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Performance of Some Post Emergence Herbicides on Management of Broad Leaved Weeds and Productivity of Wheat (*Triticum aestivum* L.)

Partha Sarathi Patra, Prasun Joddar and Ayush Lal

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ABSTRACT

A field experiment was conducted at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar during *rabi* season of 2018-19 and 2019-20 to see the comparative performance of some post emergence herbicides on weed management and productivity of wheat. Five herbicidal treatments along with weedy check and weed free plot were allocated in randomized block design and replicated thrice. Experimental field was dominated by *Chenopodium album, Melilotusindica, Anagalisarvensis*, *Circiumarvense* and *Rumexacetocella.* Results of the experiment revealed that, among the herbicidal treatments, carfentrazone ethyl 40 % DF @ 21 g a.i./ha showed highest degree of population reduction which was followed by 2,4-D amine salt 58 % SL @ 500 g a.i./ha at 30 and 60 days after application. However, among all the treatments twice hand weeding at 30 and 60 days after sowing performed best in minimizing weed population. Weedy check (T_7) recorded highest number of all categories of broad leaved weed species. Overall highest degree of weed control efficiency (75.07 and 76.02 %) was achieved with the application of carfentrazone ethyl 40 % DF at 30 days after application during 2018-19 and 2019-20 respectively, followed by 2, 4-D amine salt @ 500 g a.i. ha^{-1} and Sulfosulfuron @ 25 g a.i. ha^{-1}. Among the broad leaf weeds, *Chenopodium album* was found highly susceptible to the application of carfentrazone ethyl, 2, 4-D amine salt and sulfosulfuron. Among the herbicidal treatments, carfentrazone ethyl 40 % DF @ 21 g a.i.ha^{-1}produced 12.65 % and 7.37% higher grain yield of wheat over sulfosulfuron @ 25 g a.i. ha^{-1} and2, 4-D amine salt @ 500 g a.i. ha^{-1}, respectively.

Key words : Carfentrazone ethyl, Clodinafop, Sulfosulfuron, Metsulfuron methyl, Wheat and Herbicide

Introduction :

Wheat is the second most important cereals followed by rice in India. Weed invasion harshly confine wheat production and productivity. The yield reduction varied on weed varieties, comparative population, environmental elements etc. (Chhokar *et al.*, 2012).Weeds are foremost biotic limitations in crop production and carry severe intervention with usual crop growth,

Regional Research Station, Terai Zone, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal-73616, India. *Email: parthoagro @gmail.com

as they contest for resources like nutrients, moisture, light and space and lowers wheat yield by 37–50% (Waheed *et al.,* 2009). Chemical methods of weed control stand best in wheat. Herbicides on account of their selectivity are utmost significant tools of weed management to improve yield and quality of crop (Mitra *et al.,* 2019).

Herbicide resistance problem has seemed due to overreliance on the use of single herbicide year after year. Henceforward, application of alternative herbicides could be a viable choice to encounter herbicide resistance. Several herbicides namely clodinafop, sulfosulfuron and fenoxaprop had been developed to control grassy weeds in wheat. Due to unceasing use of clodinafop-propargyl and pinoxaden herbicides for the last few decades, weed densityin wheat has now been moved towards broad-leaved weeds. Nowadays, broad leaved weeds appeared as a threat in wheat production, though 2, 4-D offers good control of the non-grassy weeds but causes deformed spikes in many wheat cultivars (Balyan and Panwar, 1997). Metsulfuron and 2,4-D are being extensively used in wheat, but these herbicides do not offer any control of *Convolvulus arvensis, Solanumnigrum* and *Malvaparviflora* for which carfentrazone is very effective (Punia *et al.,* 2006, Walia and Singh, 2006).

So, there is an imperative necessity to find out suitable broad leaf killer in wheat. Keeping the above facts in mind present experiment was formulated to evaluate the performance of some post emergence herbicides to manage wide spectrum of broad leaved weeds in wheat for better productivity.

Materials and Methods :

This research was conducted at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India. The farm is situated at 26019'86" N latitude and 89023'53" E longitude at an elevation of 43 meters above mean sea level. The soil at the experimental site was sandy loam in texture and acidic in nature having pH of 5.71. The initial organic carbon was 0.86 %, available nitrogen 161.44 kg ha^{-1}, available phosphorus 22.18 kg ha^{-1} and available potash 114.34 kg ha^{-1}. The experiment was laid out in randomized block design and replicated thrice. The treatments comprised of carfentrazone ethyl @ 21 g a.i ha^{-1};sulfosulfuron @ 25 g a.i. ha^{-1}; Clodinafop-propagyl @ 60g a.i. ha^{-1}; 2, 4-D amine salt @ 500 g a.i. ha^{-1}; metsulfuron methyl @ g 1250 a.i. ha^{-1}; twice hand weeding (30 and 60 DAS) and weedy check.

