Application and effects of different herbicides against weed flora in wheat crop for sustainable agriculture

Abstract

Weed management is a sustainable approach which promotes the majority of crop production. To control weeds in various cropping systems, farmers employ a variety of techniques, although nowadays, the most popular method is the application of herbicides, which can be attributed to labour shortage. Application and effects of different herbicides against weed flora in wheat crop for sustainable agriculture," was conducted in 2020 and 2021. The experiment's goal was to assess how many herbicides performed against complex weed flora in wheat crop. The experiment was planned and laid out with nine treatments which are pre-emergance application of pendinethalin 1.0 kg a.i. ha^{-1} at (3 DAS) (T_2) and post emergence application of metribuzin 0.3 kg a.i. ha^{-1} (T_1), sulfosulfuron 0.03 kg a.i. ha^{-1} (T_3), metsulfuron-methyl 0.005 kg a.i. ha^{-1} (T_4), clodinafop-propargyl 0.04 kg a.i. ha^{-1} kg (T_5), 2,4-D 0.6 kg a.i. ha^{-1} (T_6), carfentrazone-ethyl 0.025 kg a.i. ha^{-1} (T_7), weed free (T_8) and weedy check (T_9) and four replications under randomized block design. The major weeds infesting the wheat crop field were *Anagallis arvensis, Chenopodium album, Phalaris minor, Parthenium hysterophorus* and *Cyperus rotundus*. The post-emergence application of carfentrazone-ethyl 0.025 kg a i/ha at 33 days after sowing was most efficient in controlling the weeds (both grassy and non-grassy) among the various applied herbicides. Weed growth suppression effect of carfentrazone-ethyl 0.025 resulted significant increase the growth parameters, yield attributes and higher economic yield of wheat over check control in order to promote the sustainability.

Key words: Wheat, Herbicide, Weeds, Bio-efficacy and Modern Agriculture

1.Introduction

India is the second largest wheat producer (93.51 million tonnes) next only to China (121.72 milliontonnes) and it covers the largest area under wheat cultivation (29.65 m ha), which is about 13.77 % of the world wheat area (217 million hectare) **(FAO, 2014).**Wheat crop was infested with both grassy and broad-leaf weeds. Competition from weeds throughout the crop season results to yield losses ranging from 10 to 70% depending upon time and intensity of weed flora. In eastern Uttar Pradesh, infestation of *Chenopodium album* is increasing at an alarming rate in wheat due to use of high inputs like fertilizers and irrigations. In eastern Uttar Pradesh, wheat crop grown mainly after rice is infested with *Phalaris minor* along with broad-leaf weeds such as *Anagallis arvensis, Parthenium hysterophorus, Rumex dentatus, Convolvulus arvensis* and *Cyperus rotundus*. So there is urgent need for broad spectrum herbicides which can provide effective control of both grassy as well as broad-leaf weeds in wheat crop.In present scenario, weed control through herbicides is increasing and popularizing among farmers day by day, because weed control through manual methods is time consuming and tedious and become very costly due to unavailability and high charges of labour in peak period due to shifting of agricultural labours to industries for better and assured wages. Wheat is sown at very narrow row spacing. Therefore, the cultural methodsof weed control could not be performed and manual control becomes unaffordable. Hence, the use of herbicides popularized particularly in irrigated wheat crop. A field experiment was conducted by **Paighan*et al*. (2013)** during rabi season of 2009-10 at Parbhani, Maharastra. The result of trial showed that application of metribuzin at 300 g a.i/ha gave significant response against monocot weeds with 63.64 per cent reduction in density and dicot weeds with 71.9 per cent reduction of density. The best weed control efficiency in case of monocot (90.8 per cent) and dicot (82.8 per cent) was achieved with metsulfuron-methyl and metribuzin, respectively comparedd to pendimethalin, carfentrazone, pinaxaprop and 2,4-D. All the treatments except pinaxaprop application gave significantly higher grain yield as compared to weedy check.

