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Impact of herbicides on density of various weed species associated with late sown wheat

S. SHIL AND [1] S. PAUL

College of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
Chhatna-722132, Susunia, Bankura, West Bengal
[1]Division of Crop Production, ICAR-CRIJAF, Barrackpore-700120, Kolkata

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ABSTRACT

An experiment was carried out to assess the effect of different herbicide treatment (single or in combination) on weed population of late sown wheat variety, UP 2425 and its associated weed during rabi season at Agronomy Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad,U.P. by taking ten treatments viz. isoproturon @ 1000 g ha^{-1}, clodinafop @ 60g ha^{-1}, sulfosulfuron @ 25 g ha^{-1}, metasulfuron methyl @ 4 g ha^{-1}, isoproturon + metasulfuron methyl @ (1000+4) g ha^{-1}, clodinafop + metasulfuron methyl @ (60+4) gha^{-1}, sulfosulfuron + metasulfuron methyl @ (25+4) g ha^{-1}, carfentazone @ 25 g ha^{-1}, Weedy and weed free. Post emergence application of sulfosulfuron + MSM (25+4 g ha^{1}) significantly reduced the number of weeds as compared to other treatments but remained at par with weed free and isoproturon +MSM @ (1000 + 4g ha^{-1}). Growth and yield of the wheat crop was significantly higher with weed free and the values were at par with post emergence application of sulfosulfuron + metasulfuron methyl @ (25 + 4 g ha^{-1}) and isoproturon + metasulfuron methyl (1000+4 g ha^{-1}. From the above experimental observation, it might be concluded that herbicidal treatments reduced the weed population per unit area appreciably over weedy at 60th, 90th day and harvest stages of crop growth. Next to weed free, post emergence application of sulfosulfuron + MSM (1000 + 4 g ha^{-1}) has been found most effective to control the weeds as compared to other herbicide treatments at all the stages. Post emergence application of isoproturon + MSM (1000 + 4 g ha^{-1}) was found at par with clodinafop + MSM (60 + 4 g ha^{-1}) and both were significantly superior to weedy check and economically feasible for higher production of late sown wheat.

***Keywords*:** herbicides, late sown wheat, post-emergence application and weed density

Weeds are considered as one of the major constraints in wheat cultivation. The introductions of high yielding dwarf varieties, which comparatively require larger amount of water and fertilizers, have created conducive condition for luxuriant growth of weeds with high density. Amongst the various agronomic practices, weed control measure plays a significant role in maximizing the crop yield and productivity and help to maintain food basket (Mukherjee, 2005). The prominent weeds noted in late sown wheat are *Phalaris minor, Cynodon dactylon, Cyperus rotundus, Anagallis arvensis, Chenopodium, album, Polygonum plebium, Vicia sativa* and *Melilotus indica*. Weed infestation in late sown wheat causes heavy reduction in crop yield ranging from 15 to 50% (Gill and Brar, 1975), which may be minimized to a greater extent simply by adopting an appropriate weed management practice. Uncontrolled weeds are reported to cause up to 62 per cent reduction in wheat grain yield (Mukherjee, 2012) or even more depending upon the weed density, type of weed flora and duration of infestation. The immunity in weeds against any herbicide may be altered through alternate application of herbicides that implies any specific herbicide should not be used continuously for a longer period in a field for a particular crop (Paul *et al.*, 2017).

Wheat yield under late sown condition is poor due to the less exploitation of potentialities of the crop. Reduction in yield is mainly caused by delayed emergence of seedling and curtailing the growth and development periods of the crop. Weeds are considered as one of the major constraints in wheat cultivation. The introductions of high yielding dwarf varieties, which comparatively require larger amount of water and fertilizers, have created conducive condition for luxuriant growth of weeds with high density. Wheat competes well with weeds especially when grown with good production techniques. Effective weed control and prevention of weed seed production in preceding crop will reduce the risk of weed problem in wheat. A healthy, vigorous stand is extremely competitive with weeds and is the single most important component of weed control strategy. Suitable cultivation practices, timely sowing, seeding rate and fertilization *etc*. ensure proper plant stand and vigorous growth *vis-a-via* yield and to some extend reduced weed population.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* season of 2013-14 and 2014-15 at the Agronomy Research Farm of N. D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabd

