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Research Communication

Effect of different weed management practices on weed growth, wheat yield attributes and yield

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ABSTRACT

A field experiment was conducted at Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh during *rabi* season of 2020–21, to determine the most effective herbicide and herbicide combinations for controlling the *Phalaris minor* and other weeds in wheat. The experiment was laid out in Randomized Block Design (RBD) comprising six chemical weed management treatments T_1, prosulfocarb 80 EC @ 1600 ml/ha (PE); T_2, prosulfocarb 80 EC @ 2000 ml/ha (PE); T_3, prosulfocarb 80 EC @ 3000 ml/ha (PE); T_4, sulfosulfuron @ 25 g/ha (PoE); T_5, clodinofop + metsulfuron @ 60 + 4g/ha (PoE); T_6, sulfosulfuron + metsulfuron @ 30 + 2 g/ha (PoE) as post-emergence herbicide and herbicide combinations and three non-chemical treatments as T_7, weed free up to 60 DAS; T_8, weedy check and T_9, 2 hand-weeding at 20 and 40 days after sowing (DAS). The results showed that weed free up to 60 DAS, recorded significantly the lowest population of *Phalaris minor* and other weeds as compared other treatments at 60, 90 DAS and harvesting stage. Weed free up to 60 DAS recorded lowest amount of weed dry weight (8.5g/m³) significantly lowerother weed control treatments. Among the herbicides, spray of sulfosulfuron + metsulfuron (30 + 2 g/ha) recorded significantly lower dry-matter (25.8g/m³) compared to herbicide applied in combinations or as alone. Combined application of herbicides was found more effective in improving growth character and yield parameters as compared to sole application of herbicides. However, weed free up to 60 DAS produced highest yield but unavailability of labours at right times and its high wages makes it uneconomical.

***Key words*:** Clodinofop, Herbicide, Metsulfuron, Prosulfocarb, Sulfosulfuron

Wheat (*Triticum aestivum* L.) is a important staple food for millions of people worldwide, belonging to family Poaceae. In many countries, it is the main cereal crop and is extremely important for maintaining food security. Despite this, widespread weed infestations drastically lower wheat productivity. Both broadleaved and grassy weeds are harmful to wheat agriculture and present a significant problem, especially in Eastern India. Finding herbicides that work well for managing mixed weed flora is therefore essential. Numerous weeds, including Avena sp. and Rumex sp., have been shown to be resistant to herbicides (Punia *et al.,* 2017).

The main wheat growing countries include China, India, U.S.A., Russia, France, Canada, Germany, Turkey, Australia, and Ukraine. In India, wheat is next only to rice in terms of area and production. Weeding at an early stage of crop growth is a veryimportant practice because heavy infestation of weeds hampers the crop growth as well asgreater reduction in wheat yield. Slow growth of wheat plants during early growth stage isprovide specific conditions for the growth of various weed flora at the time of germination and also subsequent growth periods. Estimates of yield losses, particularly from P. minor infestations alone, range from 25 to 50 percent; in cases of extremely severe infestation, losses could reach 80% or higher (Malik *et al.,* 1996). The issue with this weed is particularly severe in rice–wheat cropping systems because P. minor has become resistant to isoproturon as a result of years of constant use. Weeds must be controlled by using any efficient weed control method in order to achieve cost-effective wheat yields. Keeping these facts in view, some new herbicide molecules individually and in combination are to be tested to study their bio-efficiency in control *Phalaris minor and* other weeds in wheat.

A field experiment was conducted at the Agronomy research farm, Acharya Narendra Deva University of

