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Weed control efficiency of 2, 4-D dimethyl amine 50% SL on wheat under Indo-gangetic plains

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Abstract
A Field experiment was conducted during Rabi season 2013-14 in the sub-humid and sub-tropical condition at Regional Research Station, BCKV, Chakdaha. The experiment was conducted in R.B.D with three replications compromising nine treatments *viz.* five different doses of 2,4-D dimethyl amine 50% SL (Nufarm) applied at 0.25,0.50,0.75,1.00 a.i. kg/ha & 2.00 a.i. kg/ha (for phytotoxicity observation), 2,4-D dimethyl amine 58% SL (Commercial)applied at 0.50 a.i. kg/ha, Metsulfuron methyl 20% WP applied at 0.004 a.i. kg/ha, Two hand weeding, unweeded control. The dominant weed flora in wheat consisted of Phalaris minor, Cynodon dactylon, Avena fatua, Cyperus rotundus, Cyperus iria, Chenopodium album, Cirsium arvense, Fumaria parviflora and Anagallis arvensis. The experimental results revealed that among the nine treatments, hand weeding twice (T_7) gave the highest grain yield (2.90 t ha-1) where as control plot gives lower grain yield (1.25 t ha-1). 2,4-D dimethyl amine 50% SL (Nufarm) @ 2.00 kg a.i. ha^{-1} didn't show any phytotoxic symptoms such as epinasty /hyponasty, leaf yellowing, necrosis, etc. & it is safe for the wheat crop.

Keywords: 2, 4-D dimethyl amine 50% SL, weed management, grain yield, Phyto toxicity

Introduction
After rice, Wheat (*Triticum aestivum*) is the most important cereal crop grown exclusively in India. Wheat grain is not only used as staple food also used as cattle feed in India (Singh, 2013) [12]. This covers 17% cropped land and 35% of the staple food all over the world (Pingali, 1999) [9]. In India, it occupies about 31.19 million ha land area with the production capacity of 95.91 million tonnes (Agril. Statistics, 2014) [1]. Whereas, West Bengal occupies 0.34 million ha of land area with production 0.95 million tones and productivity of 2802 kg/ha (Agril. Satistics, 2014) [1].

Weed is one of the important biotic factor that lower wheat yield by 37-50 per cent (Waheed *et al*., 2009) [14]. Weeds are generally considered as notorious yield reducers rather than fungi, insects, fungi or other pest organisms (Savary *et al*., 1997; 2000) [11. 10]. Weeds generally competes with crops for nutrient, light, soil moisture etc (Gupta, 2004) [5].

Soil water is often limited in the top soil layer in rainfed areas and stands of wheat may be established poorly and have low yields while sowing more deeply may enhance establishment due to higher soil water content in the seed zone, leading to better germination and emergence of seedling (Mahdi *et al*.,1998) [6]. Reduction in crop yield generally depends upon weed density, timing of emergence, wheat density & cultivar and other environmental factors (Chhokar and Malik, 2002) [3]. *Phalaris minor* is one of the very serious weed in wheat which can bring down almost 100 per cent crop losses (Singh and Singh, 2002) [13]. Malik and Singh, 1995 [7] reported that, Continuous application of isoproturon may led to the development of evolutionary resistant in weed flora. Broad leave weeds can be controlled along with grasses, application of isoproturon in combination with 2, 4-D and metsulfuron-methyl (MSM) (Pandey *et al.*, 2006) [8]. 2, 4-D are herbicides are generally great broad leaf weed killer and formulated as inorganic or amine salts, or as esters (Wilson *et al.*, 1997) [13]. Herbicides are not only controlled by the hand weeding or through manual weeding but also through various herbicidal applications which should eco-friendly as well as helps in improving crop yield. Keeping in view, crop yield loss due to weed infestation, the present field experiment was carried out to know the effect of 2, 4-D dimethyl amine 50% SL (Nufarm) to control weed and improvement in wheat yield.

Materials and Methods
A field experiment was conducted at Regional Research Station, BCKV, Chakdaha which is situated at 28^0 5.3/N latitude and 83^0 5.3/ E longitude on elevation of 9.75 m above the mean

sea level to study the Weed Control efficiency of 2, 4-D dimethyl amine 50% SL on Wheat under Indo-gangetic plains during the Rabi season, 2013-2014 in the sub-humid and sub-tropical condition of West Bengal.