Email: sanjoycrijaf@yahoo.co.in

Table 1: Weed flora of experimental crop

	Weed species	Common name	Family	Habitat
		Grasses		
1.	*Phalaris minor* Retz.	Canary grass	Poaceae	Annual
2.	*Avena fatua*	Wild oat	Poaceae	Annual
3.	*Cynodon dactylon*	Bermuda grass	Poaceae	Annual
		Sedges		
1.	*Cyperus rotundus*	Nut sedge	Cyperaceae	Perennial
		Broad leaf weeds		
1.	*Chenopodium album* L.	Lambs quarter	Chenopodiaceae	Annual
2.	*Anagallis arvensis* L.	Blue pimpernal	Primulaceae	Annual
3.	*Convolvulus arvensis* L.	Field binder	Convonvulaceae	Annual
4.	*Melilotus alba* Medikus	Sweet clover	Leguminosae	Annual
5.	*Vicia hirsuta*	Common vetch	Leguminosae	Annual
6.	*Lathyrus aphaca*	-	Leguminosae	Annual

Table 2: Effect of herbicide treatments on weed density (m^{-2}) at 30 DAS

Treatments	*C. album*	*A. arvensis*	*P. minor*	*C. arvensis*	*M. alba*	*C. rotundus*	Other
Isoproturon @ 1000 g ha^{-1}	6.18 (38.13)	7.59 (57.15)	5.14 (26.01)	4.06 (16.05)	5.59 (30.88)	3.70 (13.42)	4.65 (21.10)
Clodinafop @ 60 g ha^{-1}	5.98 (35.41)	7.31 (53.07)	4.96 (24.15)	3.92 (14.91)	5.39 (28.67)	3.57 (12.29)	4.47 (19.59)
Sulphosulfuron @ 25 g ha^{-1}	5.92 (34.63)	7.23 (51.90)	4.90 (23.62)	3.88 (14.58)	5.33 (28.04)	3.53 (12.02)	4.43 (19.16)
Metasulfuron methyl @ 4 g ha^{-1}	6.33 (39.69)	7.74 (59.49)	5.24 (27.09)	4.14 (16.71)	5.71 (32.14)	3.77 (13.78)	4.74 (21.96)
IPU + MSM @ (1000+4) g ha^{-1}	6.35 (40.08)	7.76 (60.07)	5.26 (27.34)	4.16 (16.87)	5.74 (32.46)	3.79 (13.92)	4.75 (22.18)
Clodinafop + MSM @ (60+4) g ha^{-1}	6.17 (37.74)	7.54 (56.59)	5.11 (25.74)	4.04 (15.89)	5.56 (30.56)	3.68 (13.10)	4.61 (20.88)
Sulphosulfuron + MSM @ (25+4) g ha^{-1}	6.09 (36.58)	7.43 (54.82)	5.04 (24.95)	3.98 (15.40)	5.48 (29.62)	3.63 (12.70)	4.55 (20.24)
Carfentrazone @ 25 g ha^{-1}	5.86 (34.28)	7.18 (51.32)	4.87 (23.36)	3.85 (14.41)	5.30 (27.73)	3.51 (11.89)	4.40 (18.95)
Weedy	6.02 (35.80)	7.35 (53.65)	4.99 (24.42)	3.93 (15.07)	5.42 (28.99)	3.59 (12.43)	4.51 (19.81)
Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SEm (±)	**0.30**	**0.29**	**0.20**	**0.17**	**0.20**	**0.14**	**0.16**
LSD (0.05)	**0.88**	**0.86**	**0.61**	**0.52**	**0.59**	**0.43**	**0.47**

Note : Data in parentheses indicate $\sqrt{x+0.5}$ *transformed values*

(U.P.). The experimental site is situated in main campus of the university, about 42 km away from Faizabad on Raibareli road at $26^0$47' N latitude $82^0$12' E longitude and an altitude of 113 meters above mean sea level. The soil of the experimental field was silt loam in texture, low in organic carbon & nitrogen and medium in available phosphorus and potash having pH 8.4 and E.C. 0.32 dsm^{-1}. A double gene dwarf wheat cultivar UP 2425 was used. The sowing was done in line with seed drill. The experiment having a total of ten treatments that was laid out in RBD design with three replications and the herbicides applied either in a single dose or in combination of two herbicides. The different herbicides and their standard doses were isoproturon (IPU) @ 1000

