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EVALUATION OF BIO EFFICACY OF VARIOUS HERBICIDES FOR WEED CONTROL AND THEIR EFFECTS ON GROWTH AND YIELD OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was conducted during *rabi* season (winter cropping season) of 2020-2021 at Khalsa College, Amritsar to evaluate the bioefficacy of various herbicides for weed control and their effects on growth and yield of wheat (*Triticum aestivum* L.). Weeds found at experimental site *viz.*, *Phalaris minor*, *Anagallis arvensis*, *Rumex spp.*, *Melilotus alba*, *Fumaria parviflora*, *Cornopus didymus*, *Medicago denticulate*, *Chenopodium album*, *Euphorbia helioscopia*, *Sonchus arvensis*, *Cannabis sativa*. Highest grain yield and straw yield was recorded under weed free treatment *i.e.* (55.50 q ha^{-1}) and (72.45 q ha^{-1}) followed by sulfosulfuron+metsulfuron 32 g ha^{-1} *i.e.* (55.27 q ha^{-1}) and (71.07 q ha^{-1}) respectively. Among single herbicide application sulfosulfuron 25 g ha^{-1} recorded grain yield and straw yield of 50.90 q ha^{-1} and 66.44 q ha^{-1} respectively. All the weed control treatments significantly influenced the grain and straw yield of wheat excluding weed check.Over the weedy check plot, weed control treatments dramatically reduced total weed density and weed dry matter accumulation. Among weed control, post-emergence application of sulfosulfuron +metsulfuron 32 g ha^{-1} recorded complete control of all the narrow and broad-leaved weeds, highest weed control efficiency (86.27%), lowest weed dry matter of broad leaf weed (2.02 q ha^{-1}) and narrow leaf weed (1.94 q ha^{-1}). Single herbicide sulfosulfuron 25 g ha^{-1} recorded significantly highest weed control efficiency (81.63%), lowest weed dry matter of broad leaf weed (2.21 q ha^{-1}) and narrow leaf weed (2.14 q ha^{-1})over the other treatments.

(Key words: Herbicides, weeds, chemical control, bioefficacy, wheat)

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of India's most important cereal crops, particularly in the north. Wheat is a popular cereal crop originating to south west Asia that belongs to the Gramineae family. After rice, it is the second most significant staple food crop. Several reports have indicated that global wheat population would need to be enchanced by 60% to match the food needs by 2050 (Kumar *et al.,* 2021). Besides, it would be interesting to recall that the establishment of field crops is very demanding in terms of energy needs (Mebarki *et al.,* 2020).Wheat usually suffers from stress created by mix flora of weeds through competition along with interference caused by secreting toxic substances to the rhizosphere of the crop plants.Apart from increasing the production cost, they also intensify the disease and insect pest problem by serving as alternative host. Presence of weeds especially at early stages was devastating for wheat yield.Yield losses are most severe when resources are limited and weeds with crops emerge simultaneously (Hussain *et al.*, 2015). The predominant weed flora recorded in wheat fields are *Phalaris minor, Avenaludo viciana, Avena fatua, Chenopodium album, Melilotus alba, Melilotus indica, Anagallis arvensis, Asphodelus tenuifolius, Medicago denticulata, Medica gohispida, Lolium temulentum,Coronopus didymus, Lathyrus aphaca, Cirsium arvense, Fumaria parviflora,Cynodon dactylon, Vicia sativa, Vicia hirsute, Cyperus rotundus, Rumex dentatus, Rumexretro flexus, Spergula arvensis and Trifolium flagiferum* (Punia *et al*., 2006).

Weeds not only reduce yield but also lower the quality of produce and increases the cost of harvesting, threshing and cleaning. Weed is the major cause of loss of yield in the wheat crop, apart from improved agronomic practices and preventions and preventive measures, chemical weed controls one of the important key factors to enhance the wheat production and productivity. Most of the small, medium and large farmers of Punjab districts are well aware about integrated weed control strategies, even though chemical weed control measures have prominent place and popularity among them. Therefore, proper selection of herbicide and time of application remains the only resort to check weed population and to improve crop yield. Herbicidal treatments increased grain yield as compared to un-weeded and hand weeding treatment (Amin *et al.*,2008). But as a part of rat-race among each other the farmers use excessive chemicals which are not only pollute the environment but hazardous human health too. That is

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why choice of best herbicide and time of application are the important consideration for lucrative returns. Keeping in view the importance of weeds problem in wheat, this study was undertaken to investigate the effectiveness and selectivity of different herbicide for controlling the weeds and to improve productivity of wheat crop by reducing high cost of manual labour in wheat.

