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

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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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 @60 g *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% @ 32 g *a.i.*/ha at 30-35 DAS was next superior treatment.

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1. 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). "The production of wheat and other grain crops has tripled globally since 1960, and this growth is predicted to continue until the middle of the twenty-first century. It feeds almost 40% of the world's population, takes up 17% of cropland globally, and is a good addition to meet the body's nutritional needs because it provides 12.60% protein and 78.10% carbohydrates" [1]. "However, it has been shown that chemical weed management is generally easier and more affordable than manual weeding" [2]. 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" [3]. Furthermore, hand weeding or other mechanical procedures are hardly ever effective in getting rid of imitation weeds. The best solution to this issue is chemical weed management. After the initial irrigation, 2, 4-D is advised to control broadleaf weeds; grassy weeds are not controlled by this method. Furthermore, 2, 4-D might only partially control resilient broadleaf weeds [4] like golden dock (*Rumex retroflexus* L.), common vetch (*Vicia sativa* L.) and scarlet pimpernel (*Anagallis arvensis* L.).

2. METHODOLOGY

2.1 Weed Studies

2.1.1 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.

2.1.2 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.

2.1.3 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, [5].

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

Where,

X = Weed dry matter in weedy check plot

Y = Weed dry matter in treated plot

2.1.4 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 measurement of the reduction in crop output throughout treatments relative to an experiment's weed-free plot. Following formula was used in calculating weed index:-

$$\text{Weed Index} = X - Y / X * 100$$

Where,

X = Crop yield in weed free plots

Y = Crop yield in the treated plot

2.2 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 at the end.

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

a) $SEm\pm = \sqrt{EMS/r}$

b) $C.D. = SEm\pm \times \sqrt{2} \times t\%$

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

3. 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. *Chenopodium album* and *Chenopodium murale* were the major dicot weeds that appeared with the emergence of crop. Whereas, *Rumex dentatus, Heliotropium ellipticum, 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 this study were weedy check, weed free, hand weeding, 2,4-D ester at 0.5 kg/ha, sulfosulfuran @ 25 g *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 piloxaden @60 g *a.i.*/ha. The effects of 25–30 DAS on weed density and dry weight varied greatly. 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). Uninterrupted weed growth during the crop season may be the cause of the rise in dry weight of weeds during weedy control. Additionally, there has been a significant weed infestation and dry matter accumulation under weedy control reported by and Singh and Singh [6] 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). Only a shorter period of time could be achieved with Sulfosulfuran @ 25g a.i./ha to keep the crop free of weeds; after that, weed population and dry weight increased gradually under this treatment as crop growth progressed as a result of weed flushes that occurred later. As a result, comparatively higher dry weight was recorded at subsequent growth stages. Because of early hoeing and rhizosphere aeration, which completely suppressed weed growth, lush crop growth was seen in a weed-free environment as opposed to 19.18 g/m^2 under control. These results are in close conformity with the findings of Nadeem et al*.* [7] and Pisal et al*.* [8] 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). Herbicides differed greatly in how much they controlled weeds. The mean weed dry matter of 7.20 g/m^2 was recorded after post-emergence treatment of clodinafop propargyl 15% + metsulfuran methyl 1% @ 32 g *a.i.*/ha, which was lower than weedy check. The knockdown effects of clodinafop propargyl 15% + metsulfuran methyl 1% @ 32 g *a.i.*/ha on weeds appear to be the cause of the extent of weed control attained. It has been observed that metsulfuran methyl works better against broad leaf weeds, while clodinofop propargyl is more effective against narrow leaf weeds. In terms of efficacy against monocot and dicot weed flora, the ready mix combination of metsulfuran methyl and clodinafop propargyl was found to be superior. Clodinafop propargyl herbicide molecule when present in the system inhibits lipid biosynthesis (ACCase) affecting meristematic tissue similar results were reported by Punia et al*.*, [9]. As a post-emergence treatment, metsulfuron methyl is a useful herbicide for controlling wide leaf weeds. When

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 @60 g *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% @ 32.0 g *a.i.*/ha at 30-35 DAS	6.18	7.20	62.12	5.52

present in the system, this herbicide molecule binds to acetolactase synthase (ALS)/acetohydroxyacids synthase (AHAS), rendering the enzyme inactive and preventing the formation of isoleucin, valine, and leucine (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” [10]. “The results obtained in present study are in close agreement with the findings” of Hada et al. [11] 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 [12]. 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 In comparison to the maximum of 30.17 percent seen under weedy check, the lowest mean weed index of 3.61 percent was reported with Sulfosulfuron 75% + Metsulfuron 5% WG @ 32g *a.i.*/ha at 30-35 DAS. The difference in the weed index between different treatment methods is directly related to the increased weed dry matter accumulation and nutrient depletion by weeds and corresponding reduction in grain production. These results are in accordance with the findings of Chhipa et al. [13], Singh et al. [14] and Pisal et al. (2009) in wheat [15,16].

4. CONCLUSION

Herbicides play an important role for weed control in close spaced crops like wheat and barley, where manual or mechanical weeding is difficult. Clodinafop-propargyl 15% + Metsulfuron methyl 1% @ 32 g a.i./ha at 30-35 DAS was next superior treatment.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist

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