Table 3: Effect of herbicide treatments on weed density (m^{-2}) at 60 DAS

Treatment	*C. album*	*A. arvensis*	*P. minor*	*C. arvensis*	*M. alba*	*C. rotundus*	Other
Isoproturon @	3.15	4.85	4.05	3.10	4.34	3.72	2.82
1000 g ha^{-1}	(9.54)	(23.07)	(15.92)	(9.14)	(18.38)	(13.40)	(7.43)
Clodinafop @	4.02	6.19	3.41	2.62	5.53	3.14	3.16
60 g ha^{-1}	(15.68)	(37.93)	(11.15)	(6.40)	(30.22)	(9.38)	(9.50)
Sulphosulfuron @	2.87	4.39	3.29	2.53	3.93	3.03	2.68
25 g ha^{-1}	(7.79)	(18.83)	(10.35)	(5.95)	(15.00)	(8.71)	(6.69)
Metasulfuron methyl	2.08	3.13	4.42	3.38	2.81	4.07	3.42
@ 4 g ha^{-1}	(3.85)	(9.32)	(19.11)	(10.97)	(7.42)	(16.08)	(11.21)
IPU + MSM @	1.67	2.45	2.46	1.92	2.22	2.27	2.18
(1000+4) g ha^{-1}	(2.29)	(5.55)	(5.57)	(3.20)	(4.42)	(4.69)	(4.26)
Clodinafop + MSM @	1.95	2.91	2.90	2.25	2.62	2.68	2.37
(60+4) g ha^{-1}	(3.31)	(8.01)	(7.96)	(4.57)	(6.38)	(6.70)	(5.13)
Sulphosulfuron + MSM	1.43	2.07	2.15	1.69	1.87	1.99	1.75
@ (25+4) g ha^{-1}	(1.56)	(3.77)	(4.11)	(2.36)	(3.00)	(3.46)	(2.56)
Carfentrazone @	2.51	3.83	4.88	3.72	3.43	4.48	3.50
25 g ha^{-1}	(5.87)	(14.20)	(23.38)	(13.44)	(11.31)	(19.68)	(11.81)
Weedy	4.10	6.32	6.59	5.00	5.65	6.05	4.76
	(16.32)	(39.48)	(42.99)	(24.67)	(31.45)	(36.19)	(22.17)
Weed free	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SEm (±)	**0.13**	**0.16**	**0.16**	**0.14**	**0.14**	**0.14**	**0.09**
LSD (0.05)	**0.38**	**0.46**	**0.46**	**0.43**	**0.43**	**0.42**	**0.27**

Note : Data in parentheses indicate $\sqrt{x+0.5}$ *transformed values*

Table 4: Effect of herbicide treatments on weed density (m^{-2}) at 90 DAS

Treatment	*C. album*	*A. arvensis*	*P. minor*	*C. arvensis*	*M. alba*	*C. rotundus*	Other
Isoproturon @	2.80	4.06	2.48	2.08	3.24	2.47	2.21
1000 g ha^{-1}	(7.44)	(15.95)	(5.68)	(3.85)	(10.06)	(5.60)	(4.38)
Clodinafop @	3.56	5.16	2.11	1.79	4.12	2.10	2.47
60 g ha^{-1}	(12.23)	(26.23)	(3.98)	(2.70)	(16.54)	(3.92)	(5.60)
Sulphosulfuron @	2.56	3.67	2.05	1.73	2.95	2.03	2.10
25 g ha^{-1}	(6.07)	(13.02)	(3.69)	(2.50)	(8.21)	(3.64)	(3.94)
Metasulfuron methyl	1.87	2.63	2.70	2.26	2.14	2.69	2.67
@ 4 g ha^{-1}	(3.00)	(6.44)	(6.82)	(4.62)	(4.06)	(6.72)	(6.61)
IPU + MSM @	1.51	2.08	1.57	1.36	1.71	1.57	1.73
(1000+4) g ha^{-1}	(1.79)	(3.84)	(1.99)	(1.35)	(2.42)	(1.96)	(2.51)
Clodinafop + MSM	1.75	2.45	1.82	1.56	1.99	1.81	1.87
@ (60+4) g ha^{-1}	(2.58)	(5.54)	(2.84)	(1.93)	(3.49)	(2.80)	(3.02)
Sulphosulfuron +	1.31	1.76	1.40	1.22	1.46	1.40	1.42
MSM @ (25+4) g ha^{-1}	(1.22)	(2.61)	(1.47)	(1.00)	(1.64)	(1.45)	(1.51)
Carfentrazone @	2.24	3.21	2.97	2.48	2.58	2.95	2.73
25 g ha^{-1}	(4.58)	(9.82)	(8.34)	(5.66)	(6.19)	(8.23)	(6.96)
Weedy	3.63	5.27	3.98	3.29	4.20	3.95	3.68
	(12.73)	(27.31)	(15.34)	(10.40)	(17.21)	(15.13)	(13.07)
Weed free	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SEm (±)	**0.11**	**0.13**	**0.09**	**0.09**	**0.11**	**0.09**	**0.07**
LSD (0.05)	**0.34**	**0.38**	**0.27**	**0.27**	**0.31**	**0.27**	**0.21**

