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Studies on bio-efficacy and phytotoxicity of 2, 4-d ethyl hexyl ester 60% EC in wheat under Gangetic Alluvial Zone of West Bengal

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ABSTRACT

A field experiment was conducted during Rabi 2012-13 to study the bio-efficacy of 2,4-D Ethyl Hexyl Ester 60% EC in wheat at Regional Research Sub-station of Bidhan Chandra Krishi Viswavidyalaya, West Bengal. The results indicated that 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.576 kg a.i. ha^{-1} and 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.432 kg a.i. ha^{-1} recorded effective weed control in terms of least weed density and weed dry weight and there by higher weed control efficiency followed by two manual weeding treatment. In case of yield, 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.576 kg a.i. ha^{-1} resulted better yield over manual weeding, which was statistically at par with aforesaid treatments. 2, 4-D Ethyl Hexyl Ester 60% EC tested at different doses for phytotoxicity has also revealed that there was no phytotoxic symptoms observed in any of the doses and the tested new formulation is safe to the wheat crop.

Keywords : 2, 4-D ethyl hexyl ester, dose, weed, wheat.

Wheat is the second most important cereal in India after rice, providing more than 50 per cent of the calories. India has witnessed a significant increase in wheat production with 93.9 million tonnes during 2011-12 (Anon, 2012). Khaliq *et. al.,* (2003) reported that the problem of weed infestation is becoming more serious in irrigated areas, where cropping intensity is rapidly increasing with the result that weed management through fallowing, hoeing, harrowing and cultivating practices has become impossible and use of herbicide has become inevitable for obtaining higher yield and better quality of produce. Heavy infestation of weeds alone causing 33 per cent reduction in yield is a serious constraint in sustaining productivity of wheat (Mukherjee *et. al.,* 2011). The extent of yield reduction largely depends on growth behaviour of individual weed species in relation to agro-ecological condition (Singh *et al.,* 1997). Among the herbicides, isoproturon and pendimethalin are being used for the last two decades in wheat for management of grassy weeds (Walia *et al.,* 1998 and Chopra *et al.,* 2001). Singh *et al.* (2004) reported that carfentrazone ethyl at the dose of 20 and 25 g ha^{-1} registered better value of weed control efficiency (90.6 to 100%.) than 2,4-D (500g ha^{-1}) and was comparable with metsulfuron-methyl (4 g ha^{-1}). Continuous use of isoproturon led to the development of evolutionary resistant biotype and shift in weed flora (Malik and Singh, 1995). For controlling broadleaved weeds along with grasses, application of isoproturon in combination with 2,4-D, and metsulfuron-methyl (MSM) are recommended (Pandey *et. al.,* 2006). Marczewska and Rola (2003) reported that long-term use of a particular herbicide with incorrect dose and the genetic make-up of the weed contributed to the development of resistance against herbicides. Resistance of some weed species to a herbicide that has been continuously in use emerged a serious problem (Barui *et. al.,* 2006). A number of herbicides are. therefore, necessary for controlling the weeds that are also eco-safe for the present day sustainable agriculture. Sticking to the above, a field investigation was carried out to evaluate the bio-efficacy and Phytotoxicity of some new dose and formulation of 2,4-D Ethyl Hexyl Ester 60% EC herbicides as compare to present commercially available herbicide (Metsulfuron-methyl) for eco-safe weed management in wheat.

MATERIALS AND METHODS

The field experiment was conducted at Regional Research Sub-station, Chakdaha of New Alluvial Zone under BCKV, Nadia, West Bengal, during *Rabi* season of 2012-13. The location of the present experiment is situated in the sub-humid and sub-tropical condition at 28^0 5.3/ N latitude and 83^0 5.3/ E longitude and at an elevation of 9.75 meters above the mean sea level with medium land topography. Eight treatments, *viz.* different doses of 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.144, 0.288, 0.432 and 0.576 kg ha^{-1}, 2,4-D Ethyl Ester 38 per cent EC @ 0.450 kg ha^{-1}, metsulfuron methyl 20 per cent WP @ 0.004 kg ha^{-1}, hand weeding twice and un-weeded control were evaluated in RBD with three replications. All the herbicides were applied at 30 DAS (18.12.2012) as post emergence application with knapsack sprayer fitted with flat fan nozzle using 500 L

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Table 1 : Effect of treatments on weed density at 20, 40 and 60 DAS in wheat during *Rabi* 2012-13