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Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh during *rabi* season of 2020–21. The experimental field was well levelled having good irrigation and drainage facilities. The soil of experimental site was silty loam having 0.45% organic carbon, 8.22 *p*H, 147.16, 14.36 and 257.28 kg/ha available N, P and K, respectively. The source of irrigation was tube well. The experiment was laid out in RBD with six chemical weed management treatments T_1, prosulfocarb 80 EC @ 1,600 ml/ha (PE); T_2, prosulfocarb 80 EC @ 2,000 ml/ha (PE), T_3, prosulfocarb 80 EC @ 3,000 ml/ha (PE); T_4, sulfosulfuron @ 25 g/ha (PoE), T_5, clodinopop + metsulfuron @ 60 + 4 g/ha (PoE); T_6, sulfosulfuron + metsulfuron @ 30 + 2 g/ha (PoE) and rest of the treatments were T_7, weed free up to 60 DAS; T_8, weedy check and T_9, 2 hand weeding at 20 and 40 DAS. The wheat variety *DBW-252* was sown at proper moisture on 7th December, 2020. Sowing was done in row 20cm. apart and 4-5cm deep in furrow @ 100 kg/ha seeds in all the plots. All the herbicides i.e. prosulfocarb 80 EC (PE) @ 1600 ml/ha, prosulfocarb 80 EC(PE) @ 2000 ml/ha, prosulfocarb 80 EC (PE) @ 3,000 ml/ha, sulfosulfuron @ 25 g/ha, clodinafop + metsulfuron @ 60 + 4 g/ha, sulfosulfuron + metsulfuron 30 + 2 g/ha, were applied as pre and post-emergence, asper treatments, with thehelp of a knap-sack sprayer fitted with flat-fan nozzle with a spray volume of 500 l/ha water. Weed density was recorded using a quadrate of 1.0 m × 1.0 m size randomly from each plot as described by Mishra and Puri (1954). Weeds count was taken for dominated weed species wise i.e. *Phalaris minor, Chenopodium album*, *Anagallis arvensis* and *Melilotus indica* individual in each plot. Count for rest of the weeds was later as other weeds. Weeds were recorded at 30, 60 and 90 DAS stage of crop growth and reported as number of weeds/m^2. The data on number of weeds were subjected to square root transformation using ($\sqrt{x+1}$).

Effect on weed density

A perusal of the data (Table 1) revealed that the population of *Phalaris minor* and others weeds was gradually increased from

Tables 1. Effect of weed control measure on density and dry weight of weed at different crop growth stages

Treatments	Weed population (No /m^2)						Weed dry weight (g/m^2)					
	60 DAS		90 DAS		At harvesting		60 DAS		90 DAS		At harvesting	
	P. minor	Other Weed	*P.minor*	Other Weed	*P. minor*	Other Weed	*P. minor*	Other Weed	*P. minor*	Other Weed	*P. minor*	OtherWeed
Prosulfocarb 80 EC (PE) @ 1,600 ml/ha	138.1 (11.75)	187.1 (13.67)	164.7 (12.83)	232.1 (15.23)	179.3 (13.39)	248.3 (15.75)	23.29 (4.83)	7.19 (2.68)	29.29 (5.41)	8.67 (2.94)	31.8 (5.63)	9.4 (3.06)
Prosulfocarb 80 EC (PE) @ 2,000 ml/ha	104.90 (10.24)	139.4 (11.80)	151.3 (12.30)	214.3 (14.63)	163.1 (12.77)	225.1 (15.00)	28.76 (5.36)	8.57 (2.92)	35.58 (5.96)	10.39 (3.22)	37.5 (6.12)	10.9 (3.30)
Prosulfocarb 80 EC (PE) @ 3,000 ml/ha	126.9 (11.26)	171.3 (13.08)	126.1 (11.22)	176.9 (13.30)	139.9 (11.82)	191.9 (13.85)	19.77 (4.44)	6.15 (2.47)	24.57 (4.95)	7.36 (2.71)	27.5 (5.24)	8.2 (2.86)
Sulfosulfuron @ 25 g/ha (POE)	90.80 (9.52)	119.4 (10.92)	107.1 (10.34)	148.7 (12.19)	121.7 (11.03)	165.7 (12.87)	20.14 (4.48)	6.24 (2.49)	20.35 (4.51)	6.25 (2.50)	23.4 (4.83)	7.2 (2.68)
Clodinopop + metsulfuron @ 60 g + 4 g/ha (PoE)	89.0 (9.43)	120.9 (10.99)	90.4 (9.50)	124.7 (11.16)	104.4 (10.21)	141.9 (11.91)	13.42 (3.66)	4.43 (2.10)	16.54 (4.06)	5.24 (2.28)	19.7 (4.43)	6.10 (2.46)
Sulfosulfuron + metsulfuron @ 30 g + 2 g/ha (PoE)	61.90 (7.86)	82.2 (9.06)	75.3 (8.67)	102.9 (10.14)	89.3 (9.44)	120.9 (10.99)	-	-	5.36 (2.31)	2.17 (1.47)	6.10 (2.46)	2.40 (1.54)
Weed free up to 60 DAS	-	-	28.9 (5.37)	36.9 (6.07)	33.1 (5.75)	41.4 (6.43)	52.55 (7.24)	15.56 (3.94)	64.37 (8.02)	18.23 (4.26)	67.0 (8.18)	18.5 (4.30)
Weedy check	226.4 (15.04)	311.3 (17.64)	271.9 (16.48)	382.1 (19.54)	284.9 (16.87)	402.4 (20.05)	14.16 (3.76)	4.85 (2.20)	17.49 (4.18)	5.58 (2.36)	20.5 (4.52)	6.50 (2.54)
Two hand weeding @ 20 and 40 DAS	71.10 (8.43)	98.0 (9.89)	89.0 (9.43)	106.0 (10.29)	92.7 (9.62)	126.4 (11.24)	23.29 (4.83)	7.19 (2.68)	29.29 (5.41)	8.67 (2.94)	31.8 (5.63)	9.4 (3.06)
SEm±	0.14	0.01	0.05	0.08	0.09	0.14	0.02	0.02	0.07	0.08	0.07	0.13
CD (P=0.05)	0.41	0.03	0.14	0.23	0.26	0.41	0.06	0.06	0.20	0.23	0.20	0.38