Note : Data in parentheses indicate $\sqrt{x+0.5}$ *transformed values*

Table 5: Effect of herbicide treatments on weed density (m^{-2}) at harvest

Treatment	*C. album*	*A. arvensis*	*P. minor*	*C. arvensis*	*M. alba*	*C. rotundus*	Other
Isoproturon @	1.96	-	1.94	-	-	2.07	1.91
1000 g ha^{-1}	(3.38)		(3.28)			(3.80)	(3.16)
Clodinafop @	2.46	-	1.67	-	-	1.78	2.13
60 g ha^{-1}	(5.56)		(2.30)			(2.66)	(4.04)
Sulphosulfuron @	1.80	-	1.62	-	-	1.72	1.83
25 g ha^{-1}	(2.76)		(2.13)			(2.47)	(2.84)
Metasulfuron methyl	1.36	-	2.10	-	-	2.25	2.29
@ 4 g ha^{-1}	(1.37)		(3.94)			(4.56)	(4.77)
IPU + MSM @	1.14	-	1.28	-	-	1.35	1.52
(1000+4) g ha^{-1}	(0.81)		(1.15)			(1.33)	(1.81)
Clodinafop + MSM @	1.29	-	1.46	-	-	1.55	1.63
(60+4) g ha^{-1}	(1.17)		(1.64)			(1.90)	(2.18)
Sulphosulfuron +	1.03	-	1.16	-	-	1.22	1.26
MSM @ (25+4) g ha^{-1}	(0.55)		(0.85)			(0.98)	(1.09)
Carfentrazone @	1.60	-	2.30	-	-	2.46	2.35
25 g ha^{-1}	(2.08)		(4.82)			(5.59)	(5.02)
Weedy	2.50	-	3.06	-	-	3.28	3.15
	(5.79)		(8.86)			(10.27)	(9.43)
Weed free	0.71	-	0.71	-	-	0.71	0.71
	(0.00)		(0.00)			(0.00)	(0.00)
SEm (±)	**0.07**	**-**	**0.07**	**-**	**-**	**0.07**	**0.06**
LSD (0.05)	**0.22**	**-**	**0.20**	**-**	**-**	**0.21**	**0.17**

Note : Data in parentheses indicate $\sqrt{x+0.5}$ *transformed values*

g ha^{-1}; clodinafop @ 60 g ha^{-1}; sulfosulfuron @ 25 g ha^{-1}; metsulfuron methyl (MSM) @ 4 g ha^{-1}; IPU + MSM @ (1000+4) g ha^{-1}; clodinafop + MSM @ (60+4) g ha^{-1}; sulfosulfuron + MSM @ (25+4) g ha^{-1}; carfentazone @ 25 g ha^{-1}; weedy and weedy free. All herbicides (as per treatments) were applied as post emergence after first irrigation at 45 days after sowing with the help of manually operated knapsack sprayer fitted with flat fan nozzle using 600 liters water per hectare. The experimental crop was infested with a wide spectrum of weed flora and the different weed floras observed are listed in the table 1. The major flora recorded in weedy check were *viz*. *Phalaris minor* of grassy group, *Chenopodium album, Anagallis arvensis, Melilotus alba, Convolvulus arvensis* of broad leaf group and *Cyperus rotundus* of sedges group. The other less important weeds were *Cynodon dactylon, Vicia hirsuta, Lathyrus aphaca* and *Avena fatua.*

