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Evaluation of bio-efficacy of 2, 4-D Ethyl Ester 38 per cent EC for weed control in wheat

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ABSTRACT

The experiment was conducted during rabi season at the research farm of Bidhan Chandra Krishi Viswavidyalaya attached to the Regional Research Station, Chakdaha, Nadia, of West Bengal to evaluate the bio-efficacy of 2, 4-D Ethyl Ester 38 % EC in wheat. Eight different weed control treatments - four different doses of 2, 4-D EE 38 % EC (Nufarm) applied at 0.225, 0.450, 0.675 and 0.900 kg a.i. ha^{-1}; with four other treatments, viz., 2, 4-D EE 38 % EC (Commercial) at 0.450 kg a.i. ha^{-1}; metsulfuron methyl 20 % WP at 0.004 kg a.i. ha^{-1}; hand weeding twice at 25 and 45 DAS and unwedded control. The experiment was laid out in a Randomized Block Design (RBD) replicated thrice. Post emergence application of 2, 4-D EE 38 % EC (Nufarm) @ 0.900 kg a.i. ha^{-1} and 2, 4-D EE 38 % EC (Nufarm) @ 0.675 kg a.i. ha^{-1} resulted in effective weed control recording the least weed density and weed dry weight. Maximum grain yield was recorded under hand weeding treatment followed by 2, 4-D EE 38 % EC (Nufarm) @ 0.900 kg a.i. ha^{-1} as post emergence application.

***Keywords*:** 2, 4-D, ethyl ester, metsulfuron-methyl, weed, wheat

Wheat (*Triticum aestivum* L.) is widely grown winter cereal and is the backbone of food security in India. Wheat compares well with other important cereals in its nutritive value containing more protein than other cereals (Singh, 2013). It is grown in an area of about 31.19 million ha in the country with production of 95.91 million tonnes in India. Punjab covers 14 per cent of the total wheat area and accounts for 25 per cent of national wheat production (Kaur *et al.* 2015). In West Bengal, it is grown in 0.34 million ha area producing 0.95 million tons of grains with the productivity of 2802 kg ha^{-1} (Agril. Statistics, 2014). Weeds are one of the predominant constraints in achieving potential yield of wheat. Available literature suggest that with production of each kilogram of weed, one kilogram wheat grains yield is reduced (Chaudhary *et al*. 2008). Several broadleaf weeds are becoming a serious problem along with grassy weeds in wheat. Most common and effective herbicide to kill all the broad-leaved weeds in wheat field is 2, 4-D, which is sprayed in wheat field at 32-35 days after sowing (Singh, 2013). The ester formulation of 2, 4-D is preferred to amine and sodium salts formulation for control of difficult weeds like *Asphodelus tenuifolius, Convolvulus arvensis and Cirsium arvense* because of the fastest absorption on the plant surface (Das, 2013). Barui *et al.* (2006) reported 45.24 per cent weed control efficiency in wheat on application of 2, 4-D Ethyl Ester 38 per cent EC at 450 g ha^{-1}. Metsulfuron-methyl, a broad-leaved weed killer applied at 4 g/ha has been reported to effectively control broad-leaved weeds, (Kaur *et al.* 2015). Among the herbicidal treatments, post-emergence application (30 DAS) of sulfosulfuron + metsulfuron [32 g ha^{-1}] significantly decreased density and biomass of weeds; increased the LAI and ultimately enhanced production of grain yield of wheat (Singh *et al.* 2015). For control of broad-leaf weeds in wheat, three major herbicides being used in India are metsulfuron, 2, 4-D and carfentrazone (Chhokar *et al.* 2007). Weed infestation is one of the main causes of low wheat yield not only in India but all over the world, and wheat yield reduction to the tune of as high as 37-50 per cent has been reported (Waheed *et al*. 2009). Loss in yield depends upon weed type, density, timing of emergence, wheat density, wheat cultivar and soil and environmental factors (Chhokar and Malik, 2002).

MATERIALS AND METHODS

A field experiment was conducted in a medium land under sub-humid and sub-tropical condition at the research farm of BCKV attached to the Regional Research Station, Chakdaha, Nadia, West Bengal located at $8^0$5.3' N latitude and $83^0$5.3' E longitude and the altitude of 9.75 m above mean sea level to study the bio-efficacy of 2, 4-D Ethyl Ester 38 per cent EC in wheat during wheat growing season. The experiment was laid out in randomized block design (RBD) with three replications of eight treatments comprising eight different weed control measures *viz.* four different doses of 2, 4-D EE 38 per cent EC (Nufarm) applied at 0.225,

