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Studies on 2,4-D Dimethylamine 50% SL to Control Weeds in Wheat

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ABSTRACT

A field experiment was conducted at regional research station of Bidhan Chandra Krishi Viswavidyalaya, Chakdaha, Nadia, West Bengal during *Rabi season*, 2012-13 to find out the various effect for controlling weeds in *Rabi* wheat (PBW- 343) grown with recommended package of practices by the application of 2,4-D Dimethylamine 50% SL. The experiment was laid out in Randomized Block Design, comprising of nine treatments. Treatments were as follows:T_1 - 2,4-D amine 50% SL (Nufarm) @ 0.25 kg a.i. ha^{-1}, T_2 - 2,4-D amine 50% SL (Nufarm) @ 0.50 kg a.i. ha^{-1}, T_3 - 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1}, T_4 - 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1}, T_5 - 2,4-D amine 58% SL (Commercial) @ 0.50 kg a.i. ha^{-1}, T_6 - Metsulfuron methyl 20% WP @ 0.004 kg a.i. ha^{-1}, T_7 - Hand Weeding at 20 DAS & 40 DAS, T_8 – Unweeded control treatments and T_9 - 2,4-D amine 50% SL (Nufarm) @ 2.00 kg a.i. ha^{-1} and replicated thrice. In between aforesaid treatments, T_9 - 2,4-D amine 50% SL (Nufarm) @ 2.00 kg a.i. ha^{-1} was included only for phytotoxicity observation. *Phalaris minor*, *Cynodon dactylon*, *Avena fatua*, *Chenopodium album*, *Cirsium arvense*, *Fumaria parviflora*, *Anagallis arvensis*, *Cyperus rotundus and Cyperus iria* were the dominant weed species. Among the weed control methods 2,4-D amine 50% SL (Nufarm) @ 1.0 kg a.i. ha^{-1}(T_4)(40.00, 16.73 and 34.34 % respectively) and 2,4-D amine 50% SL(Nufarm) @ 0.75 kg a.i. ha^{-1}(T_3) (40.00, 15.82 and 32.06% respectively) recorded the higher weed control efficiency after hand weeding twice at 20, 40 and 60 DAS. Among the herbicide treatments, maximum grain yield and lowest weed index were recorded under 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) (1.80 t $ha^{-1}$and 2.70% respectively) plot. The herbicide 2,4-D amine 50% SL tested at different doses and the tested new formulation is safe to the wheat crop.

Introduction

Wheat (*Triticum aestivum* L.) is the king of the cereals and provides more nourishment (rich in carbohydrates). To fulfil the world food demand, wheat ranks top mostly grown and consumed in almost whole of the world (Noorka *et al.*, 2013). It belongs to family Poaceae, is a worldwide-cultivated important cereal crop. A 17% world's cropped area is under wheat cultivation which together adds 35% of the staple food and 20% of the calories (Chhokar *et al.,* 2006). It is the cheapest source supplying 72% of calories and protein in the average diet (Heyne, 1987 and Noorka *et al.,* 2012).

In India, the larger part of the population depends upon wheat for food and its enhanced production is indispensable for food security. The wheat production in India, has increased from 11.0 Million Tonnes (MT) during 1960-61 to 93.50 MT during 2015-16. It covers an area of 30.23 M ha with an average yield of 3093 $kgha^{-1}$and in West Bengal, it is grown in 0.34M ha area with the production of 0.96MT (Agri. Stat. at a glance, 2016). It is true that wheat production may be increased by either increasing the area under wheat crop or maximizing yield per unit area but this yield is gradually decreasing day by day due to different factors in which weed is one of them. Weeds cause more loses to agriculture than all pests (Gella *et al.,* 2013). There are innumerable reports on negative effects of weeds on crop plants (Javaid *et al.,* 2007) thus cause huge yield losses (Rathore *et al.,* 2014). Unchecked weed growth reduces crop yield up to 57% (Singh *et al.,* 1997). Weed infestation may reduce yield by 30-50% (Pandey *et al.,* 1997), 45.5 to 63.9% (Reddy and Reddi, 2002), 40.3% (Rajeev *et al.,* 2012), 30% (Zand *et al.,* 2007), 25.35% (Dangwal *et al.,* 2010) in wheat while reduced up to 92% by competition from ryegrass (Dickson *et al.,* 2011), 17.62% due to wild oat (Marwat *et al.,* 2011).