MATERIALS AND METHODS

The study was carried out at Student's Research farm of P.G. Department of Agriculture, Khalsa College Amritsar,during *rabi* season of 2020-2021.The soil of the experimental field was categorized as sandy loam.The soil tested was found in low organic carbon (0.39 per cent) and available N (179 kg ha^{-1}). However,available P (22 kg ha^{-1}) and K (296 kg ha^{-1}) were in medium category.The soil pH (8.4) and electrical conductivity (0.21dSm^{-1}) values were within the normal range.The experiment comprised of eleven treatments,pendimethalin at 750 g ha^{-1} as pre-emeregence, pinoxaden 40 g ha^{-1}, metsulfuron 4 g ha^{-1}, sulfosulfuron 25 g ha^{-1},clodinafop 60 g ha^{-1},sulfosulfuron+metsulfuron 32 g ha^{-1}, mesosulfuron+iodosulfuron14.4g ha^{-1}, metribuzin + clodinafop 210+60 g ha^{-1}, fenoxaprop + metribuzin 120+210 g ha^{-1}, weed free (three hand weeding's) and weed check. Pendimethalin was sprayed next DAS (days after sowing) and all the other herbicides were applied at 30-35 DAS (days after sowing) using knapsack sprayer. On October 31, 2020, Unnat PBW 343, a wheat genotype, was planted using three different ways. A basal dose of 62.5 kg P ha^{-1} was applied at the time of sowing, with 125 kg N ha^{-1} applied in two splits (at first and second irrigation).On April 25, 2021, the crop was harvested. Yield and yield parameters *viz.*,grain yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1})and harvest index (H.I.) % were recorded at harvest. Weed parameters *viz.*, weed dry matter accumulation, weed density and weed control efficiency were recorded at 30, 60, 90, 120 days and at harvest, and subjected to "(x+1) transformation before statistical analysis. Statistical analysis of the data recorded was done as per random block design (Gomez *and* Gomez, 1984) using CPCS-1 software developed by the department of Mathematics and Statistics, PAU, Ludhiana. Weed control efficiency was calculated by using formula given by Kondap and Upadhayay (1985).

$$WCE=\frac{DMC-DMT}{DMC} X\ 100$$

Where,

WCE : Weed control efficiency

DMC : Dry matter of weeds from controlled (no weed control) plots

DMT : Dry matter of weeds from treated plots

RESULTS AND DISCUSSION

Effect on growth and yield

The maximum grain yield (55.5 q ha^{-1}) and straw yield (72.45 q ha^{-1}) was recorded under weed free conditions.The improved grain and straw yield under weed free treatment was closely followed by sulfosulfuron +metsulfuron 32 g ha^{-1} (55.26 q ha^{-1}) which was statistically at par with metribuzin+clodinafop 14.4 g ha^{-1} (Table 1). Usha Rani *et al.* (2013) reported that the uptake of NPK and the fertilizer use efficiency were maximum with the application of 50% N through urea along with neem cake followed by castor cake in both plants and ratoon crops. The higher yields under these treatments could be ascribed to better control of weeds which favored higher uptake of nutrients and water resulting optimum growth characters, *viz*., plant height, effective tillers, grain weight.These growth and yield attributes evidently reflected in higher grain and straw yields under these treatments.Significantly lower grain and straw yield were recorded under weed check.These findings were in close conformity with Singh and Singh (2004), who reported highest grain yield with pendimethalin 0.9 kg ha^{-1} pre-emergence supplemented by one hand weeding.In combination all the herbicides, fenoxaprop + metribu-zinrecorded lowest grain yield due to its phototoxicity to wheat plants and reduced the grain yield but recorded complete control of all the weeds.Efficacy of above herbicides in wheat crop has been reported earlier by Dhillion *et al*.(2005) and Singh (2007), who reported that combination of fenoxaprop+metribuzin recorded complete control of all the weeds, it might be due to phototoxicity effect to wheat plants which reduced the grain yield. Effective control of narrow and broad-leaved weeds with herbicides increased the number of effective tillers and the wheat plant produced longer panicles and the wheat yield increased.The effective tillers were significantly lower under clodinafop 60 g ha^{-1}as compared to all the treatments.Toxicity of metribuzin on wheat plants particularly at higher doses had been reported earlier by Pandey *et al*.(2002).

Table 1.Effect of different weed control treatments on yield (q ha^{-1}) and harvest index (%)

Treatments	Dose (g ha^{-1})	Biological yield (q ha^{-1})	Straw yield (q ha^{-1})	Grain Yield (q ha^{-1})	H.I. (%)
Weed free	-	127.95	72.45	55.50	43.57
Weed check	-	88.99	53.63	35.40	39.77
Pendimethalin	750	108.04	63.18	44.80	41.51
Pinoxaden	40	116.36	65.86	50.50	42.39
Metsulfuron	4	108.55	63.42	45.13	41.37
Sulfosulfuron	25	117.33	66.44	50.90	42.52
Clodinafop	60	109.73	64.13	45.60	41.55
Metsulfuron+sulfosulfuron	32	126.32	71.05	55.27	43.40
Mesosulfuron+iodosulfuron	14.4	123.70	70.90	52.80	42.67
Metribuzin+clodinafop	210+60	125.24	70.67	54.56	42.81
Fenoxaprop+metribuzin	120+210	120.48	68.89	51.60	42.31
SEm (±)		**3.95**	**2.76**	**1.6**	-
CD(p=0.05)		**11.93**	**8.19**	**4.51**	-