Treatments	Dose (a.i. kg ha^{-1})	Formulation (L ha^{-1})	Broad leaf weed (No. m^{-2})			Grassy weed (No. m^{-2})			Sedge weed (No. m^{-2})			Total weed population (No. m^{-2})		
			$20	40	60	20	40	60	20	40	60	20	40	60
2,4-D EHE 60% EC (Nufarm)	0.144	0.240	0.76	5.51	8.20	0.26	3.05	3.04	0.52	3.34	4.66	1.49	11.72	15.18
2,4-D EHE 60% EC (Nufarm)	0.288	0.480	0.74	5.09	7.62	0.25	1.92	2.60	0.49	3.16	4.20	1.42	11.31	14.11
2,4-D EHE 60% EC (Nufarm)	0.432	0.720	0.68	3.80	4.56	0.21	1.39	1.83	0.43	2.49	2.65	1.31	8.27	8.29
2,4-D EHE 60% EC (Nufarm)	0.576	0.960	0.60	3.18	4.06	0.15	0.88	1.58	0.41	2.45	2.49	1.30	6.27	8.29
2,4-D EE 38% EC (Commercial)	0.450	1.184	0.70	4.06	5.32	0.21	1.65	2.04	0.46	2.81	3.39	1.32	9.27	11.31
Metsulfuron methyl 20% WP	0.004	0.02 (kg)	0.73	4.54	5.76	0.22	1.74	2.07	0.46	3.05	3.95	1.39	8.29	12.00
Hand weeding twice	-	-	0.41	1.78	2.01	0.08	1.37	0.62	0.27	0.72	1.48	0.79	3.29	4.11
Control (Unweeded)	-	-	3.47	7.36	16.74	0.76	3.17	4.96	2.08	6.72	9.30	6.31	16.00	31.00
SE (d)			**0.05**	**0.22**	**0.40**	**0.01**	**0.09**	**0.14**	**0.02**	**0.14**	**0.17**	**0.31**	**0.69**	**1.33**
LSD (0.05)			**0.10**	**0.47**	**0.84**	**0.03**	**0.19**	**0.29**	**0.04**	**0.30**	**0.35**	**0.66**	**1.47**	**2.82**

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 (a.i. kg ha^{-1})	Formulation (L ha^{-1})	Dry matter accumulation (g m^{-2})			Weed control efficiency (%)			Phytotoxicity observation			Grain yield (t ha^{-1})
			20	40	60	20	40	60	#7	14	21	
2,4-D EHE 60% EC (Nufarm)	0.144	0.240	1.40	8.50	14.40	39.39	30.33	2.70	0	0	0	1.40
2,4-D EHE 60% EC (Nufarm)	0.288	0.480	1.32	8.40	14.20	42.86	31.15	4.05	0	0	0	1.50
2,4-D EHE 60% EC (Nufarm)	0.432	0.720	0.98	6.30	13.00	57.58	48.36	12.16	0	0	0	1.60
2,4-D EHE 60% EC (Nufarm)	0.576	0.960	0.84	6.29	12.20	63.64	48.44	17.57	0	0	0	1.70
2,4-D EE 38% EC (Commercial)	0.450	1.184	1.10	8.31	13.10	52.38	31.89	11.49	0	0	0	1.55
Metsulfuron methyl 20% WP	0.004	0.02 (kg)	1.20	8.40	13.50	48.05	31.15	8.78	0	0	0	1.50
Hand weeding twice	-	-	0.60	4.20	11.30	74.03	65.57	23.65	0	0	0	1.79
Control (Unweeded)	-	-	2.31	12.20	14.80	-	-	-	0	0	0	1.31
SE(d)			**0.06**	**0.48**	**0.66**	**-**	**-**	**-**	**-**	**-**	**-**	**0.022**
LSD (0.05)			**0.13**	**1.01**	**1.41**	**-**	**-**	**-**	**-**	**-**	**-**	**0.043**