Wheat yield severely reduced due to broad-spectrum weed flora in different areas of India. Number of weed species in wheat field varied country to country and up to 90 weed species have been reported in India (Rao, 2000), 73 in Bangladesh (Begum *et al.,* 2003), 45 in Pakistan (Qureshi and Bhatti, 2001) and 33 in Iran (Buczek *et al.,* 2011). Moreover, weeds serve as alternate hosts to insects, nematodes and pathogenic fungi such as common broad leaved weeds for Fusarium (Postic *et al.,* 2012), wild grasses and grassy weeds for wheat streak mosaic virus and its vector and wheat curl mite (Ito *et al.,* 2012).

Weeds are one of the major constraints of wheat production and weed control is the key factor in increasing yield (Lopez-Granados, 2011; Shehzad *et al.,* 2012).Weed control has been observed as one of the most important practice in crop production because good weed control will ensure maximum yield and high quality of farm produce (Njoroge, 1999). Weeds can be controlled by different approaches such as manual methods, mechanical methods, allelopathic weed control, biological weed control and chemical control. Currently, chemical weed control has emerged as an effective tool for weed management because it is approachable, less time consuming as well as economical (Duke and Lydon, 1987; Jarwar *et al.,* 1999; Baghestani *et al.,* 2007). This method involves the use of chemicals commonly known as Herbicides or Weedicides. 2,4-D is an exclusively broad-leaved killer herbicide and has some sedge (*Cyperusrotundus/esculentus*) killing activity (Das, 2013). 2,4-D are generally formulated as inorganic or amine salts, or as esters (Wilson *et al.,* 1997). 2, 4-D amine salts are usually in liquid form. They have balanced solubility in lipoid and water. The persistence in soil is greater and more absorption/uptake by plant through roots (Das, 2013). Metsulfuron and 2,4-D herbicides have been used for control of weeds in wheat crop. Because this combination control of both type of weed flora i.e. narrow and broad leaved (Singh *et al.,* 2013).

Keeping in view the losses due to weed infestation and high efficiency of weed control by chemical method, the present study was undertaken to test the Performance of 2, 4-D

Dimethylamine 50% SL to control of weeds and also the ability of increasing yield in wheat.

Materials and Methods

Experimental location, topography and soil type

A field experiment was conducted at Regional Research Station (28^0 5.3$^/$N latitude and 83^0 5.3$^/$ E longitude and the election of 9.75 m above the mean sea level), BCKV, Chakdaha, West Bengal to study the effect of 2,4-D dimethylamine 50% SL to control of weeds in Wheat during the Rabi season, 2012-2013 in the sub-humid and sub-tropical condition of West Bengal. Topography of the land was referred as medium land situation and the soil of the experiment field was sandy loam with moderate pH level (6.8). The available N status of the soil was low whereas available P and K contents were in medium range with high base saturation and CEC (Cation Exchange Capacity).

Experimental details

The experiment was laid out in Randomized Block Design, comprising of nine treatments. Treatments were as follows:T_1 - 2,4-D amine 50% SL (Nufarm) @ 0.25 kg a.i. ha^{-1}, T_2 - 2,4-D amine 50% SL (Nufarm) @ 0.50 kg a.i. ha^{-1}, T_3 - 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1}, T_4 - 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1}, T_5 - 2,4-D amine 58% SL (Commercial) @ 0.50 kg a.i. ha^{-1}, T_6 - Metsulfuron methyl 20% WP @ 0.004 kg a.i. ha^{-1}, T_7 - Hand Weeding at 20 DAS & 40 DAS, T_8 – Unweeded control treatments and T_9 - 2,4-D amine 50% SL (Nufarm) @ 2.00 kg a.i. ha^{-1} and replicated thrice. In between aforesaid treatments, T_9 - 2,4-D amine 50% SL (Nufarm) @ 2.00 kg a.i. ha^{-1} was included only for phytotoxicity observation. Each plots for this experiment was divided in 5m × 4m area and the wheat variety PBW- 343was planted at20 cm spacing between rows using seed rate 100 kgha^{-1} on 7th December, 2012. Herbicidal treatments were applied as pre emergence (Metsulfuron methyl 20% WP) on 10thDecember, 2012and in case of post emergence (2,4-D amine 50% SLand 2,4-D amine 58% SL) on 10th January, 2013 as their respective doses as per treatments. Spraying was done with the help of knapsack sprayer fitted with a flat fan nozzle with the spray volume of water 500 lha^{-1}.The crop was managed as per the standard package of practices. All the recommended plant protection measures were undertaken during the course of investigation.