Experimental details

The experiment was carried out in Randomized Block Design, comprising of nine treatments and replicated thrice. Treatments were as follows:T_1 - 2,4-D dimethyl amine 50% SL (Nufarm) @ 0.25 kg a.i. ha-1, T_2 - 2,4-D dimethyl amine 50% SL (Nufarm) @ 0.50 kg a.i. ha-1, T_3 - 2,4-D dimethyl amine 50% SL (Nufarm) @ 0.75 kg a.i. ha-1, T_4 - 2,4-D dimethyl amine 50% SL (Nufarm) @ 1.00 kg a.i. ha-1, T_5 - 2,4-D dimethyl 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 dimethyl amine 50% SL (Nufarm) @ 2.00 kg a.i. ha^{-1} was applied only for phytotoxicity observation. The experimental plot were divided in 5 m × 4 m area and the wheat variety PBW- 343 was sown at 20 cm spacing in between rows by using 100 kgha-1 of wheat seed on 4th December, 2013. Post emergence application of 2, 4-D amine 50% SL and 2, 4-D amine 58% SL on 9th January, 2014 were done as per their respective doses. Herbicidal Spraying was done through the help of knapsack sprayer fitted with a flat fan nozzle with the spray volume of water 500 lha^{-1}. Standard package of practices followed for proper management of crop and recommended plant protection measures were taken during the field experimentation.

Data recording

Data on weed was recorded at 20, 40 & 60 Days After Sowing (DAS). For counting of species from the experimental field an area of 0.25 m^2 was selected randomly at two spots by throwing a quadrate of 0.5 × 0.5 m, and after that density was expressed in number m^{-2}. The collected weeds were first sun-dried and then kept in an electric oven at 70 ± 2˚C for 72 h for the measurement of dry weight or biomass and were expressed as g m^{-2}. Weed control efficiency was calculated based on the weed biomass respectively are as follows-

$$WCE\ (\%) = \frac{\text{Weed count in unweeded plot} - \text{Weed count in treated plot}}{\text{Weed count in unweeded plot}} \times 100$$

Weed index has also been calculated with the help of following formula:

$$\text{Weed index} = \frac{\text{Yield from weed free plot- yield from treated plot}}{\text{Yield from weed free plot}} \times 100$$

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.

Grain yield of wheat were recorded at the time of harvest from the above treatments in kilogram and later expressed in tonnes per hectare (t ha^{-1}).

Statistical Analysis

The treatments were allocated randomly to different plots with the help of random number table (Fisher, 1958) [4]. The data were analyzed by ANOVA, and ranked by using the critical differences (CD) at 5% level.

Results and Discussion

Dominant Weed Flora

During the time of field experimentation different kinds of weed flora like grasses, sedges and broad leaves were found predominantly. Among the grasses *Phalaris minor, Cynodon dactylon, Avena fatua* and non-grassy weeds like *Chenopodium album, Cirsium arvense, Fumaria parviflora and Anagallis arvensis* were found. Sedges like *Cyperus rotundus & Cyperus iria were observed.* Bandyopadhyay *et al.,* (2017) [2] also reported similar type of observation.

Effect on weed control measures

Weed Density

The total weed density was significantly reduced in the herbicide treatments. The data on Fig 1 weed count has revealed that 2,4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1} (T_4) has resulted in effective control of all type of weeds and has recorded least weed count at 20, 40 and 60 DAS and remained on par among themselves and superior to the other treatments except hand weeding twice (T_8). 2,4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1} (T_4) was on par with 2,4-D dimethyl amine 50% SL 0.75kg a.i. ha^{-1} (T_3) in controlling the total weed population.

The unweeded control treatment (T_8) recorded the highest weed count at all the observations with the pre dominance of broad leaf weeds followed by sedges and grasses respectively. Application of 2, 4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1}(T_4) was proved to control individual weed species *viz*., *Chenopodium album, Cirsium arvense, Fumaria parviflora, Anagallis arvensis* in broad leaved weeds, *Cyperus rotundus, Cyperus iria* in sedges and *Phalaris minor, Cynodon dactylon, Avena fatua in* grasses at all the stages of observation.

Weed dry weight and weed control efficiency

The dry matter production of weeds was recorded at 20, 40 and 60 DAS. Significant differences in DMP were observed among the treatments at all the stages. At 20, 40 and 60 DAS, the lowest DMP of 0.67, 0.85 and 1.02 gm m^{-2} was recorded in hand weeding twice (T_7) followed by 2,4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1}(T_4)and 2,4-D amine 50% SL 0.75kg a.i.ha^{-1}(T_3). Consequent to the lower density of weeds observed in hand weeding twice (T_7) followed by 2,4-D di methyl amine 50% SL 1.0 kg a.i. ha^{-1}(T_4) and 2,4-D amine 50% SL 0.75kg a.i. ha^{-1}(T_3), The weed dry weight was recorded least in the aforesaid treatments. The weed dry weight in the aforesaid treatments remained on par among themselves and remain significantly superior to the other treatments at all the stages especially that the standard treatments *viz*., 2,4-D dimethyl 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).

