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Bio-efficacy of carfentrazone-ethyl 40% DF against weeds in wheat and its carryover effect on succeeding sorghum

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ABSTRACT

Effects of different broad-leaf herbicides against complex weed flora in wheat and carryover effect on succeeding sorghum were evaluated at Agronomy Research Farm, CCS Haryana Agricultural University, Hisar during 2017-18. Application of different herbicides significantly reduced the dry weight of weeds compared to weedy check at different growth stages of crop. At 30 days after treatment (DAT), weed control efficiency (WCE) was higher with carfentrazone 20 g/ha (91.8%) compared to carfentrazone 10 g/ha (78.9%). Carfentrazone at different doses provide better control of weed as compared to 2,4-D amine at 60 DAT and at harvest. Number of tillers/m^2 (401) and grain yield (6.11 t/ha) were recorded significantly higher with carfentrazone at 20 g/ha than carfentrazone at 10 g/ha (372 and 5.62 t/ha), 2,4-D amine at 500 g/ha (366 and 5.26 t/ha) and metsulfuron at 4 g/ha (389 and 5.79 t/ha), respectively. Also, there were no residual effect different herbicides on succeeding sorghum.

Due to continuous use of clodinafop-propargyl and pinoxaden herbicides for the last 20 and 10 years, respectively, weed flora of wheat has now been shifted towards broad-leaf weeds. Sulfosulfuron recommended to control grassy weeds *Phalaris minor* and *Avena ludoviciana* provides marginal control of broad-leaf weeds. 2,4-D is not effective against certain weed species such as *Rumex dentatus, Malva parviflora, Convolvulus arvensis, Cirsium arvensis* and *Lathyrus aphaca*. Metsulfuron and 2,4-D are being widely used, but these herbicides do not provide any control of *C. arvensis, Solanum nigrum* and *Malva parviflora* for which carfentrazone is very effective (Punia *et al.* 2006, Walia and Singh 2006). Moreover, combination of 2,4-D with recommended herbicides like clodinafop and fenoxaprop results in antagonism. Secondly many wheat cultivars show malformed spikes due use of 2, 4-D (Balyan and Panwar 1997), Hence, there was strong need for a herbicide which can provide effective control of broad-leaf weeds in wheat. A contact, non-residual, translocated herbicide carfentrazone-ethyl of aryl triazolinone family have been found effective to control broad-leaf weeds in wheat (Singh *et al.* 2004) by inhibiting activity of protoporphyrinogen oxidase in chlorophyll biosynthetic pathway (Witkowski and Halling 1989) against broad-leaf weeds. Therefore, the present investigation was conducted during winter (*Rabi*) season of 2017-2018 and compared with existing brands of carfentrazone available in market.

The soil of the experimental field was sandy loam soil in texture with a pH of 8.2. Experiment was conducted in randomized design with three replications, keeping a plot size of 6.0 x 6.0 m. Wheat crop variety '*WH 1105*' was planted on 28th November, 2017 by using 100 kg seed /ha. Crop was raised as per package of practices recommended by CCS HAU, Hisar except herbicide treatments given as per treatment (details in tables 1-5). All the herbicides were applied at 35 days after sowing (DAS) by knapsack sprayer using 500 litres of water per ha.

Weed density was recorded before spray and at 30 and 60 days after treatment (DAT) and at harvest. Visual toxicity on crop was recorded at 1, 3, 5, 7, 10 DAT on a 0 -10 scale where 0 = No injury and 10 = Complete mortality of crop plant. At harvest, the numbers of ear bearing shoots were counted from two randomly marked spots per meter row length in each plot and converted into per square meter.

To study the residual carry over effect of different herbicides, sorghum crop was planted in the same layout without disturbing the original layout of the experiment. No. of plants per meter row length, plant height and green fodder yield of sorghum were recorded to study the residual effect of different treatments. Weather data on different parameters was recorded during October 2017-July, 2018.

Weed flora

Weed flora of experimental field in weedy check consisted of broad-leaf weeds, *viz. Rumex dentatus* (29.2%), *Convolvulus arvensis* (1.27%), *Anagallis arvensis* (32.85%), *Chenopodium album* (2.55%), *Lathyrus aphaca* (11.4%) *and Medicago denticulata* (22.8%).