Data recording

Data on weeds were recorded at 20, 40 and 60 Days After Sowing (DAS). An area of 0.25 m^2 was selected randomly at two spots by throwing a quadrat of 0.5 × 0.5 m, weed species were counted from that area and density was expressed in number m^{-2}. The collected weeds were first sun-dried and then kept in an electric oven at 75˚C for 72 h for the measurement of dry weight or biomass and was expressed as g m^{-2}. Weed control efficiency was calculated based on the weed biomass respectively. The WCE efficiency was calculated as:

$$\text{W.C.E}\,(\%) = \frac{\text{Weed dry matter in control plot} - \text{weed dry matter in treated plot}}{\text{Weed dry matter in control plot}} \times 100$$

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.

The grain weight of wheat for above aforesaid treatments was recorded in kilogram and later expressed in tonnes per hectare (t ha^{-1}).

Weed index has been calculated with the formula:

$$WI = \frac{x-y}{x} \times 100$$

Where,

x = weight of seed yield (t ha^{-1}) in treatment which has highest yield

y = weight of seed yield (t ha^{-1}) in treatment for which weed index is to be calculated.

Statistical analysis

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 by using the critical differences (CD) at 5% level.

Results and Discussion

Dominant weed flora

The dominant weed flora found in the experiment plot at different stages during the crop period indicated that different types of grassy and non-grassy weeds. Among grassy weeds, predominant *Phalaris minor*, *Cynodon dactylon*, *Avena fatua and* among non-grassy weeds, *viz. Chenopodium album*, *Cirsium arvense*, *Fumaria parviflora*, *Anagallis arvensis* were under broadleaf weedsand in sedges, *viz. Cyperus rotundus and Cyperus iria* were observed. Similar type of observation was also reported by Bandyopadhyay *et al.*, (2017).

Effect of different weed control measures

Weed density

The density of broad leaf weed, grassy weed and sedge weeds at 20, 40 and 60 DAS (Days After Sowing) has been presented in table 1. The data on weed count has revealed that the population of broad leaf weed (0.68, 1.62 and 2.36 no. m^{-2} respectively), sedge weed (0.46, 0.66 and 1.60 no. m^{-2} respectively) and grassy weed (0.13, 0.54 and 0.65no. m^{-2} respectively) was recorded lowest underhand weeding twice plot at 20, 40 and 60 DAS. All the weed control treatments significantly reduced all type of weeds compared to unweeded control treatment.

Among the herbicidal treatments, 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) recorded least weed population at given days' interval followed by 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1}(T_3). Appraisal of the data revealed that 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) has resulted in effective control of total weed population and has recorded least weed count (1.67, 3.65 and 5.00no. m^{-2} respectively) at 20, 40 and 60 DAS and remained at par among themselves and superior to the other treatments except hand weeding twice (T_7). 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) was statistically at par with 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1} (T_3) in controlling the total weed population. This result corroborated the findings of Kundu *et al.*, 2018.

The unweeded control treatment (T_8) recorded the highest weed count at all the observations on given days' interval with the pre dominance of broadleaf weeds (4.35, 5.58 and 8.80no. m^{-2} respectively) followed by sedges (2.61, 5.09 and 4.89no. m^{-2} respectively) and after than grasses (0.95, 1.46 and 2.61no. m^{-2} respectively).

The population of different type of weeds followed the same tradition in all the treatments. These results were in harmony with the findings of several workers (Kundu *et al.*, 2017 and Bandyopadhyay *et al.*, 2017).