A field experiment was carried out at Pantnagar,Uttrakhand during rabi season of 2010-11 and 2011-12 to test the efficacy of different doses of Metribuzin 42 per cent + clodinafop-propargyl 12 per cent W.G in wheat and associated weeds.The experimental field was naturally dominated with *Phalaris minor* (5.74 and 40.7%) as a grassy weeds and *Chenopodium album* (2.8 and 13.3%), *Coronopusdidymus* (2.8 and 10.4%), *Melilotus indica* (2.5 and 9.4%), *Rumex* spp.(2.0 and 4.8%) and *Fumaria parviflora* (1.8 and 3.8%) were major broad-leaved weeds infesting wheat experimental area during 2010 and 2011, respectively (**Singh *et al.* 2015)**. **Kaur *et al.* (2016)** has conducted an experiment on wheat at Punjab Agricultural University, Ludhiana, Punjab during three successive winter seasons of 2010-11,2011-12 and 2012-2013, to evaluate the efficacy of different clodinafop-propargyl formulation against little seed canary grass in wheat. The experimental field contained only

Phalaris minor as grassy weed. The population of *Phalaris minor* (no/m^2) 185 at 60 days after sowing during the course of study, and also dry matter accumulation (g/m^2) 127.Present study is focused on effect of weed management practices in wheat crop.

2.Material & Methods

The experiment was carried out during 2020 and 2021 at Agricultural Research Farm, Shri Durga Ji Post Graduate College, Azamgarh (U.P.). The experiment was plannedhaving major weeds infesting the wheat crop field were *Anagallis arvensis*, *Chenopodium album*, *Phalaris minor*, *Parthenium hysterophorus* and *Cyperus rotundu* laid out with nine treatments which are pre-emerganceapplication of pendinethalin 1.0 kg a.i. ha^{-1} at (3 DAS) (T_2) and post emergence(33 DAS) application of metribuzin 0.3 kg a.i. ha^{-1} (T_1), sulfosulfuron 0.03 kg a.i. ha^{-1} (T_3), metsulfuron-methyl 0.005 kg a.i. ha^{-1} (T_4), clodinafop-propargyl 0.04 kg a.i. ha^{-1} kg (T_5), 2,4-D 0.6 kg a.i. ha^{-1} (T_6), carfentrazone-ethyl 0.025 kg a.i. ha^{-1} (T_7), weed free (T_8) and weedy check (T_9) and four replications under randomized block design. The Wheat variety 'HD-2967' was sown in the experimental field with seed rate of 100 kg ha^{-1} in the row distance (22.5 cm.) during both the years. Fertilizers were given uniformly to all the plots through urea, single super phosphate and muriate of potash at the rate of 120 kg Nitrogen, 60 kg Phosphorus and 40 kg Potassium ha-^{1} during both the years. Half of the nitrogen and full quantity of phosphorus and potash was given as basal and remaining nitrogen was given in two splits just after day of first and second irrigation in both the years.Observations for weed population and their dry matter accumulation were recorded at 60 DAT with the help of random quadrate (0.5 x 0.5 m) at four places in each plot and then converted into per m^2. Data was subjected to square root (x+1) transformation to normalize their distribution before analysis. Data on per cent visual control by herbicides recorded on 0-100 scale was transformed by using arcsine transformation method and data on yield attributes and grain yield of wheat was also recorded at harvest which was statistically analyzed using analysis of variance

3.0 Results

2.1 Effects of weed control measures on weed flora and its density

The density of total weeds was significantly influenced due to the application of different weed control measures at 90 days stage of crop growth. Total weed population per unit area was increased up to 90 days during both the stages of crop growth, thereafter decreased days stage in weedy check. The treatment effect was found to be significant at 90 daysstages of crop growth during both the crop seasons whereas all the weed control methods significantly suppressed total weed infestation over weedy check. During every stage of crop growth in both crop seasons, not a single weed was found in the weed-free plot. At 90 days stage of crop growth and 65.44 to 92.75 per cent and 62.43 to 88.58 per cent in the first crop season and 64.99 to 90.45 per cent and 60.89 to 84.36 per cent in the second crop season but it was unable to check the growth of weed completely as noticed in weed- free plot at this stage in both the crop seasonsas shown in Fig 1. Given table 1 represents the value of weed density.

