5.7	19.3	21.0	17.1	16.7
T_1W_2	0.8	0.8	0.4	0.9	1.1	0.9	1.0	3.6	3.8	1.4	3.6	4.5	3.5	3.9
T_1W_3	0.7	0.7	0.3	0.7	0.8	0.7	0.7	2.5	2.5	0.8	2.2	3.1	2.4	2.6
T_2W_0	5.0	5.1	2.8	2.0	6.4	5.0	4.8	16.0	17.0	5.5	20.0	21.3	17.3	18.0
T_2W_2	1.0	1.0	0.5	1.0	1.1	1.0	1.2	3.7	4.0	1.4	4.3	4.1	3.5	4.4
T_2W_3	0.8	0.8	0.4	0.8	0.9	0.9	1.0	2.6	3.0	1.0	3.0	3.2	2.8	3.1
HSD ($p \le 0.05$)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Legend: same as Table-1.

Table 3. Effect of herbicides and their application timings wheat phenology, yield and yield characters

Treatments	Fertile tillers m^{-2}	Spikelets per spike	Grains per spike	1000-grain weight (g)	Grain yield ($t\ ha^{-1}$)	Harvest index (%)
T_1	334.4	14.5	42.6	44.3	3.8 A	28.2
T_2	333.4	14.2	41.9	44.2	3.7 B	28.1
HSD($p \leq 0.05$)	NS	NS	NS	NS	0.05	NS
W_0	298.7 D	12.6 C	37.4 B	41.9 B	3.3 C	25.1 B
W_1	360.4 A	15.6 A	45.9 A	45.7 A	4.1 A	29.6 A
W_2	330.2 C	14.2 AB	41.8 AB	45.0 A	3.8 B	28.7 A
W_3	346.25 B	14.9 A	44.0 A	44.5 A	3.9 A	29.2 A
HSD($p \leq 0.05$)	6.5	0.83	2.8	1.24	0.13	0.86
T_1W_0	302.2	13.2	39.1	42.2	3.4	25.0
T_1W_1	358.5	15.7	46.2	45.6	4.2	29.7
T_1W_2	329.8	14.2	41.9	44.7	3.8	28.7
T_1W_3	347.2	14.7	43.3	44.8	4.1	29.3
T_2W_0	295.3	12	35.8	41.6	3.2	25.1
T_2W_1	362.3	15.5	45.6	45.8	4	29.4
T_2W_2	330.7	14.1	41.8	45.2	3.9	28.8
T_2W_3	345.3	15.2	44.7	44.2	3.8	29.1
HSD($p \leq 0.05$)	NS	NS	NS	NS	NS	NS

Legend: same as Table-1.

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