The weed control efficiency derived from the weed dry weight revealed, hand weeding twice (T_7) resulted with the higher weed control efficiency of 90.85, 89.53 and 85.71% during 20, 40 and 60 DAS respectively. This was followed by 2,4-Ddimethylamine 50% SL 1.0 kg a.i. ha^{-1}(T_4) (88.39,81.65 and 66.39% at 20, 40 and 60 DAS respectively) and 2,4-D dimethyl amine 50% SL 0.75kg a.i. ha^{-1}(T_3) (88.11, 81.40 and 60.92% 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).

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 dimethyl amine 50% SL 2.0 kg a.i. ha^{-1} (T_9).

Yield and yield parameters of Wheat

The data on Table 2 shows that Hand weeding twice (T_7) recorded the highest grain yield of 2.90t ha^{-1}which was followed by2,4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1}(T_4) (2.75 t ha^{-1}), 2,4-D dimethyl amine 50% SL 0.75 kg a.i. ha^{-1}(T_3) (2.50 t ha^{-1})and 2,4-D dimethyl amine 50% SL 0.5 kg a.i. ha^{-1}(T_2) (2.15 t ha^{-1}) respectively. Similar to grain yield, straw yield was also influenced due to different weed management practices. Among the treatments, Hand weeding twice (T_7) recorded the highest straw yield of 4.35 t ha^{-1}which was followed by 2,4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1}(T_4) (4.10 t ha^{-1}) and 2,4-D dimethyl amine 50% SL 0.75 kg a.i. ha^{-1}(T_3) (3.30 t ha^{-1}).