Table- 1Density of total weeds metre^{-2} at 90 days' stages of crop growth as influenced by different weed management practices

Treatment		**Total weed density**	
		90 DAS	
		2019-20	**2020-21**
T_1	Metribuzin	13.95(193.50)	13.87(180.50)
T_2	Pendimethalin	13.46(180.25)	12.87(164.75)
T_3	Sulfosulfuron	14.99(223.75)	14.52(209.75)
T_4	Metsulfuron methyl	11.95(141.75)	11.40(129.00)
T_5	Clodinafop-propargyl	18.26(332.25)	17.54(306.50)
T_6	2,4-D	12.87(164.75)	12.66(159.25)
T_7	Carfentrazone –ethyl	11.40(129.00)	10.68(113.00)
T_8	Weed free	1.00(0.00)	1.00(0.00)
T_9	Weedy	19.65(385.00)	19.09(363.25)
SEm(±)		**0.35**	**0.34**
C.D. (P=0.05)		**1.03**	**1.00**

Original values in parentheses and data subjected to square root ($\sqrt{x+1}$)transformation

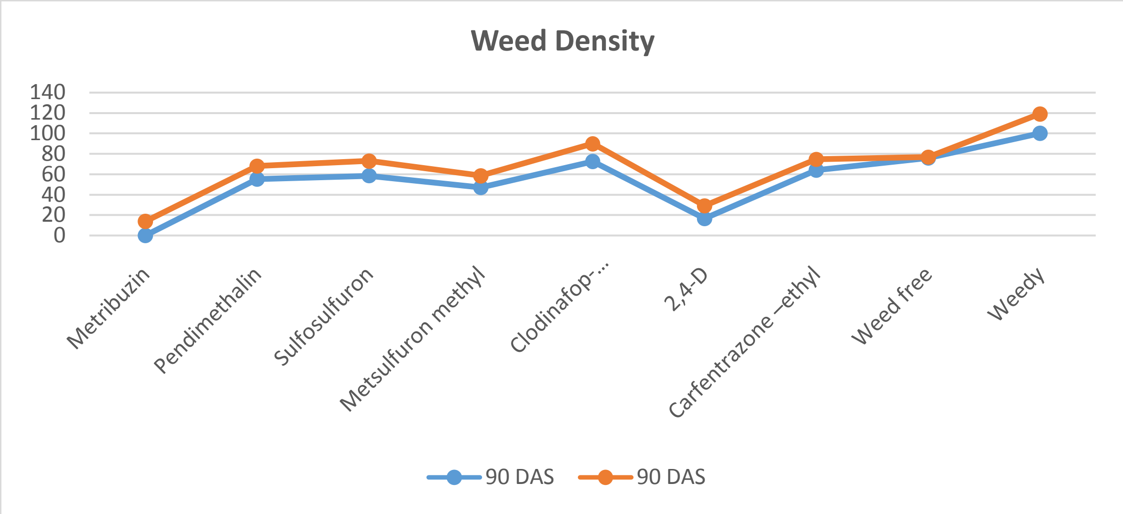

Figure- 1Weed Densitymetre^{-2} at various stages of crop growth

3.2 Effects of weed control measures on weed control efficiency

The data clearly indicate that the effect of weed control methods on weed killing efficiency was significant at 90 DAS in both the crop seasons. Weed free treatment had hundred percent weed killing efficiency at 90 DAS in both the crop seasons. Application of carfentrazone-ethyl 0.025 kg a.i. ha^{-1} did not differ appreciably with metsulfuron methyl 0.005 kg a.i. ha^{-1} and both the treatments had significantly higher weed killing efficiency than that of rest chemical method of weed control practices at 90 DAS in both the crop seasons. Application of 2,4-D 0.6 kg a.e. ha-1 also had appreciably higher weed killing efficiency than rest chemical methods of weed control practices at 90 DAS in both the crop seasons. Application of metribuzin 0.3 kg a.i. ha^{-1} on par with pendimethalin 1.0 kg a.i. ha^{-1} and both the treatments had significantly higher weed killing efficiency than that of sulfosulfuron methyl 0.03 kg a.i. ha^{-1} and clodinafop- propargyl 0.04 kg a.i. ha^{-1} and 90 DAS in both the crop seasons. Application of clodinafop-propargyl 0.04 a.i. ha^{-1} had appreciably lower weed killing efficiency than that of rest chemical method of weed control practices at 90 DAS in both the crop seasons as shown in figure 2. Given table 2 represents the percentage of weed control efficiency