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0.450, 0.675 and 0.900 kg a.i. ha^{-1}, 2, 4-D EE 38 per cent EC (Commercial) at 0.450 kg a.i. ha^{-1}, metsulfuron methyl 20 per cent WP at 0.004 kg a.i. ha^{-1}, hand weeding twice at 25 and 45 DAS and unweeded control. Wheat variety *'PBW 343'* was sown in 20 cm spacing using 100 kg seed ha^{-1} on December 07, 2012. Herbicidal treatments were applied as post emergence (after first irrigation) 34 days after sowing at their respective doses as per treatments. Spraying was done with the help of knapsack sprayer fitted with a flat fan nozzle with spray volume of 500 l water ha^{-1} while hand weeding treatment was practiced twice at 25 and 45 DAS. Species-wise and total weed counts (no. m^{-2}) were recorded from three places selected at random in each plot at various stages. A quadrate of 0.25 m^2 size was used for recording weed density and weed dry weight. The weeds inside each quadrate were uprooted, cleaned and dried. After sun drying, weeds were dried in hot air oven at $70 \pm 1\ ^0C$ for 48 hours to obtain a constant weight. After drying, dry weight and weed control efficiency was calculated using standard formula. The treatments were allocated randomly to different plots with the help of random number table (Fisher, 1958) and the data were analysed by ANOVA, and ranked using the critical differences (CD) at 5 per cent level.

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was infested with grasses, *viz. Phalaris minor, Cynodon dactylon, Avena fatua, sedges viz. Cyperus rotundus, Cyperus iria* and few broad-leaved weeds, *viz. Chenopodium album, Anagallis arvensis, Cirsium arvense, Fumaria parviflora.*

Weed density

The density of population of broad leaf weed, grass weed and sedge weeds at 20, 40 and 60 DAS are presented in table 1. Appraisal of the data revealed lowest populations of all the three types of weeds under hand weeding twice followed by 2, 4-D EE 38 per cent EC (Nufarm) @ 0.900 kg a.i. ha^{-1} and 2, 4-D EE 38 per cent EC (Nufarm) 0.675 kg a.i. ha^{-1}. All the weed control treatments significantly reduced all type of weeds compared to unweeded control (Table 1). The data on weed count revealed that among the different herbicide treatments, 2, 4-D EE 38 per cent EC (Nufarm) @ 0.900 kg a.i. ha^{-1} resulted in effective control of all type of weeds recording the lowest weed count at 20, 40 and 60 DAS and remained *on par* among themselves and superior to the other herbicidal treatments. The unweeded control treatment recorded the highest weed count at all the observation dates with dominance of broad leaf weeds followed by sedges and grasses.

Total weed dry weight and weed control efficiency

Compared to unweeded control, dry matter production of weeds was significantly reduced under different weed control treatments (Table 2). At 20, 40 and 60 DAS, the lowest dry matter production of 0.43, 1.10 and 2.32 g m^{-2} were observed with hand weeding followed by application of 2, 4-D EE 38 per cent EC (Nufarm) @ 0.900 kg a.i. ha^{-1} and 2, 4-D EE 38 per cent EC (Nufarm) @ 0.675 kg a.i. ha^{-1}. Judged by the weed dry weight, application of 2, 4-D EE 38 per cent EC (Nufarm) at all the rates of application proved superior to the commercial grade of 2, 4-D EE 38 per cent EC (Commercial) and Metsulfuron methyl 20 per cent WP.

The weed control efficiency derived from the weed dry weight was significantly higher in hand weeding with values ranging from 81.86 per cent at 20 DAS to 71.95 per cent during 60 DAS. Hand weeding was followed by 2, 4-D EE 38 per cent EC (Nufarm) @ 0.900 kg a.i. ha^{-1} (70.46, 68.19 and 70.13 per cent at 20, 40 and 60 DAS respectively) and 2, 4-D EE 38 per cent EC (Nufarm) @ 0.675 kg a.i. ha^{-1} (66.67, 57.21 and 64.09 per cent at 20, 40 and 60 DAS respectively). The weed control efficiency of the aforesaid treatments remained comparable with each other and better than other treatments. The lowest WCE was recorded in unweeded control plot.

Effect on crop phytotoxicity

The observation on visual crop toxicity was recorded at 07, 14 and 21 days after herbicide application (DAHA). The visual crop toxicity symptoms like leaf injury, vein clearing, epinasty, hyponasty, scorching and necrosis were observed. There were no crop Phytotoxicity symptoms among the different treatments including the highest dose of 2, 4-D EE 38 per cent EC (Nufarm) @ 0.900 kg a.i. ha^{-1}. This herbicide formulation thus proved environment friendly as well as economically cheap.

Effect on crop yield

Hand weeding twice recorded the highest grain yield of 2.00 t ha^{-1} (Table 2) followed by 2, 4-D EE 38 per cent EC (Nufarm) @ 0.900 kg a.i. ha^{-1} (1.98 t ha^{-1}); 2, 4-D EE 38 per cent EC (Nufarm) @ 0.675 kg a.i. ha^{-1} (1.95 t ha^{-1}) and 2, 4-D EE 38 per cent EC (Nufarm) @ 0.450 kg a.i. ha^{-1} (1.92 t ha^{-1}).