Effects on weeds

The predominant weed flora at experimental site were *Phalaris minor*,*Avena ludoviciana*, *Chenopodium album*, *Medicago denticulate*, *Rumex dentatus*, *Trigonella polycerata*, *Melilotu salba*, *Rumex spinosus* and *Anagallis arvensis*. Among broad leaf weeds the major weeds *Chenopodium album*, *Anagallis arvensis*, *Melilotus alba* and *Convolvulus arvensis* were found in the experimental field.Among single herbicides post emergence application of sulfosulfuron 25 g ha^{-1} alone was found superior to all the single herbicides, because sulfosulfuron produced the higher number of spikes which might be due to the better control of weeds.Weed control efficiency (WCE) was significantly higher with the application of sulfosulfuron 25 g ha^{-1} (81.63%) among single application of herbicides. Application of sulfosulfuron+metsulfuron 32 g ha^{-1} resulted in 86.27% WCE which was at par with metribuzin+clodinafop 210+60 g ha^{-1}, it might bedue to more control of narrow and broadleaf weeds (Table 2).Pinoxaden 40 g ha^{-1} and clodinafop 60 g ha^{-1}recorded effective control of narrow-leaved weeds only as these are basically grass herbicides.The lowest weed control efficiency (WCE) was observed under unweeded control, because of better weed competition stress.Effective control of narrow and broad-leaved weeds with herbicides increased the number of effective tillers and the wheat plant produced longer panicles and the wheat yield increased. The positive effect of herbicide mixtures in controlling complex weed flora have also been reported by Singh *et al.*(2005). Pinoxaden 40 g ha^{-1} was better in control of narrow and broad-leaf weeds as compared to pendimethalin 750 g ha^{-1}, metsulfuron 4 g ha^{-1}, clodinafop 60 g ha^{-1}. Pendimethalin steadily increased the total population of bacteria, fungi, and actinomycetes in soil under cotton after a short leg phase during the crop growth period. However, after harvest the soil microorganisms were affected by the pendimethalin residue in soil (Balasubramanian and Sankaran, 2001).

It is inferred from the data that combination of sulfosulfuron+metsulfuron 32 g ha^{-1}, single herbicide sulfosulfuron 25 g ha^{-1}produced maximum grain yield and straw yield by checking weed flora. Hence, these two treatments can be recommended while cultivating wheat in sandy loam soils of Punjab.

Table 2. Effect of different treatments on weed growth and weed control efficiency

Treatments	Weed dry matter At harvest (qha^{-1}) (Broad leaf weed)	Weed dry matter At harvest (qha^{-1}) (narrow weed leaf)	Weed density At harvest ($no.m^{-2}$) (Broad leaf weed)	Weed density At harvest ($no.m^{-2}$) (narrow weed leaf)	Weed control efficiency WCE(%)
Weed free	1(0)	1(0)	1(0)	1(0)	100
Weed check	4.12(15.99)	5.06(24.69)	7.63(57.27)	17.14(292.78)	0
Pendimethalin	3.32(10.08)	3.40(10.58)	3.71(12.83)	10.56(110.72)	49.21
Pinoxaden	2.29(4.25)	2.36(4.58)	3.10(8.62)	5.02(24.25)	78.21
Metsulfuron	2.46(5.10)	2.46(5.08)	3.35(10.25)	5.39(28.11)	74.90
Sulfosulfuron	2.21(3.89)	2.14(3.58)	2.98(7.89)	5.32(27.36)	81.63
Clodinafop	2.63(5.92)	2.50(5.28)	3.52(11.43)	5.12(25.28)	72.46
Sulfosulfuron+metsulfuron	2.02(3.10)	1.94(2.80)	2.49(5.23)	4.40(18.36)	86.27
Mesosulfuron+iodosulfuron	2.14(3.61)	1.96(2.85)	2.69(6.26)	4.60(20.19)	84.11
Metribuzin+clodinafop	2.05(3.21)	1.95(2.82)	2.61(5.82)	4.49(19.17)	85.17
Fenoxaprop+metribuzin	2.15(3.66)	1.97(2.88)	2.86(7.19)	4.88(22.91)	83.92
SEm (±)	**0.35**	**0.21**	**0.32**	**0.17**	
CD(p=0.05)	**1.02**	**0.62**	**0.91**	**0.51**	

The original data in parenthesis was subjected to $\sqrt{x+1}$ transformation

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