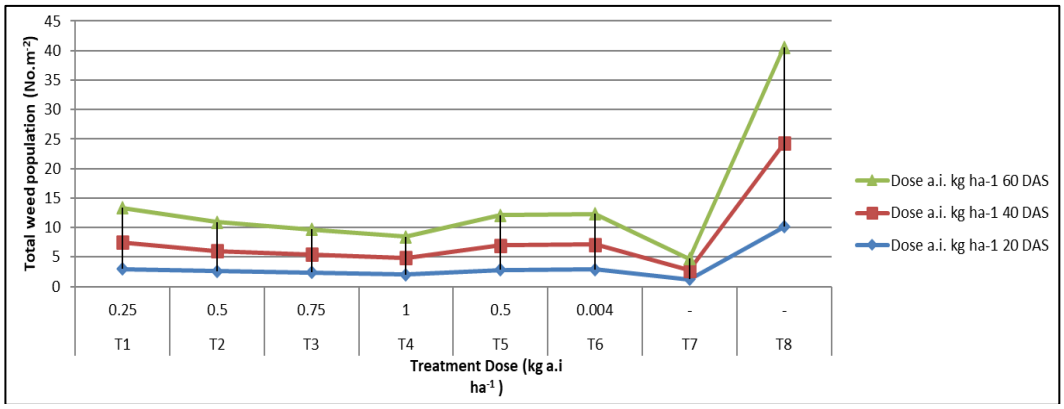

Fig 1: Effect of treatments on Total weed population (No.m^{-2}) in wheat

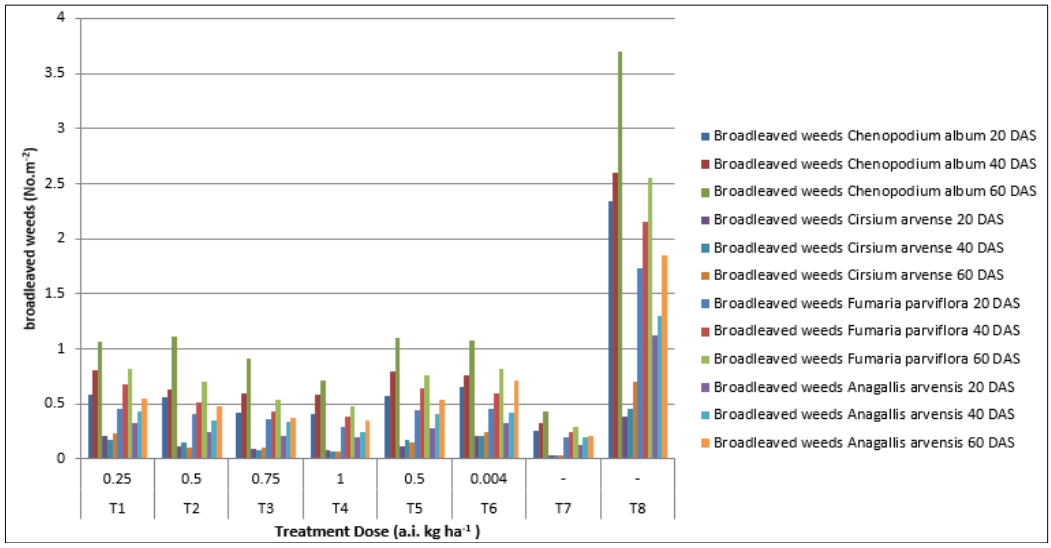

Fig 2: Effect of treatments on population of Broadleaved weeds (No.m^{-2}) in wheat