PE, pre-emergence; PoE, post-emergence

30 days to harvesting stage under all weed management treatments except weed free treatment where crop was kept weed free up to 60 days and thereafter weeds were allowed to grown. Weed free up to 60 days, recorded significantly the lowest population of *Phalaris minor* and other weeds as compare to rest of the treatments at 90 days and harvesting stage. Lower weed population under weed free as compared to rest of the treatments was mainly because of the fact that early emergence of weeds almost at critical period of weed crop competition was checked by providing hand weeding up to 60 days hence, weeds emerged after 60 days was less in number thus weed free up to 60 days recorded the lowest population at 90th and harvesting stage. Among the herbicide treatments, post emergence spray of ready mixture of sulfosulfuron + metsulfuron @ 30 g + 2 g/ha recorded significantly the lowest weed population of *P. minor* and other weeds at all stages of crop growth as compared to rest of the treatments which was followed by clodinafop + metsulfuron @ 60 g + 4 g/ha, sulfosulfuron @ 2.5 g/ha and all 3 formulation of prosulfocarb. Two hand weeding at 20 and 40 days of sowing recorded significantly the lower weed population of *P. minor* and other weeds at 60th, 90th and harvesting stage as compared to rest of the herbicidal treatments except sulfosulfuron + metsulfuron @ 30 g + 2 g/ha. This was because of the fact that the emergence of weeds after critical period was less as crop was kept weed free by providing 2 hand weeding at 20 and 40 days of sowing. Among the prosulfocarb formulations, pre emergence spray of prosulfocarb @ 2,000 ml/ha recorded the lowest population of weeds which was followed by prosulfocarb @ 3,000 ml/ha. Lower dose of prosulfocarb @ 1,600 ml/ha recorded the highest population of weeds as compared to its both higher dose i.e. 2,000 ml/ha and 3000 ml/ha. Ready mixture of either sulfosulfuron + metsulfuron @ 30 g + 2 g/ha or clodinafop + metsulfuron @ 60 g + 4 g/ha was found effective as compared to herbicide applied alone. Similar lower population of weeds with application of herbicide mixture in wheat crop was reported by Tomar and Tomar (2014), Singh *et al*. (2013).

Effect on weed dry weight

A perusal of data presented in table- 1 indicate that the dry weight of weed species wise increased at all stages of cop growth under all doses of prosulfocarb and weedy check treatments. However, application of sulfosulfuron @ 25 g/ha, clodinafop + metsulfuron @ 60 + 4 g/ha (PoE) and Sulfosulfuron + Metsulfuron @ 30 g + 2 g/ha (PoE) recorded the lowest dry weight of weeds at 60 days stage and thereafter increased up to harvesting stage. While, in case of weed free up to 60 days, the dry weight of weeds was, however, significantly lower as compared to rest of the treatment but increased at 90 days and harvesting stage. Dry weight of weeds was also increased with 2 hand weeding treatments from 60 days to harvesting stage of crop due to emergence of weeds after 40 days. Among the herbicide treatments application of ready mixture of clodinafop + metsulfuron @ 60 + 4 g/ha recorded the lowest amount of weed dry weight at 30 days stages which was followed by sulfosulfuron + metsulfuron @ 30 + 2 g/ha, and sulfosulfuron @ 25 g/ha. All 3 formulation of prosulfocarb recorded significantly the highest amount of dry weight of weeds as compared to rest of the herbicides treatments, however pre-emergence application of prosulfocarb @ 2000 ml/ha recorded the lowest amount of dry weight of weeds at all stages of crop growth which was followed by prosulfocarb @ 3,000 ml/ha and highest being with prosulfocarb @ 1,600 ml/ha. The lowest dry weight of weeds with post-emergence application of either sulfosulfuron + metsulfuron @ 30 + 2 g/ha or clodinafop + metsulfuron @ 60 + 4 g/ha as compared to rest of herbicides application at 60, 90 days and harvesting stage might be due to effective control of both i.e. narrow weeds and broad-leaved weeds as compared to herbicide applied as alone. Hence, recorded the lowest weed dry weight with ready mixture of herbicide application. Similar effective control of both type of weed flora in wheat crop was reported by Singh *et al.* (2010), Singh *et al.* (2011), Meena and Singh (2011). However, all formulations of pre-emergence spray of prosulfocarb recorded the higher dry weight of weeds as compared to sulfosulfuron @ 25 g/ha was mainly attributed to effective control of weeds. Similar, lower weed dry weight was recorded under sulfosulfuron @ 25 g/ha as compared to other herbicide applied as alone was recorded by Singh *et al.* (2010), Singh *et al.* (2011), Meena and Singh (2011).

