Effect of Different Herbicides on Weed Dynamics in Wheat (*Triticum aestivum* L.)

Abstract

A field experiment was conducted at Research farm, Vivekananda Global University, Jaipur during *Rabi*, 2023 on loamy sand soil. The experiment comprises 11 treatments of weed management practices in wheat (Weedy check, Weed free, Hand weeding at 30-35 DAS, 2,4-D ester @ 0.75 kg/ha at 30-35 DAS, Sulfosulfuron @ 25 g a. i. at 30-35 DAS, Carfentrazone ethyl @20 g/ha at 30-35 DAS, Metsulfuron methyl @ 4 g/ha at 30-35 DAS, Pinoxaden @60g a. i./ha 25-30 DAS, Piroxofop- propargyl 15% WP @60g a. i./ha 30-35 DAS, Sulfosulfuron 75% + Metsulfuron 5% WG @ 32g a. i./ha at 30-35 DAS and Clodinafop-propargyl 15% + Metsulfuron methyl 1% @ 32 g a.i./ha at 30-35 DAS) thereby experiment was laid out in randomized block design and replicated thrice. Results showed that application of Sulfosulfuron 75% + Metsulfuron 5% WG @ 32g a. i./ha at 30-35 DAS at 30-35 DAS treatment resulted significant reduction in weed density, weed dry matter in comparison to most of the treatments while highest weed control efficiency and lowest weed index was recorded with the same treatment except weed free treatment. Clodinafop-propargyl 15% + Metsulfuron methyl 1% @ 32g a.i./ha at 30-35 DAS was next superior treatment.

Introduction

Wheat [*Triticum aestivum* (L.) emend.Fiori & Paol)] is grown all over the world for its wider adaptability and high nutritive value than any other food crop. Currently it is grown on an area of about 224.82 million hectares and production of about 785.0 million tonnes with productivity of 3.49 tonnes per hectare (Anonymous, 2023). Since 1960, world production of wheat and other grain crops has tripled and is expected to grow further through the middle of the 21st century. It is occupying 17 per cent of crop acreage worldwide, feeding about 40 per cent of the world population and good supplement for nutritional requirement of human body as it contains 12.60 per cent protein and 78.10 per cent carbohydrate (Kumar *et. al*., 2011). Conventional method of physical weed control in wheat is time consuming and labour intensive. However, the additional benefits of providing greater aeration, improving root growth enabling greater absorption of moisture and nutrients from deeper soil layers and moisture conservation cannot be ignored. On the other hand chemical control of weeds in general has been realized to be more cost effective and easy compared to manual weeding (Yadav and Malik, 2005). To combat this situation, refinement in existing technology is a researchable issue.

Herbicides play an important role for weed control in close spaced crops like wheat and barley, where manual or mechanical weeding is difficult (Yaduraju and Das, 2002). Also the mimicry weeds can hardly be weeded out by hand weeding or other mechanical methods. Chemical weed control is most suitable option to overcome this problem. For controlling of broadleaf weeds, 2, 4-D is recommended after first irrigation but it does not control grassy weeds. Moreover, 2, 4-D may lead to only partial suppression of hardy broadleaf weeds (Malik *et al*., 2000) like golden dock (*Rumex retroflexus* L.), common vetch (*Vicia sativa* L.) and scarlet pimpernel (*Anagallis arvensis* L.).

Methodology

Weed Studies:

Weed population per metre square

Weed population was taken at 50 DAS from five random spots in each plot by counting the number of weeds per quadrate of 0.25 m^2 and the average was computed.

Dry weight of weeds

Weeds samples from two randomly selected spots in each plot were taken at harvest stage with the help of 0.25 m^2 quadrate and the average was worked out. The samples so collected were subjected to oven dry, weighed and average was computed.