Effect on weeds

All the herbicides significantly reduced the density and dry weight of weeds as compared to weedy check. 2,4-D amine applied at 500 g/ha was not effective against *C. arvensis, L. aphaca, A. arvensis* and *M. denticulata* whereas metsulfuron applied at 4 g/ha was not effective against *C. arvensis* and *L. aphaca* (**Table 1-3**). All the herbicide treatments caused significant reduction in dry weight of weeds as compared to weedy check at 30, 60 DAT and at harvest. At 30 DAT, minimum dry weight of weeds (2.13 g/m^2) was recorded with carfentrazone 20 g/ha (Bharat Rasyan) with WCE 91.8% which was at par with carfentrazone 40 g/ha but significantly higher than its lower dose 10 g/ha. At 60 DAT, minimum weed dry weight (3.36 g/m^2) was

Table 1. Effect of different weed control treatments on density of (no./m^2) two weeds in wheat

Treatment	Dose (g/ha)	Time of application	*Rumex dentatus*				*Convolvulus arvensis*			
			Before spray	30 DAT	60 DAT	At harvest	Before spray	30 DAT	60 DAT	At harvest
Carfentrazone	10	35 DAS	7.21(51.3)	2.08(4.0)	1.82(2.7)	1.82(2.7)	1.93(3.0)	1.41(1.0)	1.71(2.0)	1.47(1.3)
Carfentrazone	20	35 DAS	7.45(55.0)	1.24(0.7)	1.67(2.0)	1.55(1.7)	1.75(2.3)	1.0(0)	1.0(0)	1.41(1.3)
Carfentrazone	40	35 DAS	7.15(53.0)	1.24(0.7)	1.41(1.3)	1.14(0.3)	1.67(2.0)	1.0(0)	1.0(0)	1.33(1.0)
Carfentrazone (market sample)	20	35 DAS	7.54(56.3)	2.07(3.3)	1.0(0)	1.24(0.7)	1.82(2.3)	1.0(0)	1.0(0)	1.0(0)
2,4-D amine	500	35 DAS	7.35(53.3)	1.73(2.0)	1.0(0)	1.49(1.3)	2.10(3.7)	1.96(2.9)	1.82(2.3)	2.10(3.7)
Metsulfuron	4	35 DAS	7.30(54.7)	1.55(2.0)	1.0(0)	1.73(2.3)	1.79(2.3)	1.91(2.7)	1.73(2.0)	1.67(2.0)
Weedy check	-	-	7.35(53.0)	5.89(36.7)	3.10(8.7)	2.72(6.7)	1.79 (2.3)	1.79(2.3)	1.73(2.0)	2.25(4.0)
LSD (p=0.05)			NS	1.19	0.23	0.73	NS	0.48	0.33	0.48

*****Transformed values ($\sqrt{x+1}$), original values are given in parentheses; DAT: Days after treatment

Table 2. Effect of different treatment on density of (no./m^2) of two weeds in wheat

Treatment	Dose (g/ha)	Time of application	*Anagallis arvensis*				*Chenopodium album*			
			Before spray	30 DAT	60 DAT	At harvest	Before spray	30 DAT	60 DAT	At harvest
Carfentrazone	10	35 DAS	8.08(55.3)	1.90(2.67)	1.24(0.6)	1.63(1.7)	2.46(5.33)	2.51(5.3)	2.36(4.7)	2.07(3.3)
Carfentrazone	20	35 DAS	7.60(63.7)	1.49(1.33)	1.41(1.3)	1.41(1.3)	2.57(5.67)	1.49(1.3)	1.0(0)	1.0(0)
Carfentrazone	40	35 DAS	8.34(62.7)	1.24(0.67)	1.0(0)	1.0(0)	2.45(5.33)	1.0(0)	1.0(0)	1.0(0)
Carfentrazone (market sample)	20	35 DAS	8.44(66.3)	1.24(0.67)	1.0(0)	1.0(0)	2.36(4.67)	1.49(1.3)	1.0(0)	1.0(0)
2,4-D amine	500	35 DAS	7.68(58.3)	4.79(22.0)	4.35(19.0)	4.24(17.0)	2.37(4.67)	1.86(2.7)	1.0(0)	1.0(0)
Metsulfuron	4	35 DAS	7.88(61.3)	1.48(1.67)	1.0(0)	1.0(0)	2.13(3.67)	1.47(1.3)	1.0(0)	1.0(0)
Weedy check	-	-	7.85(60.0)	5.80(32.67)	5.52(29.7)	5.16(25.7)	2.32(4.67)	2.36(4.7)	2.22(4.7)	2.23(4)
LSD (p=0.05)			NS	0.73	0.40	0.50	NS	0.59	0.45	0.48

*****Transformed values ($\sqrt{x+1}$), original values are given in parentheses; DAT: Days after treatment

Table 3. Effect of different treatment of density on (no./m^2) two weeds in wheat