Wheat variety PBW-343 was used in the experiment and the crop was sown on 5th November in 2018 and 11th November in 2019 with a continuous row spacing of 25 cm. Plot size of 6 m x 5m was maintained during both the year of experimentation. All the recommended improved package of practices was followed in this experiment including the plant protection measures. Full doses of phosphorus through single super phosphate and potash through muriate of potash each @ 60 kg ha^{-1} was applied as basal. Recommended dose of nitrogen @ 120 kg ha^{-1} through urea was applied in 3 splits at basal, 25 and 65 DAS. All the treatments having herbicides were applied on 18.11.2018 and 20.11.2019 with a

spray volume of 500 L ha^{-1} by knapsack sprayer fitted with flat fan deflector nozzle. Surfactant Iso-octylphenoxyl-poloxenthol 12.5 % was added while sprayed metsulfuron 20 % WP. Observations on species wise weed count (per sq. m area) were recorded at 30 and 60 days after application (DAA) of tested herbicides from each plot using 1 X 1 m^{-2} quadrate in marked area. Weed control efficiency (WCE) is expressed as the percentage of control of weeds over unweeded control. It denotes the efficiency of the applied herbicide for comparison purpose. WCE of different treatments was computed on the basis of weed population by using the following formula,

Weed Control Efficiency (%) = (X-Y)/ (X*100)

Where, X= Weed population in control (untreated or un-weeded) plot; Y= Weed population in treated plot.

The crop was harvested at maturity and yield was recorded in kg $plot^{-1}$ and converted to t ha^{-1}.The data so obtained were subjected to standard statistical analysis using statistical software SPSS, version 20.

Results and Discussion :

Weed Population :

Weed flora in the experimental field were predominantly consisted of *Chenopodium album*, *Melilotusindica*, *Anagalisarvensis*, *Circiumarvensis* and *Rumexacetocella*. Data presented in Table 1 and 2 on weed population exhibited that herbicidal treatments were better than untreated control in reduction of the weed population.

Among all the herbicidal treatments, reduction of weed population was found highest under carfentrazone ethyl 40 % DF @ 21 g a.i./ha (T_1) which was followed by 2,4-D amine salt 58 % SL @ 500 g a.i./ha (T_4) and sulfosulfuron @ 25 g a.i. ha^{-1}(T_2) at 30 and 60 Days after application during 2018-19 and 2019-20. Clodinafop-propagyl@60g a.i. ha^{-1} showed less efficiency in controlling broad leaved weeds because it is mainly used as grass killer in cereals. Among the broad leaved weeds, *Chenopodium album*was found most sensitive to application of carfentrazone ethyl, 2,4-D amine salt and sulfosulfuron followed by *Rumexacetocella* and *Melilotusindica*.

However, among all the treatments twice hand weeding at 30 and 60 days after sowing (T_6) was the best treatment with minimum weed population. Weedy check (T_7) recorded highest population of all categories of broad leaved weed species.

Weed control Efficiency :

Species wise and overall weed control efficiency (WCE) of different broad leaved weed species are presented in Table 3 and 4. Among the herbicidal treatments carfentrazone ethyl 40% DF @ 21 g a.i. ha^{-1} (T_1) showed highest weed control efficiency with disregard to the species followed by 2,4-D amine salt 58 % SL @ 500 g a.i./ha (T_4) and sulfosulfuron @ 25 g a.i. ha^{-1}(T_2). Overall weed control efficiency of 75.07 % and 76.02 % was achieved with carfentrazone ethyl 40% DF @ 21 a.i. ha^{-1} at 30 days after application during 2018-19 and 2019-20 respectively, which was very closed to twice hand weeded plot (T_6) having weed control efficiency of 76.83% and 77.37 %. Carfentrazone-ethyl has been

found effective against broad-leaved weeds due to its hindering action of protoporphyrinogen oxidase and subsequently triggering cell death (Singh *et al.*, 2004 and Witkowski & Halling, 1989). Brar *et al.* (2005) also found outstanding efficacy of carfentrazone against broad leaved weeds in wheat.