Weed Control Efficiency (WCE)

In order to evaluate the weed control treatments for their efficacy,weed control efficiency of each treatment at harvest stage was calculated by using the following formula. The formula was suggested by Umrani and Boi, 1982.

$$\text{Weed control efficiency (\%)} = \frac{X - Y}{X} \times 100$$

Where,

X = Weed dry matter in weedy check plot

Y = Weed dry matter in treated plot

Weed Index (WI)

Weed index is a derived parameter from the crop yields obtained across the treatments of weed control researches (Yadav and Mishra, 1982). It is a measure of the crop yield loss accrued across treatments in comparison to a weed free plot adopted in an experiment. Following formula was used in calculating weed index:-

$$\text{Weed Index} = \frac{X - Y}{X} \times 100$$

Where,

X = Crop yield in weed free plots

Y = Crop yield in the treated plot

Statistical analysis

In order to test the significance of variation in experimental data obtained for various treatment effects, the data were statistically analyzed as described by Fisher (1950). The critical differences were calculated to assess the significance of treatment mean wherever the F' test was found significant at 5 per cent level of probability. To elucidate the nature and magnitude of treatment effects, summary tables along with SEm± and CD (P=0.05) were prepared and are given in the text of the chapter. Experimental results and their analyses of variance are given in Appendices at the end.

The following formula were used for standard error, critical difference and coefficient of variance estimations-

a) SEm± = $\sqrt{EMS/r}$

b) C.D. = SEm± × $\sqrt{2}$ × t%

c) C.V. (%) = $\frac{\sqrt{EMS}}{\text{Grand mean}} \times 100$

Where,

r = Number of replications

t = Number of treatments

D.F. = Degree of freedom

SEm± = Standard error of mean

EMS = Error mean squares

C.D. = Critical difference

C.V. = Coefficient of variance

Results and Discussion

Regular survey during the period of experimentation showed that wheat crop was infested with a number of broad leaf and grassy weeds. *Chenopodiumalbum* and *Chenopodiummurale* were the major dicot weeds that appeared with the emergence of crop. Whereas, *Rumex dentatus, Heliotropiumellipticum, Melilotus alba* and *Spergulla arvensis* infested at later stage of crop growth. *Cyperus rotundus, Phalaris minor* and *Asphodelus tenuifolius* were the dominating monocot weed species during the wheat seasons. The weed control treatments evaluated in present study *viz.*, weedy check, weed free, hand weeding, 2,4-D ester at 0.5 kg/ha, sulfosulfuran @ 25 gm *a.i.*/ha, metsulfuran methyl @ 4 g *a.i.* / ha, sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g *a.i.* /ha, piroxofop-propargyl 15 % WP 60 g *a.i.* /ha, clodinafop propargyl 15 % +metsulfuran methyl 1 % @ 32 g *a.i.* /ha, carfentrazone ethyl 40 % DF @ 20 g *a.i.*/ha and Pinoxaden @60g a. i./ha 25-30 DAS differed widely in their effect on density and dry weight of weeds. All the weed control treatments led to significant reduction in weed population and dry weight of weeds at 50 DAS (Table 1). The mean weed dry weight of 19.18 g/m^2 was recorded from weedy check plot (Table 1). The increase in dry weight of weeds under weedy check might be attributed to uninterrupted growth of weeds throughout the crop season. Heavy infestation of weeds and their dry matter accumulation under weedy check has also been reported by and Singh and Singh (2005) in wheat. Similarly weed free plots in wheat registered lowest monocot & dicot weed population as well as dry matter production reduction of weeds at 50 DAS stage of crop growth. However, among the control treatments sulfosulfuran 75 % + metsulfuran methyl 5% WG @ 32 g *a.i.* /ha registered maximum reduction in weed population as well as dry matter production of weeds (Table 1). Sulfosulfuran @ 25g *a.i* /ha could retain the crop weed free for shorter period only and thereafter, population and dry weight of weeds increased progressively under this treatment with the advancement of crop growth due to later flushes of weeds and thus relatively higher dry weight was recorded at subsequent growth stages. The luxuriant crop growth observed in a weed free environment due to hoeing and aeration in rhizosphere during early stages that smothered weed growth altogether as against 19.18 g/m^2 recorded under control.

These results are in close conformity with the findings of Nadeem *et al.* (2007) and Pisal *et al.* (2009) in wheat.