Treatment	Dose (g/ha)	Time of application	*Lathyrus aphaca*				*Medicago denticulata*			
			Before spray	30 DAT	60 DAT	At harvest	Before Spray	30 DAT	60 DAT	At harvest
Carfentrazone	10	35 DAS	4.16(16.7)	3.09(8.7)	2.32(4.7)	1.24(0.7)	6.39(40.7)	4.35(18.0)	4.27(17.3)	1.75(2.3)
Carfentrazone	20	35 DAS	4.25(19.3)	3.00(8.0)	1.49(1.3)	1.49(1.3)	6.94(49.7)	3.49(11.3)	2.51(5.3)	1.49(1.3)
Carfentrazone	40	35 DAS	3.96(15.3)	2.65(6.0)	1.55(2.0)	1.24(0.7)	7.24(52.0)	3.31(10.0)	2.95(8.0)	1.14(0.3)
Carfentrazone (market sample)	20	35 DAS	4.40(18.3)	2.88(4.7)	2.07(3.3)	2.45(5.0)	6.52(42.0)	4.18(16.7)	2.87(7.3)	1.49(1.3)
2,4-D amine	500	35 DAS	3.67(15.0)	4.04(15.3)	3.19(9.3)	2.99(0.7)	5.67(32.3)	4.28(17.3)	4.51(19.3)	1.0(0)
Metsulfuron	4	35 DAS	3.85(16.7)	4.09(16.0)	3.21(7.3)	2.88(7.3)	4.97(24.3)	3.31(10.7)	1.77(3.3)	1.0(0)
Weedy check	-	-	4.69(21.0)	4.35(18.0)	3.85(14.0)	3.85(14.0)	6.53(41.7)	6.24(38.0)	3.87(11.3)	3.95(14.7)
LSD (p=0.05)			NS	0.50	0.82	0.53	NS	0.70	0.82	0.52

***** Transformed values ($\sqrt{x+1}$), original values are given in parentheses; DAT: Days after treatment

Table 4. Effect of different treatment on weeds dry weight, number of tillers and grain yield of wheat

Treatment	Dose (g/ha)	Time of application	Dry weight of weeds (g/m²)			WCE (%)			No of tillers/m² (at harvest)	Grain yield (t/ha)
			30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest		
Carfentrazone	10	35 DAS	2.54(5.5)	2.91(7.5)	5.10(25.3)	78.9	78.7	62.8	372	5.62
Carfentrazone	20	35 DAS	1.75(2.1)	2.05(3.7)	2.92(7.5)	91.8	89.5	86.0	401	6.12
Carfentrazone	40	35 DAS	2.08(3.5)	2.04(3.4)	2.44(5.0)	86.1	90.4	92.6	402	6.21
Carfentrazone (market sample)	20	35 DAS	2.16(3.7)	2.23(4.0)	2.72(7.5)	86.0	88.7	89.0	399	6.14
2,4-D amine	500	35 DAS	2.47(5.2)	2.97(8.4)	6.80(45.3)	79.9	76.3	33.6	366	5.26
Metsulfuron	4	35 DAS	2.13(3.9)	2.17(3.8)	2.90(7.5)	85.2	89.3	89.0	389	5.79
Weedy check	-	-	5.21(26.2)	5.94(35.4)	8.20(68.3)	0	0	0	353	4.96
LSD (p=0.05)			1.41	0.77	1.74	-	-	-	21.3	0.13

*Transformed values ($\sqrt{x+1}$), original values are given in parentheses; DAT: Days after treatment

recorded with carfentrazone 40 g/ha with WCE 90.4% but statistically at par with carfentrazone (Bharat Rasyan and market sample) and metsulfuron 4 g/ha. At harvest, all herbicides caused significant reduction in dry weight of weeds except 2,4-D amine which was at par with weedy check. Carfentrazone 20 g/ha did not show any phytotoxicity on wheat plants in terms of yellowing, stunting and necrosis, hyponasty and epinasty. Carfentrazone at 40 g/ha showed yellowing with intensity of 4 (0-10 scale) at 3 DAT which diminished with time and remained only 1 at 7 DAT. No stunting, necrosis, hyponasty and epinasty of wheat plants was observed with carfentrazone 40 g/ha and no any yield penalty.

Effect on yield

Different weed control treatments had a bearing on grain yield and yield attributing characters of wheat. Maximum number of tillers (402/m^2) were recorded with carfentrazone 40 g/ha which was at par with carfentrazone 20 g/ha (Bharat Rasyan and market sample) but higher than carfentrazone 10 g/ha, metsulfuron and 2,4-D amine (**Table 4**). Similar trend was observed with grain yield of wheat. Presence of weeds throughout growing season caused 20.1% reduction in grain yield of wheat. Brar *et al*. (2005) and Patel *et al*. (2005) also reported excellent efficacy of carfentrazone against broadleaf weeds in wheat.

Residual effect on succeeding crop

Carfentrazone at any dose did not show any residual effect on succeeding sorghum. Fodder yield in plots treated with carfentrazone 20 g/ha (Bharat Rasyan) was maximum 44.9 t/ha being at par with carfentrazone 20 g/ha (Market sample) and untreated check. Punia *et al*. (2006) did not report any residual carryover effect of carfentrazone on succeeding sorghum crop

Carfentrazone 40% DF supplied by Bharat Rasyan Ltd. at 20 g/ha applied at 35 DAS of wheat successfully controls broadleaf weeds in wheat without causing any residual toxicity on succeeding sorghum.

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