Among the herbicidal treatments, application of clodinafop-propagyl @ 60g a.i. ha^{-1} recorded lowest weed control efficiency of 39.51 % and 39.34% respectively during 2018-19 and 2019-20, as because clodinafop-propagyl is effective against grassy weeds.

Yield attributes and yields of wheat :

From Table 5 it was clearly seen that among the herbicidal treatment, highest grain yield of 4.90 and 4.72 t ha^{-1}were obtained in the plot receiving carfentrazone ethyl 40% DF @ 21 g a.i. ha^{-1} (T_3) due to higher values yield attributes viz. no. of grains $spike^{-1}$ (64.33 & 59.25), length of spike (10.74 & 10.50 cm), number of spike m^{-2} (368.50 & 341.50) and test weight (41.50 & 39.25 g) and lesser weed competition during 2018-19 and 2019-20 respectively followed by 2, 4-D Amine Salt 58% SL @ 500 g a.i. ha^{-1},sulfosulfuron @ 25 g a.i. $ha^{-1}$and metsulfuron methyl @ 1.25 kg a.i. ha^{-1}, though all are statistically at par. Brar *et al.* (2005) and Patel *et al.* (2005) also found higher grain yield of wheat with the application of carfentrazoneethyl by minimizing weed population.

Among the treatments, twice hand weeded plot (T_6) produced highest grain yield of 5.14 t ha^{-1} and 5.03 t ha^{-1}, respectively during 2018-19 and 2019-20 which was 67.43 % and 70.51 % higher over weedy check (T_7) simply due to lesser weed competition and higher values of yield attributes. Clodinafop-propagyl @ 60g a.i. ha^{-1} treated plot recorded lowest grain yield of 3.94 t ha^{-1} and 3.75 t ha^{-1} respectively during 2018-19 and 2019-20.

Conclusion :

It can be concluded from the two year field data that among the post emergence herbicides available in the market, carfentrazone ethyl 40% DF was found most efficient in controlling wide spectrum of broad leaved weed in wheat. So the farmers of North Bengal can apply carfentrazone ethyl 40% DF @ 21 g a.i. ha^{-1} in wheat for controlling broad leaved weeds emerged in wheat season for higher production.

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Table 1 : Population of major broad leaved weeds 30 days after application of herbicides during 2018-19 and 2019-20

Treatments	2018-19					2019-20				
	Cha	***Mi***	***Aa***	***Cia***	***Ra***	***Cha***	***Mi***	***Aa***	***Cia***	***Ra***
T_1=Carfentrazone ethyl @21 g a.i ha^{-1}	2.36	2.34	2.36	2.36	2.36	2.33	2.34	2.36	2.36	2.38
	(1.85)	(1.80)	(1.85)	(1.85)	(1.85)	(1.78)	(1.80)	(1.85)	(1.85)	(1.90)
T_2= Sulfosulfuron @ 25 g a.i. ha^{-1}	2.53	2.50	2.64	2.56	2.60	3.56	2.54	2.64	2.60	2.64
	(2.36)	(2.27)	(2.71)	(2.46)	(2.58)	(2.46)	(2.39)	(2.69)	(2.58)	(2.69)
T_3= Clodinafop-propagyl@60g a.i. ha^{-1}	**3.16	3.01	3.13	2.98	3.27	**3.21	3.04	3.17	3.03	3.31
	*(4.68)	(4.06)	(4.57)	(3.95)	(5.16)	*(4.92)	(4.20)	(4.72)	(4.13)	(5.36)
T_4=2, 4-D amine salt @ 500 g a.i. ha^{-1}	2.53	2.51	2.53	2.64	2.60	2.57	2.56	2.69	2.68	2.64
	(2.36)	(2.29)	(2.36)	(2.69)	(2.58)	(2.48)	(2.44)	(2.87)	(2.83)	(2.71)
T_5= Metsulfuron methyl @ 1.25kg a.i. ha^{-1}	3.03	2.98	2.97	2.90	3.05	3.07	3.03	3.01	2.94	3.10
	(4.16)	(3.95)	(3.92)	(3.62)	(4.24)	(4.31)	(4.13)	(4.06)	(3.78)	(4.42)
T_6= Twice hand weeding (30 and 60 DAS)	2.30	2.30	2.31	2.30	2.32	2.31	2.30	2.32	2.31	2.33
	(1.70)	(1.68)	(1.72)	(1.70)	(1.75)	(1.72)	(1.70)	(1.75)	(1.72)	(1.78)
T_7= Weedy check	3.89	3.54	3.65	3.64	3.77	3.94	3.69	3.70	3.71	3.81
	(8.39)	(6.95)	(7.05)	(7.00)	(7.70)	(8.67)	(7.25)	(7.30)	(7.35)	(7.91)
SEm (±)	0.36	0.29	0.27	0.26	0.33	0.39	0.32	0.33	0.37	0.35
CD (P = 0.05)	1.10	0.95	0.89	0.87	0.96	1.12	0.93	0.97	1.05	1.09