Application of other herbicides also resulted in significant reduction in weed dry matter production and population of weeds 50 DAS stage as compared to weedy check and other treatments (Table 1). The magnitude of weed control varied significantly among herbicides. Post emergence application of clodinafop propargyl 15 % + metsulfuran methyl 1 % @ 32 g *a.i.*/ha recorded the mean weed dry matter of 7.20 g/m^2, that was lower than weedy check. The extent of weed control achieved with clodinafop propargyl 15 % + metsulfuran methyl 1 % @ 32 g *a.i.*/ha seems to be due to their knock down effects on weeds. Clodinofop propargyl is reported to be more effective against narrow leaf weeds, while metsulfuran methyl proves more effective against broad leaf weeds. The ready mix combination clodinafop propargyl + metsulfuran methyl proved more effective against both monocot and dicot weed flora. Clodinafop propargyl herbicide molecule when present in the system inhibits lipid biosynthesis (ACCase) affecting meristematic tissue. Similar results were reported by (Punia *et al.*, 2008). Metsulfuron methyl is an effective herbicide to control broad leaf weeds as post emergence treatment. This herbicide molecule when present in the system, binds with the acetolactase synthase (ALS)/ acetohydroxyacids synthase (AHAS) making the enzyme inactive and checking the synthesis of valine, leucine and isoleucine (Gupta, *et. al.* 2012). Due to this, phloem transport in plant is hampered (Singh *et al.*, 2013). The primary mechanism of action of this group is inhibition of amino acid synthesis and the secondary inhibition of photosynthetic, respiration and protein synthesis (Zimdahl, 2004). The results obtained in present study are in close agreement with the findings of Hada *et al.* (2008) and Bhatia *et al.* (2012).

Further, apparent from the data that all the weed control treatments showed variation in their efficiency to control the weeds (Table 1) and weed indices (Table 1). The mean weed control efficiency due to treatments at 50 DAS and weed index ranged between 33.64 to 100.00 and 3.61 to 30.17 per cent respectively. Data showed that barring weed free treatment the highest weed control efficiency of 100 per cent was observed. Next superior was Sulfosulfuron 75% + Metsulfuron 5% WG @ 32g a. i./ha at 30-35 DAS to controlled the weeds to the extent of 72.33 per cent. Clodinafop propargyl 15 % + metsulfuran methyl 1 % @ 32 g a.i. /ha also controlled the weeds to the extent of 62.12 per cent than weedy check and thus found the most superior herbicidal treatment.

Weed index also declined due to applied treatments in comparison to weedy check. Data presented in table 1 indicated that Sulfosulfuron 75% + Metsulfuron 5% WG @ 32g a. i./ha at 30-35 DAS recorded the lowest mean weed index of 3.61 per cent, as against the maximum of 30.17 per cent observed under weedy check. The higher weed dry matter accumulation and nutrient depletion by weeds and corresponding reduction in grain yield is directly associated with variation in the weed index among different treatment. These results are in accordance with the findings of Chhipa *et al.* (2005), Singh *et al.* (2006) and Pisal *et al.* (2009) in wheat.

Table 1 Effect of weed control treatments on Weed population, weed dry matter production, WCE and weed index

Treatments	Weed Population (At 50 DAS)	Weed dry matter production (50 DAS)	Weed control efficiency (%)	Weed index (WI %)
Weedy check	24.46	19.18	0	30.17
Weed free	0.00	0.00	100	0.00
Hand weeding at 30-35 DAS	7.52	9.02	52.54	6.29
2,4-D ester @ 0.75 kg/ha at 30-35 DAS	10.34	11.41	40.77	17.70
Sulfosulfuron @ 25 g a. i. at 30-35 DAS	7.83	9.33	50.98	9.51
Carfentrazone ethyl @20 g/ha at 30-35 DAS	10.90	12.74	33.64	20.33
Metsulfuron methyl @ 4 g/ha at 30-35 DAS	11.27	13.88	27.39	23.49
Pinoxaden @60g a. i./ha 25-30 DAS	9.05	11.22	41.31	15.20
Piroxofop- propargyl 15% WP @60g a. i./ha 30-35 DAS	10.00	10.55	44.61	11.01
Sulfosulfuron 75% + Metsulfuron 5% WG @ 32g a. i./ha at 30-35 DAS	5.70	5.29	72.33	3.61
Clodinafop-propargyl 15% + Metsulfuron methyl 1% @ 32.0g a.i./ha at 30-35 DAS	6.18	7.20	62.12	5.52

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