Effect on yield attributes and yield

Weed management practices significantly affected the all-yield attributes and grain yield of wheat are presented in Table 2 revealed that wheat crop maintained as weed free up to 60 DAS recorded significantly highest values of all yield attributes like effective tillers/m^2, spike length, grain/spike, grain weight/spike and 1000 grain weight as compared to rest of the weed management practices. However, the difference between weed free up to 60 DAS and sulfosulfuron + metsulfuron (30 + 2 g/ha) was not significant for spike length and grain weight/spike. Among the herbicidal treatments application of sulfosulfuron + metsulfuron (30 + 2 g/ha) and clodinopop + metsulfuron (60 + 4 g/ha) was at par with each other but recorded significantly higher values of all yield attributes over rest of the herbicide treatments.

Weed free up to 60 DAS recorded significantly higher

Table 2. Effect of weed control measure on yield and yield attributes of wheat

Treatment	Yield attributes					
	Effective tillers/ m^2	Grain/ spike (no.)	Spike length (cm)	Grain weight/ spike	1,000-Grain weight (g)	Grain yield (t/ha)
Prosulfocarb 80 EC (PE) @ 1,600 ml/ha	370.12	43.33	8.96	1.59	37.72	3.32
Prosulfocarb 80 EC (PE) @ 2,000 ml/ha	378.16	44.50	9.03	1.60	37.90	3.46
Prosulfocarb 80 EC (PE) @ 3,000 ml/ha	365.25	43.80	9.00	1.52	37.77	3.36
Sulfosulfuron @ 25 g/ha (POE)	390.46	44.90	9.14	1.65	38.26	3.71
Clodinopop + metsulfuron @ 60 g + 4 g/ha (PoE)	406.13	45.70	9.80	1.83	38.65	4.05
Sulfosulfuron + metsulfuron @ 30 g + 2 g/ha (PoE)	415.18	46.10	9.82	1.85	40.34	4.06
Weed free up to 60 DAS	466.26	52.3	10.12	1.94	41.22	4.20
Weedy check	302.16	40.23	7.35	1.32	32.63	3.22
Two hand weeding @ 20 and 40 DAS	420.11	46.86	9.85	1.87	40.56	4.10
SEm±	6.72	0.40	0.168	0.081	0.35	0.33
CD (P=0.05)	19.89	1.18	0.47	0.23	1.03	0.98

PE, pre-emergence; PoE, post-emergence

grain yield (4.20 t/ha) over rest of the treatments. However, application of sulfosulfuron + metsulfuron (30+2 g/ha) being at par with clodinopop + metsulfuron (60 g + 4 g/ha) but produced significantly higher grain yield over rest of the treatments. The higher grain yield with weed free upto 60 DAS was mainly attributed due to higher availability of plant nutrients owing to efficient weed control and higher values of yield attributes. Similarly, combination of herbicides, controlled the both type of weed i.e., narrow as well as broad leaved weeds as compared to single herbicides caused lower crop-weed competition and higher availability of plant nutrients for growth, resulted in higher value of yield attribute and yield of wheat crop. Similar results have been reported by Khokhar and Nepalia (2010), Patel *et al.* (2017), Chandra, *et al.* (2018).

From one season study it can be said that combine application of herbicides was found more effective to manage entire weeds, improving yield attributes and yield as compare to rest of the treatments. However, weed free up to 60 DAS produced highest yield but unavailability of labour at right times and it's high wages makes it uneconomical.

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