EHE= Ethyl Hexyl Ester, EC= Emulsified concentration, WP= Wettable powder, a.i.= Active ingredient, L= Litre, $DAS= Days after sowing, #DAHA=Days after herbicide application

ha^{-1} of water. The wheat variety *'PBW 343'* was sown in 20 cm spaced rows using 100 kg ha^{-1} on 17.11.2012. The crop was fertilized with 120 kg N, 60 kg P_2O_5 and 40 kg k_2O per ha. The nitrogen was applied in the form of urea (46% N), P_2O_5 in the form of single super phosphate (16% P_2O_5) and k_2O in the form of muriate of potash (60% k_2O). Entire quantity of phosphorus and potassium and one-half of nitrogen was applied at the time of sowing. Remaining N was broadcasted with the first irrigation. Data on weed count and dry matter accumulation of weeds was taken, with quadrate measuring 0.5 x 0.5 m placed randomly at three spots per plot at 20, 40 and 60 DAS. Different categories of weeds (grass, sedge and broad leaved) were counted separately for each plot species wise. Category-wise different weed m^{-2} was calculated. For measuring dry matter accumulation of weed, weeds were separately collected from each plot, labelled properly and washed thoroughly with water, air dried and kept in a drier at a temperature of 60°C. Then the dry matter weights of the weeds were recorded separately and converted it in g m^{-2}. Weed control efficiency was calculated based on the dry weight of weeds recorded at 20, 40 and 60 DAS by using the standard formula. The observation on phytotoxicity parameters *viz*., leaf injury on tips/surface, wilting, vein clearing, necrosis, hyponasty and epinasty was done visually at 7, 14 and 21 days after herbicide application (DAHA). For recording observation 1-10 rating scale (PRS) was used. The observation on the level of phytotoxicity by visual assessment was recorded by counting the affected wheat plants in each plot. The data on grain yield of wheat was recorded at the time of crop harvest.

RESULTS AND DISCUSSION

Effect on weeds

Dominant weed flora consisted of *Phalaris minor*, *Cynodon dactylon* and *Avena fatua* among grasses; *Cyperus rotundus* and *Cyperus iria* among sedges and *Chenopodium album*, *Cirsium arvense*, *Fumaria parviflora* and *Anagallis arvensis* among broad leaf weeds. The total weed density was significantly reduced in the herbicide treatments. The data on weed count has revealed that 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.576 kg a.i. ha^{-1} has resulted in effective control of all type of weeds and has recorded least weed count at 20, 40 and 60 DAS and remained *at par* among themselves and superior to the other treatments except hand weeding twice. 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.576 kg a.i. ha^{-1} was *at par* with 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.432 kg a.i. ha^{-1} in controlling the total weed population. The unweeded control treatment recorded the highest weed count at all the observations with the pre dominance of broad leaf weeds followed by sedges and grasses respectively. Significant differences in dry matter production (DMP) were observed among the treatments at all stages. At 20, 40 and 60 DAS, the lowest DMP of 0.60, 4.20 and 11.30 g m^{-2} was recorded in hand weeding twice followed by 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.576 kg a.i. ha^{-1} and 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.432 kg a.i. ha^{-1}. The weed dry weight was recorded least in the aforesaid treatments. The weed dry weight in the aforesaid treatments remained *at par* among themselves and remain significantly superior to the other treatments at all the stages especially that the standard treatments *viz.* 2,4-D Ethyl Ester 38% EC (Commercial) @ 0.45 kg a.i. ha^{-1} and Metsulfuron methyl 20% WP kg a.i. ha^{-1}. The weed control efficiency (WCE) derived from the weed dry weight revealed that hand weeding twice resulted with the higher WCE of 74.03, 65.57 and 23.65 per cent during 20, 40 and 60 DAS respectively. This was followed by 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.576 kg a.i. ha^{-1}.(63.64, 48.44 and 17.57 at 20, 40 and 60 DAS respectively) and 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.432 kg a.i. ha^{-1}.(57.58, 48.36 and 12.16 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 done on 7, 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 at the above mentioned time period. There were no crop Phytotoxicity symptoms among the different herbicide treatments.

Effect on crop yield

From the table 2, it has been observed that hand weeding twice recorded the highest grain yield of 1.79 t ha^{-1}, which was followed by 2,4-D Ethyl Hexyl Ester 60% EC @ 0.576 kg a.i. ha^{-1} (1.70 t ha^{-1}) and 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.432 kg a.i. ha^{-1} (1.60 t ha^{-1}) respectively. Consequently unweeded control produced lowest grain yield (1.31 t ha^{-1}).

It was concluded from the present study that; 2,4-D Ethyl Hexyl Ester 60 per cent EC @ 0.576 kg a.i. ha^{-1} was found efficient for control of mixed weed flora in wheat regarding the least weed density, weed dry weight and there by higher weed control efficiency and better yield among the other herbicide treatments after hand weeding twice treatment.

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