Table- 2Weed control efficiency (%) as influenced by different weed management practices

Treatments		Weed control efficiency (%)	
		90 DAS	
		2019-20	**2020-21**
T_1	Metribuzin	55.23	59.03
T_2	Pendimethalin	58.44	60.85
T_3	Sulfosulfuron	47.12	49.92
T_4	Metsulfuron methyl	72.39	76.54
T_5	Clodinafop-propargyl	16.47	15.39
T_6	2,4-D	64.01	66.77
T_7	Carfentrazone –ethyl	75.79	76.08
T_8	Weed free	100.00	100.00
T_9	Weedy	0.00	0.00
SEm(±)		**1.64**	**1.70**
C.D. (P=0.05)		**4.79**	**4.96**

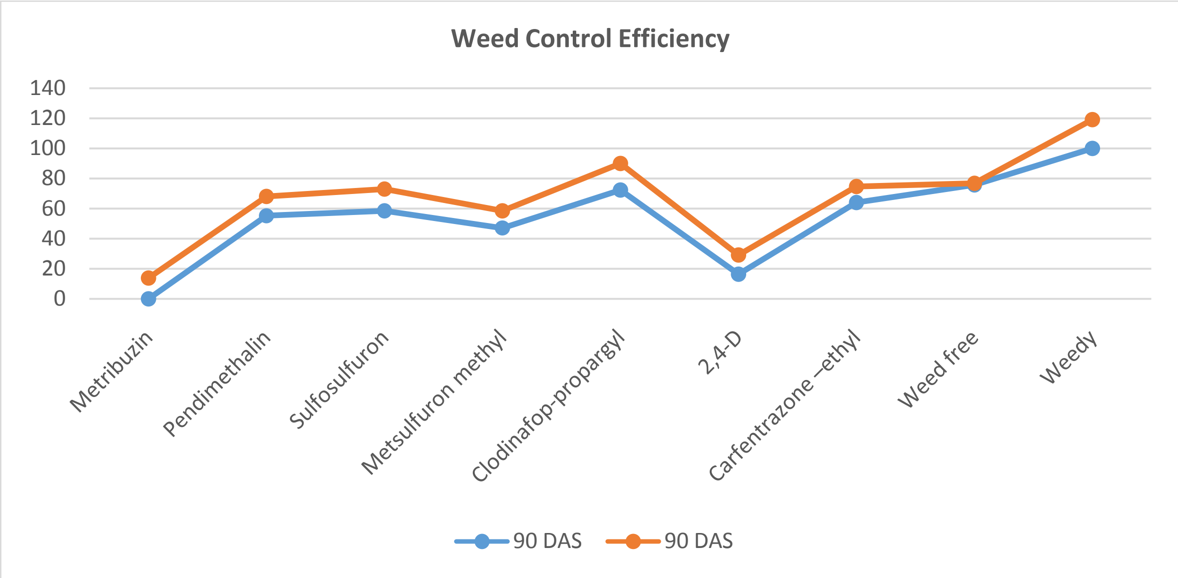

Figure- 2Weed Control efficiency (%)at 90 stages of crop growth

4.0 Discussion

The experimental field was infested by seventeen weed species out of them three grassy, thirteen non-grassy and one sedge were registered in experimental field. The dominant weed in experimental field were *Cyperus rotundus, Anagallis arvensis, Chenopodium album, Cynodondactylon* and *Parthenium hysterophorus.* The crop rotation, tillage and herbicides have pronounced effect on the type of weed flora **(Anderson and Beck 2007, Chhokar *et al.*, 2007a).** Reduced tillage or no till wheat with high moisture in rice-wheat system favours infestation of *Rumex dentatus* L. and *Malva parviflora* L. **(Chhokar *et al.*, 2007a).** The probable reason for high density of non-grassy weed over grassy and sedges in experimental plot might be due to fallowing of experimental field in *Kharif* season of 2019-20 and 2020-21, light texture soil and private irrigated pump of experimental field.