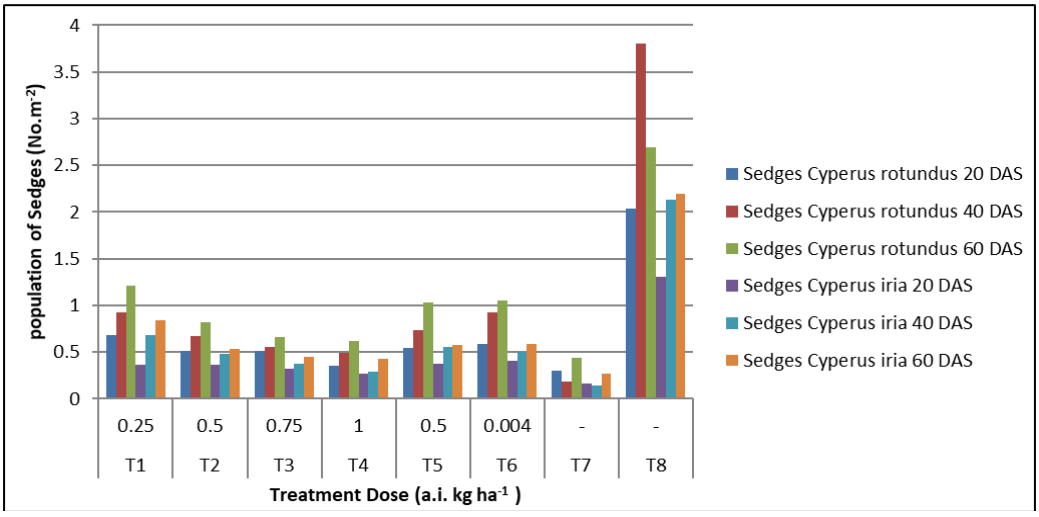

Fig 3: Effect of treatments on population of Sedges (No.m^{-2}) in wheat

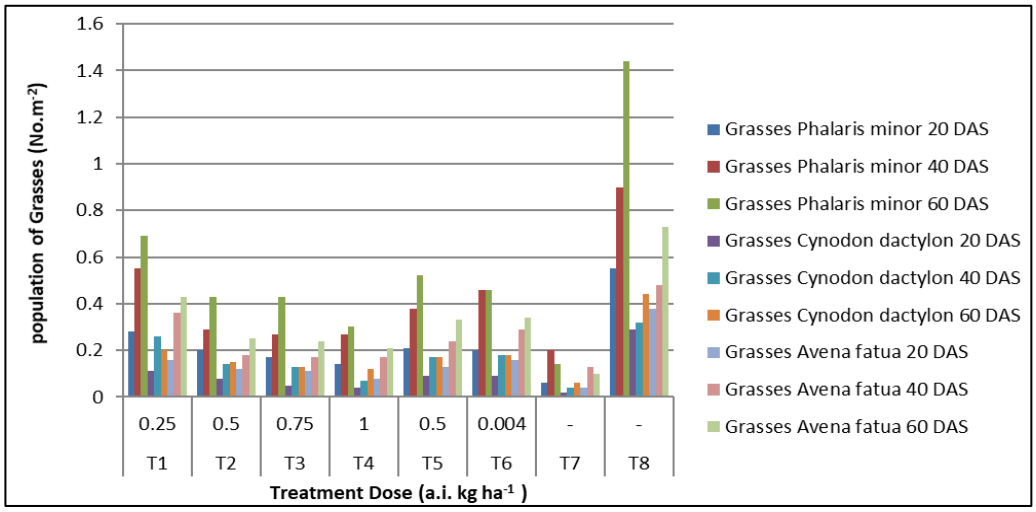

Fig 4: Effect of treatments on population of Grasses (No.m^{-2}) in wheat

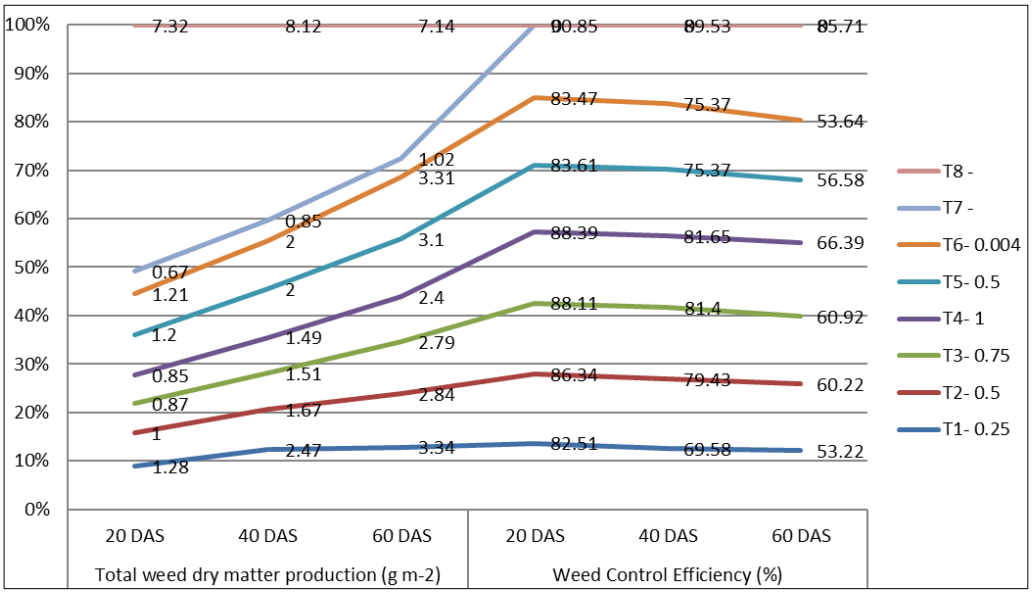

Fig 5: Effect of treatments on Total weed dry matter production (g m^{-2}), Weed Control Efficiency (%)

Table 1: Effect of treatments on Phytotoxicity

Treatment	Dose a.i. kg ha^{-1}	Phytotoxicity Observation		
		7 DAHA	14 DAHA	21 DAHA
2,4-D amine 50% SL (Nufarm)	0.25	0	0	0
2,4-D amine 50% SL (Nufarm)	0.50	0	0	0
2,4-D amine 50% SL (Nufarm)	0.75	0	0	0
2,4-D amine 50% SL (Nufarm)	1.00	0	0	0
2,4 D amine 58% SL(Commercial)	0.50	0	0	0
Metsulfuron methyl 20% WP	0.004	0	0	0
Hand weeding 20 DAS & 40DAS	-	0	0	0
Unweeded control	-	0	0	0
2,4-D amine 50% SL (Nufarm)	2.00	0	0	0

Table 2: Effect of treatments on Grain yield (t ha^{-1}), Straw yield (t ha^{-1}) & Harvest Index (%)

Treatment	Dose a.i. kg ha^{-1}	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)
2,4-D amine 50% SL (Nufarm)	0.25	2.00	2.72	42.37
2,4-D amine 50% SL (Nufarm)	0.50	2.15	2.98	41.91
2,4-D amine 50% SL (Nufarm)	0.75	2.50	3.30	43.10
2,4-D amine 50% SL (Nufarm)	1.00	2.75	4.10	40.14
2,4 D amine 58% SL(Commercial)	0.50	2.10	2.85	42.42
Metsulfuron methyl 20% WP	0.004	2.00	2.80	41.66
Hand weeding 20 DAS & 40DAS	-	2.90	4.35	.40.00
Unweeded control		1.25	2.00	38.46
S. Em (±)		0.36	0.45	-
LSD (0.05)		0.76	0.84	-

Conclusion

From the above study, it is inferred that 2,4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1} (T_4)and 2,4-D dimethyl amine 50% SL 0.75kg a.i. ha^{-1} (T_3) has resulted in effective weed control, recording the least weed density and weed dry weight and there by higher weed control efficiency after manual weeding twice treatment plot (T_7). In case of yield, 2,4-D dimethyl amine 50% SL 1.0 kg a.i. ha^{-1} (T_4) and manual weeding twice plot resulted better yield which was on par with aforesaid treatments.

2,4-D dimethyl 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.

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