Table.1 Effect of treatments on density of various weeds (No. m^{-2}) in wheat

Tr. No.	Treatments	Dose (kg a.i. ha^{-1})	Broad leaf weed (No. m^{-2})			Sedge weed (No. m^{-2})			Grassy weed (No. m^{-2})			Total weed population (No. m^{-2})		
			20 *DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
T_1	2,4-D amine 50% SL (Nufarm)	0.25	1.25	2.18	5.16	0.85	1.56	2.82	0.43	1.20	1.98	2.42	4.63	9.39
T_2	2,4-D amine 50% SL (Nufarm)	0.50	1.00	1.81	3.45	0.70	1.25	1.85	0.30	0.77	1.28	2.00	4.00	6.38
T_3	2,4-D amine 50% SL (Nufarm)	0.75	0.92	1.80	2.69	0.70	1.10	1.74	0.28	0.72	0.95	2.00	3.85	5.29
T_4	2,4-D amine 50% SL (Nufarm)	1.00	0.87	1.79	2.54	0.52	1.08	1.66	0.25	0.68	0.90	1.67	3.65	5.00
T_5	2,4 D amine 58% SL(Commercial)	0.50	1.16	2.10	3.89	0.72	1.50	2.06	0.34	0.92	1.41	2.11	4.29	7.93
T_6	Metsulfuron methyl 20% WP	0.004	1.23	2.11	3.96	0.74	1.54	2.53	0.38	1.12	1.94	2.41	4.58	8.42
T_7	Hand weeding twice	-	0.68	1.62	2.36	0.46	0.66	1.60	0.13	0.54	0.65	1.31	3.00	4.82
T_8	Unweeded control		4.35	5.58	8.80	2.61	5.09	4.89	0.95	1.46	2.61	7.91	12.13	16.30
S.Em. (±)			**0.06**	**0.13**	**0.22**	**0.02**	**0.08**	**0.09**	**0.02**	**0.05**	**0.08**	**0.37**	**0.53**	0.65
CD (P=0.05)			**0.13**	**0.28**	**0.47**	**0.05**	**0.18**	**0.20**	**0.04**	**0.10**	**0.18**	**0.79**	**1.11**	1.38

*- Days After Sowing

Table.2 Effect of treatments on total weed dry matter accumulation and weed control efficiencyin wheat

Tr. No.	Treatments	Dose (kg a.i. ha^{-1})	Total weed dry matter accumulation (g m^{-2})			Weed control efficiency (%)		
			20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
T_1	2,4-D amine 50% SL (Nufarm)	0.25	1.81	12.93	16.20	9.50	2.12	19.84
T_2	2,4-D amine 50% SL (Nufarm)	0.50	1.21	11.32	13.87	39.50	14.31	31.37
T_3	2,4-D amine 50% SL (Nufarm)	0.75	1.20	11.12	13.73	40.00	15.82	32.06
T_4	2,4-D amine 50% SL (Nufarm)	1.00	1.20	11.00	13.27	40.00	16.73	34.34
T_5	2,4 D amine 58% SL(Commercial)	0.50	1.31	12.00	14.21	34.50	9.16	29.69
T_6	Metsulfuron methyl 20% WP	0.004	1.73	12.78	14.27	13.50	3.26	29.39
T_7	Hand weeding twice	-	0.97	8.47	11.27	51.50	35.88	44.24
T_8	Unweeded control		2.00	13.21	20.21	-	-	-
	S.Em. (±)		**0.07**	**0.52**	**0.65**	-	-	-
	CD (P=0.05)		**0.15**	**NS**	**1.38**	-	-	-

Table.3 Effect of treatments on phytotoxicity, grain yield (t ha^{-1}) and weed index (%) in wheat

Tr. No.	Treatments	Dose a.i. kg ha^{-1}	Phytotoxicity observation			Grain yield (t ha^{-1})	Weed index (%)
			7 *DAHA	14 DAHA	21 DAHA		
T_1	2,4-D amine 50% SL (Nufarm)	0.25	0	0	0	1.35	27.02
T_2	2,4-D amine 50% SL (Nufarm)	0.50	0	0	0	1.61	12.97
T_3	2,4-D amine 50% SL (Nufarm)	0.75	0	0	0	1.70	8.10
T_4	2,4-D amine 50% SL (Nufarm)	1.00	0	0	0	1.80	2.70
T_5	2,4 D amine 58% SL(Commercial)	0.50	0	0	0	1.52	17.83
T_6	Metsulfuron methyl 20% WP	0.004	0	0	0	1.40	24.32
T_7	Hand weeding twice	-	0	0	0	1.85	-
T_8	Unweeded control		0	0	0	1.30	29.72
**T_9	2,4-D amine 50% SL (Nufarm)	2.00	0	0	0	-	-
S.Em. (±)			-	-	-	**NS**	-
CD (P=0.05)			-	-	-	**NS**	-