The relative density of grassy weed to total weed mass was lowest at all stages of crop growth as compared to non-grassy and sedges. **Paighan*et al.* (2013)** have also observed lower density of monocot weeds over dicot at 60 days after sowing in the experimental plot atParbhani, Maharastra.

The increase in total weed population in weedy plot was observed up to 90 days after sowing thereafter it decreased. This indicate that all weeds emerged during first 90 days, thereafter competition among weeds and with crop plant caused reduction in total weed population. This result was also in conformity of **Kumar *et al.* (2013)** results in which they reported that higher total weed count per unit area at 90 days stage over at harvest stage of crop growth. The lower weed density with that treatment might be due to inherent ability of weed free to the effect of cell division, cell growth and hampering the germination of weeds. Similar findings reported by **Pandey and Kumar (2005).** The lowest weed biomass observed with these treatments was due to efficient control of dominant weeds from the beginning of crop growth **(Pandey and Dwivedi 2011).** Similarly, dry weight of weed was also registered significantly lower with weed free treatment at all the stages of crop growth. Hand weedings exhibited significant influence on weed population at all the stages of crop growth. Significantly the lowest weed density was observed with weed free treatment at all the stages of crop growth. This might be due to timely reduction of weeds below threshold level by intercultural tools. The weeds were uprooted and killed. Similar findings were observed by **Pandey *et al.* (1996).** Weed free treatment recorded lowest weed population metre^{-2} at all the stages of crop growth. Weedy check exhibited appreciably higher biomass metre^{-2} at all the stages of crop growth.

Weed control efficiency was found maximum with weed free treatment due to best control of most of the seed ages besides controlling of broad leaf weeds and grassy weeds. This has registered in significant lower weed population and had also led to very less dry weight of weeds when compared with other treatments. These findings are in close conformity with those of **Singh *et al.* (2002)** and **Singh *et al.* (2013).** Maximum weed index (%) was recorded with weedy check treatment and it was significantly higher than rest chemical methods of weed control practices. This might be due to the reduction in yield due to presence of weeds in comparison with weed free treatment.

5. Conclusion

From above study it is concluded that,among the different used herbicides, the most effective method of suppressing weeds (both grassy and non-grassy) was the post-emergence treatment of carfentrazone-ethyl 0.025 kg an i/ha 33 days after planting. The application of carfentrazone-ethyl 0.025 to suppress weed development led to a major enhancement of the growth parameters, yield attributes, and economic yield of wheat in comparison to the check control. Therefore, we can say that this method of weed control is seeming to be helpful for rural farmers and society. By using these recent technologies, we can achieve the higher levels of food production by reducing environmental damage and results to the more sustainable agricultural systems.

Reference

Anderson, R. L. and Beck, D. L. 2007. Charcterzing weed communities among various rotations in central south. *Dakota weed technology***21**: 76-79.

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

Kumar, S., Rana, S. S., Ramesh, and Chander, N. 2013. Herbicide combinations for broad-spectrum weed control in wheat. *Indian Journal of Weed science***45**(1): 29-33.

Paighan, V. B., Gore, A. K. and Chavan, A. S. 2013. Effect of new herbicides on growth and yield of wheat. *Indian Journal of Weed Science***45**(4): 291-293.

Pandey, I.B. and Kumar, K. (2005). Response of wheat (*Triticum aestivum*) to seeding methods and weed management. Indian J. Agron., 50 (1) : 48-51.

Pandey, I. B. and Dwivedi, D. K. (2007).Effect of planting pattern and weed-control methods on weed growth and performance of wheat (*Triticum aestivum*). Indian Journal of Agronomy, 52(3): 235-238.

Pandey JR, Sharma R, Singh P, Chander S (1996). Effect of time and method of Isoproturon application on weeds and yield of wheat (Triticum aestivum L.). Ind. J. Agron. 41:570

Singh G, Singh M and Singh VP (2002). Effect of metsulfuron-methyl alone and in combination with 2,4-D and surfactant on non-grassy weeds and wheat yield. Indian Journal of Weed Science 34: 175-177.

Singh, R. K., Verma, S. K. and Singh, R. P. 2013. Bio-efficacy of carfentrazone-ethyl + sulfosulfuron in wheat. *Indian Journal of Weed Science.* **45**(4): 243-246