Though hand weeding twice proved the best in terms of the least weed density and weed dry weight and there by higher weed control efficiency, 2, 4-D EE 38 per cent EC (Nufarm) @ 0.900 kg a.i. ha^{-1} and 2, 4-D EE 38 per cent EC (Nufarm) @ 0.675 kg a.i. ha^{-1} also proved its effectiveness in controlling different types of weeds in wheat field without appreciable phytotoxicity and detrimental effect on the environment and proved to be

Table 1: Effect of treatments on density of different weeds per m^2 on 20, 40 and 60 DAS in Wheat during *Rabi* 2012-13

Treatments	Dose (kg a.i. ha^{-1})	Formulation (L ha^{-1})	Broad leaf weed (No. m^{-2}) 20 DAS	40 DAS	60 DAS	Grassy weed (No. m^{-2}) 20 DAS	40 DAS	60 DAS	Sedge weed (No. m^{-2}) 20 DAS	40 DAS	60 DAS	Total weed opulation (No. m^{-2}) 20 DAS	40 DAS	60 DAS
2,4-D EE 38% EC (Nufarm)	0.225	0.592	1.52	2.46	4.12	0.42	1.33	2.10	1.05	1.80	2.18	2.99	5.29	8.40
2,4-D EE 38% EC (Nufarm)	0.450	1.184	0.75	2.40	2.86	0.26	1.03	1.00	0.50	1.47	1.60	1.45	4.80	5.28
2,4-D EE 38% EC (Nufarm)	0.675	1.776	0.74	2.35	2.59	0.25	1.03	0.80	0.45	1.41	1.58	1.43	4.70	5.25
2,4-D EE 38% EC (Nufarm)	0.900	2.368	0.72	1.87	2.47	0.21	0.72	0.78	0.43	1.27	1.58	1.43	4.00	5.20
2,4-D EE 38% EC (Commercial)	0.450	1.184	0.99	2.40	3.24	0.27	1.06	1.20	0.64	1.55	1.69	1.82	4.90	6.00
Metsulfuron methyl 20% WP	0.004	0.02 (kg)	1.00	2.43	3.30	0.30	1.12	1.21	0.69	1.73	2.02	1.98	5.23	6.12
Hand weeding twice at 25 & 45 DAS	-	-	0.51	1.30	2.05	0.10	0.56	0.65	0.37	0.53	1.50	0.98	2.40	4.28
Unweeded control	-	-	4.58	5.11	9.83	1.00	1.36	2.91	2.75	4.66	5.46	8.33	11.10	18.20
S. Em (+)			**0.06**	**0.13**	**0.22**	**0.02**	**0.05**	**0.08**	**0.02**	**0.09**	**0.09**	**0.42**	**0.47**	**0.74**
LSD (0.05)			**0.13**	**0.28**	**0.47**	**0.03**	**0.10**	**0.16**	**0.04**	**0.18**	**0.19**	**0.88**	**1.00**	**1.58**

Table 2: Effect of treatments on weed dry matter accumulation, weed control efficiency, phytotoxicity and grain yield of wheat during *Rabi* 2012-13

Treatments	Dose (kg a.i. ha^{-1})	Formulation (L ha^{-1})	Broad leaf weed (No. m^{-2}) 20 DAS	40 DAS	60 DAS	Grassy weed (No. m^{-2}) 20 DAS	40 DAS	60 DAS	Sedge weed (No. m^{-2}) 7 DAHA	14 DAHA	21 DAHA	Grain Yield (t ha^{-1})
2,4-D EE 38% EC (Nufarm)	0.225	0.592	0.97	2.38	5.27	59.07	45.54	36.28	0	0	0	1.60
2,4-D EE 38% EC (Nufarm)	0.450	1.184	0.81	1.98	2.97	65.82	54.69	64.09	0	0	0	1.92
2,4-D EE 38% EC (Nufarm)	0.675	1.776	0.79	1.87	2.97	66.67	57.21	64.09	0	0	0	1.95
2,4-D EE 38% EC (Nufarm)	0.900	2.368	0.70	1.39	2.47	70.46	68.19	70.13	0	0	0	1.98
2,4-D EE 38% EC (Commercial)	0.450	1.184	0.82	2.00	3.00	65.40	54.23	63.72	0	0	0	1.89
Metsulfuron methyl 20% WP	0.004	0.02 (kg)	0.83	2.37	3.00	64.98	45.77	63.72	0	0	0	1.85
Hand weeding twice at 25 & 45 DAS	-	-	0.43	1.10	2.32	81.86	74.83	71.95	0	0	0	2.00
Unweeded control	-	-	2.37	4.37	8.27	-	-	-	0	0	0	1.32
S. Em (+)			**0.06**	**0.18**	**0.27**	**-**	**-**	**-**	**-**	**-**	**-**	0.24
LSD (0.05)			**0.13**	**0.38**	**0.57**	**-**	**-**	**-**	**-**	**-**	**-**	0.72

Note: EE= Ethyl Ester, EC= Emulsified Concentration, WP= Wettable Powder, a.i.= active ingredient, L= Litre, DAS= Days After Sowing, DAHA=Days After Herbicide Application

safe. Under present scenario of scarcity of manpower for hand weeding this formulation could be an effective option for control pf weeds in wheat field in Eastern India.

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