* - Days After Herbicide Application
**- Included only for phytotoxicity

Total weed Dry Matter Accumulation [DMA] and Weed Control Efficiency [WCE]

The dry matter production of weeds was recorded at 20, 40 and 60 DAS. Significant differences in DMA were observed among the treatments at all the stages. At 20, 40 and 60 DAS the lowest DMA of 0.97, 8.47 and 11.27gm m^{-2}was recorded in hand weeding twice (T_7) followed by 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) (1.20, 11.00

and 13.27gm m^{-2}respectively) and 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1} (T_3) (1.20, 11.12 and 13.73gm m^{-2}) respectively. Consequent to the lower density of weeds observed in hand weeding twice (T_7) followed by 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) and 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1} (T_3), The weed dry weight was recorded least in the aforesaid treatments.

The weed dry weight in the recommended treatments remained at par among themselves and also recorded significantly superior to the other treatments at all the stages especially than the standard treatments viz., 2,4-D amine 58% SL (Commercial) @ 0.50 kg a.i. ha^{-1} (T_5) and Metsulfuron methyl 20% WP @ 0.004 kg a.i. ha^{-1} (T_6).

In between all the given the treatments, maximum DMA of weeds was recorded under the unweeded control treatment (2.00, 13.21 and 20.21gm m^{-2} respectively) at all the observations. This was in close conformity with the findings of Biswas *et al.,* 2017.

The weed control efficiency derived from the weed dry weight revealed, hand weeding twice (T_7) resulted with the higher weed control efficiency of 51.50, 35.88 and 44.24 % during 20, 40 and 60 DAS respectively that's already shown in table 2. This was followed by 2,4-D amine 50% SL (Nufarm) @ 1.0 kg a.i. ha^{-1} (T_4) (40.00, 16.73 and 34.34 % at 20, 40 and 60 DAS respectively) and 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1} (T_3) (40.00, 15.82 and 32.06% 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 (T_8). Similar type of results was also observed by the application of 2,4-D to reduce weed dry weight and WCE in irrigated wheat (Singh *et al.,* 2013).

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. There were no crop Phytotoxicity symptoms among the different treatments as well as at the highest dose of 2,4-D amine 50% SL (Nufarm) @ 2.00 kg a.i. ha^{-1}(T_9) shown in table 3 and also indicated that the herbicide was safe for wheat.

Grain yield and Weed Index [WI]

From the table 3, it has been observed thatHand weeding twice (T_7) recorded the highest grain yield of 1.85 t ha^{-1} which was on par with2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) (1.80 t ha^{-1}). This was followed by 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1} (T_3) (1.70 t ha^{-1}) and 2,4-D amine 50% SL (Nufarm) @ 0.50 kg a.i. ha^{-1} (T_3) (1.61 t ha^{-1}) respectively.

On the basis of recorded data presented in table 3, its clearly reveal that except hand weeding twice (T_7) treatment, the lowest weed index which was shown in 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) (2.70%) that's followed by 2,4-D amine 50% SL (Nufarm) @ 0.75 kg a.i. ha^{-1} (T_3) (8.10%). Lower weed index indicated lesser grain yield reduction due to minimum crop-weed competition period suggested by Raj *et al.,* 2013.

From the above study, it can be concluded that 2,4-D amine 50% SL (Nufarm) @ 1.00 kg a.i. ha^{-1} (T_4) and 2,4-D amine 50% SL

(Nufarm) @ 0.75 kg a.i. ha^{-1} (T_3) was most effective to check all type of weed population and also resulted better wheat grain yield which may be recommended to the farmer of gangetic alluvial zone, West Bengal for remunerative growth and development of *rabi* season wheat.

2,4-D amine 50% SL tested at different doses for Phytotoxicity has revealed that there is no Phytotoxicity symptoms observed in any of the doses and the tested new formulation is safe to the wheat crop in the agro-zones of West Bengal including the country as a whole.

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