Weed density

Species wise weed density in the experimental field was calculated by placing 0.25 m^2 quadrat randomly in 3 different locations in each field. Weed abundance was calculated by counting and recording the weed species within 0.25 m^2 quadrat in each plot at 30, 60, 90 days and at harvest stage. Shannon-Wiener index (H) was calculated out using the formula:

$$H = \frac{N \log N - \sum fi \log fi}{N}$$

Where, N is the total number of abundance per location, fi is the abundance of individual specie. Density was calculated using the formula by Sharma (1998) as shown below:

$$D = \frac{\text{Frequency}/100 \times \text{Abundance}}{\text{Number of quadrats}}$$

RESULTS AND DISCUSSION

Species wise weed density recorded at 30th, 60th, 90th day stages and at harvest have been presented in the tables 2, 3, 4 and 5, respectively. It is obvious from the data that weedy check recorded the highest weed density while the lowest was recorded with weed free at all the stages of crop growth. At 30 DAS, before application of herbicide highest density of *A. arvensis* followed by *M. alba* and *C. album* were recorded. At 60 DAS, the density of all the weed species decreased due to various herbicidal treatments. Amongst herbicides sulfosulfuron + MSM @ 25 + 4g ha^{-1} as post emergence has been found most effective to reduce the population of almost all species of weed flora followed by isoproturon + MSM (1000+4g ha^{-1}) as post emergence. Both the treatments were found significantly better to control weeds of different species as compared to weedy check and rest of the treatments (Table 3). Similar results were also

observed at 90 DAS (Table 4). At harvest, weeds like *A. arvensis, C. arvensis* and *Melilotus alba* were not present in the field (Table 5).

Divergent weed flora like *P. minor, C. dactylon, A. fatua* of grassy weeds, *C. album, A. arvensis, C. arvensis, M. indica, Asphodelus* spp., *V. hirsuta* and *L. aphaca* of broad leaf weed and *C. rotundus* of sedges were noted. Similar weed flora of wheat crop under normal as well as late sown condition has also been reported by Tripathi and Vaishya (1997), Singh *et al.* (2006) and Malik *et al.* (2006). Reduced weed density under these treatments has resulted in reduced weed dry weight. Similar findings were also reported by Dhawan *et al.* (2009).

By and large, all the herbicidal treatments reduced the weed population per unit area appreciably over weedy at 60th, 90th day and harvest stages of crop growth. Next to weed free, post emergence application of sulfosulfuron + MSM (1000 + 4 g ha^{-1}) has been found most effective to control the weeds as compared to other herbicide treatments at all the stages. Post emergence application of isoproturon + MSM (1000 + 4 g ha^{-1}) was found at par with clodinafop + MSM (60 + 4 g ha^{-1}) and both were significantly superior to weedy check. Effective weed control in wheat by the use of herbicide has also been observed by Verma *et al.* (2008).

Keeping above results in view it may be concluded that for effective weed control and maximize the grain as well as straw yield (as mentioned below), post-emergence application of sulfosulfuron (25g ha^{-1}) tank mixed either with MSM (4 g ha^{-1}) or with IPU + MSM @ (1000 + 4) g ha^{-1} may be applied at 45 days after sowing in late sown wheat. Regarding grain yield, sulfosulfuron (25g ha^{-1}) application resulted 34.10 q ha^{-1}, sulfosulfuron (25g ha^{-1}) tank mixed with MSM (25 + 4 g ha^{-1}) brought about 38.23 q ha^{-1}and IPU + MSM @ (1000 + 4) g ha^{-1} caused to 36.51 q ha^{-1} of grain yield in late sown wheat. Whereas in case of straw yield, Sulfosulfuron (25 g ha^{-1}) application resulted 46.32 q ha^{1}, Sulfosulfuron (25g ha^{-1}) tank mixed with MSM (25 + 4 g ha^{-1}) brought about 51.98 q ha^{-1} and IPU + MSM @ (1000+4) g ha^{-1} caused to 49.21 q ha^{-1} of straw yield in late sown wheat. So, it is recommended to apply the above mentioned three treatments for proper weed management along with improved the productivity of late sown wheat.

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