*Data in the parenthesis are original value

**Square root transformed value of (X+1) was used for statistical analysis

Cha: *Chenopodium album,*Mi : *Melilotusindica,*Aa: *Anagalisarvensis* Cia: *Circiumarvensis* and Ra: *Rumexacetocella*

Table 2 : Population of major broad leaved weeds 60 days after application of herbicides during 2018-19 and 2019-20

Treatments	2018-19					2019-20				
	Cha	***Mi***	***Aa***	***Cia***	***Ra***	***Cha***	***Mi***	***Aa***	***Cia***	***Ra***
T_1=Carfentrazone ethyl @21 g a.i ha^{-1}	2.83 (3.35)	2.81 (3.28)	2.86 (3.48)	2.85 (3.45)	2.86 (3.48)	2.85 (3.44)	2.82 (3.33)	2.86 (3.48)	2.86 (3.46)	2.79 (3.23)
T_2= Sulfosulfuron @ 25 g a.i. ha^{-1}	2.83 (3.36)	2.83 (3.35)	2.91 (3.65)	2.93 (3.75)	2.91 (3.68)	2.86 (3.46)	2.82 (3.34)	2.92 (3.69)	2.88 (3.55)	2.92 (3.69)
T_3= Clodinafop-propagyl@60g a.i. ha^{-1}	**3.38 *(5.68)	3.33 (5.45)	3.37 (5.65)	3.17 (4.75)	3.48 (6.17)	**3.43 *(5.92)	3.28 (5.22)	3.38 (5.71)	3.47 (6.13)	3.51 (6.35)
T_4=2, 4-D amine salt @ 500 g a.i. ha^{-1}	2.85 (3.45)	2.91 (3.65)	2.96 (3.85)	2.93 (3.75)	2.97 (3.89)	2.86 (3.49)	2.84 (3.39)	2.96 (3.87)	2.98 (3.93)	2.93 (3.73)
T_5= Metsulfuron methyl @ 1.25kg a.i. ha^{-1}	3.28 (5.23)	3.18 (4.78)	3.16 (4.68)	3.14 (4.62)	3.3 (5.29)	3.30 (5.31)	3.26 (5.14)	3.25 (5.10)	3.19 (4.82)	3.34 (5.52)
T_6= Twice hand weeding (30 and 60 DAS)	2.82 (3.34)	2.77 (3.15)	2.84 (3.41)	2.80 (3.27)	2.86 (3.48)	2.80 (3.26)	2.82 (3.33)	2.86 (3.46)	2.83 (3.36)	2.62 (2.61)
T_7= Weedy check	4.06 (9.39)	3.78 (7.75)	3.87 (8.25)	3.85 (8.15)	3.95 (8.75)	4.12 (9.74)	3.89 (8.37)	3.91 (8.50)	3.88 (8.35)	3.99 (8.95)
SEm (±)	0.39	0.28	0.27	0.29	0.31	0.35	0.33	0.29	0.27	0.39
CD (P = 0.05)	1.11	0.89	0.90	0.87	0.89	1.12	0.96	0.93	0.89	1.15

*Data in the parenthesis are original value

**Square root transformed value of (X+1) was used for statistical analysis

Cha: *Chenopodium album,*Mi: *Melilotusindica,*Aa: *Anagalisarvensis* Cia: *Circiumarvensis* and Ra: *Rumexacetocella*

Table 3 : Weed control efficiency (%) of different post-emergence herbicides on wheat 30 days after application during 2018-19 and 2019-20

Treatments	2018-19						2019-20					
	Cha	***Mi***	***Aa***	***Cia***	***Ra***	***Overall***	***Cha***	***Mi***	***Aa***	***Cia***	***Ra***	**Overall**
T_1=Carfentrazone ethyl @21 g a.i ha^{-1}	77.95	74.10	73.76	73.57	75.97	75.07	79.47	75.17	74.66	74.83	75.98	76.02
T_2= Sulfosulfuron @ 25 g a.i. ha^{-1}	71.87	67.34	61.56	64.86	66.49	66.42	71.63	67.03	63.15	64.90	65.99	66.54
T_3= Clodinafop-propagyl@60g a.i. ha^{-1}	44.22	41.58	35.18	43.57	32.99	39.51	43.25	42.07	35.34	43.81	32.24	39.34
T_4=2, 4-D amine salt @ 500 g a.i. ha^{-1}	71.87	67.05	66.52	61.57	66.49	66.70	71.40	66.34	64.68	63.50	66.94	66.57
T_5= Metsulfuron methyl @ 1.25kg a.i. ha^{-1}	50.42	43.17	44.40	48.29	44.94	46.24	50.29	43.03	44.38	48.57	44.12	46.08
T_6= Twice hand weeding (30 and 60 DAS)	79.74	75.83	75.60	75.71	77.27	76.83	80.16	76.55	76.03	76.60	77.50	77.37
$T_{7=}$Weedy check	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 : Weed control efficiency (%) of different post-emergence herbicides on wheat 60 days after application during 2018-19 and 2019-20

Treatments	2018-19					2019-20				
	Cha	***Mi***	***Aa***	***Cia***	***Ra***	***Cha***	***Mi***	***Aa***	***Cia***	***Ra***
T_1=Carfentrazone ethyl @21 g a.i ha^{-1}	64.32	57.68	57.82	57.67	60.23	64.68	60.22	59.06	58.56	63.91
T_2= Sulfosulfuron @ 25 g a.i. ha^{-1}	64.22	56.77	55.76	53.99	57.94	64.48	60.10	56.59	57.49	58.77
T_3= Clodinafop-propagyl @60g a.i. ha^{-1}	39.51	29.68	31.52	41.72	29.49	39.22	37.63	32.82	26.59	29.05
T_4=2, 4-D amine salt @ 500 g a.i. ha^{-1}	63.26	52.90	53.33	53.99	55.54	64.17	59.50	54.47	52.93	58.32
T_5= Metsulfuron methyl @ 1.25kg a.i. ha^{-1}	44.30	38.32	43.27	43.31	39.54	45.48	38.59	40.00	42.28	38.32
T_6= Twice hand weeding (30 and 60 DAS)	64.43	59.35	58.67	59.88	60.23	66.53	60.22	59.29	59.76	70.84
$T_{7=}$ Weedy check	-	-	-	-	-	-	-	-	-	-

Table 5 : Yield and yield attributes of wheat as influenced by different post-emergence herbicides

Treatments	No. of Grain/Spike		Length of Spike(cm)		No. of Spike/m^2		Test Weight (g)		Grain Yield (t/ha)	
	1^{st}yr	2^{nd}yr	1^{st}yr	2^{nd}yr	1^{st}yr	2^{nd}yr	1^{st}yr	2^{nd}yr	1^{st}yr	2^{nd}yr
T_1= Carfentrazone ethyl @21 g a.i ha^{-1}	64.33	59.25	10.74	10.50	368.50	341.50	41.50	39.25	4.90	4.72
T_2= Sulfosulfuron @ 25 g a.i. ha^{-1}	46.0	43.20	10.16	10.07	322.75	312.50	38.75	38.06	4.38	4.15
T_3= Clodinafop-propagyl@60 g a.i. ha^{-1}	37.25	35.10	9.22	9.65	279.33	251.25	37.12	36.0	3.94	3.75
T_4=2, 4-D amine salt @ 500 g a.i. ha^{-1}	59.25	55.50	10.40	10.25	319.75	303.33	38.25	36.27	4.55	4.40
T_5= Metsulfuron methyl @ 1.25kg a.i. ha^{-1}	43.0	44.33	10.05	10.23	319.50	321.25	36.0	37.12	4.16	4.13
T_6= Twice hand weeding (30 and 60 DAS)	67.50	62.10	11.25	10.80	394.25	382.11	41.95	41.24	5.14	5.03
T_7= Weedy check	36.70	31.25	9.14	9.05	274.45	252.05	34.16	32.51	3.07	2.95
SEm (±)	8.46	7.85	0.53	0.26	25.64	28.33	1.62	1.54	0.32	0.23
CD (P = 0.05)	24.01	22.07	1.39	0.82	66.13	82.14	4.88	4.69	0.95	0.71