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Bio-efficacy of some new herbicides for eco-safe weed management in wheat (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was conducted at Kalyani to find out an effective eco-safe herbicide for controlling weeds in wheat during winter' 2003 and 2004. *Eleusine indica, Echinochloa colona* and *Digitaria sanguinalis* among the grasses, *Melilotus alba, Chenopodium album, Vicia hirsuta* and *Gnaphalium luoteoalbum* among broad-leaf weeds and *Cyperus rotundus* among the sedge were found dominant in the experimental plot during both the year. Hand weeding twice resulted in lowest weed density and weed biomass followed by clodinafop + 2,4 DEE. Hand weeding recorded the highest grain yield followed by clodinafop + 2,4 DEE treatment, which were 48.1% and 38.9% higher over weedy check respectively. Among the herbicidal treatments, clodinafop + 2,4 DEE yielded maximum followed by sulfosulfuron, isoproturon, pendimethalin respectively. All the herbicides significantly reduced the microbial population upto 15 days after application but recovered thereafter.

Key word : Herbicide, Weed, Yield, Wheat, Bacteria.

Wheat is an important winter cereal in eastern India. Heavy infestation due to grasses became a serious problem in increasing and sustaining productivity of wheat. Weeds reduce wheat yield by 25-40%. Morphological similarities of grass weeds with wheat make it difficult to eradicate them by manual methods. The existing herbicides are unable to control some of the weeds. Resistance of some weed species to a herbicide that has been continuously in use emerged a serious problem. 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 bio-efficacy of some new herbicides for eco-safe weed management in wheat.

MATERIALS AND METHODS

The field experiment was carried out on wheat during winter' 2003-04 and 2004-05 at farmers' field, Kalyani, West Bengal in new alluvial soil with a pH of 6.7, organic carbon 0.55%, total nitrogen 0.054% and available phosphorus and potassium of 22.37 and 131.62 kg ha^{-1}, respectively. The experiment was laid out in a randomized block design (RBD) with ten treatments replicated thrice. The treatments were trifluralin 48 EC 1000 g ha^{-1} and pendimethalin 30 EC 1000 g ha^{-1} as pre-emergence application at 2 days after sowing (DAS), sulfosulfuron 75 WG 25 g ha^{-1} + adjuvant, 2,4-D ethyl ester 38 EC at 450 g ha^{-1}, clodinafop 15 WP 60 g ha^{-1}, fenoxaprop p-ethyl 10 EC 100 g ha^{-1} + adjuvant, isoproturon 75 WP 1000 g ha^{-1} and clodinafop 15 WP 60 g ha^{-1}+ 2,4-D ethyl ester 38 EC at 450 g ha^{-1} as post emergence application at 30 DAS, hand weeding twice 20 and 40 DAS and weedy check. Wheat cv. ***Rajlakshmi*** was grown with all recommended package of practices except water and weed management. 0.5 x 0.5 m^2 quadrate was used twice randomly in each plot to record weeds for their dry weight at 25, 50 and 75 DAS and was converted into g m^{-2}. The data on weed count and dry weight showed considerable variation. Before statistical scrutiny the data transformed into square root value. Yield and yield components were taken at harvesting stage of the crop. The enumeration of microbial population was done on agar plate containing appropriate media following serial dilution technique and pour plate method (Parmer and Schmidt, 1965). Jensen's agar medium (Jensen, 1930) and Pikovskaia's agar medium were used for counting aerobic non-symbiotic nitrogen fixing bacteria and phosphate solubilising bacteria, respectively.

RESULTS AND DISCUSSION

Weed flora

Eleusine indica, Echinochloa colona and *Digitaria sanguinalis* among the grasses, *Melilotus alba, Chenopodium album, Vicia hirsuta* and *Gnaphalium luoteoalbum* among broad-leaf weeds and *Cyperus rotundus* among the sedge were found dominant in the experimental plot during both the year.

Bio-efficacy

Population and dry matter accumulation of weeds were reduced with all the weed control treatments under study over weedy check (Table 1). Hand weeding twice resulted in lowest weed density and weed biomass followed by clodinafop + 2,4 DEE. Among the herbicidal treatments, clodinafop when applied in conjunction with 2,4 DEE recorded significantly lower weed dry weight and population over their sole application in both the years. Trifluralin, fenoxaprop-p-ethyl, isoproturon and pendimethalin were not very much effective in controlling weeds in comparison to clodinafop+ 2,4 DEE. Among the herbicides, clodinafop+ 2,4 DEE exhibited higher weed control efficiency and hence proved its superiority in controlling weeds followed by sulfosulfuron in both the years. The result was in conformity with the observations made by Tiwari and Vaishya (2005).

Yield and yield component

Hand weeding treatment produced maximum number of effective tillers m^{-2} followed by clodinafop + 2,4 DEE application while weedy check recorded the minimum. (Table-2). Among the herbicidal treatments sulfosulfuron, pendimethalin and isoproturon exhibited statistically at par result with clodinafop + 2,4 DEE but 2,4 DEE alone recorded the lowest value. Considering the length of spike, all chemical treatments were at par and significantly more than weedy check. The spike weight was highest in hand weeding treatment closely followed by isoproturon. However, clodinafop + 2,4 DEE, sulfosulfuron, pendimethalin, fenoxaprop-p-ethyl produced equivalent spike weight.

Hand weeding recorded the highest grain yield followed by clodinafop+ 2,4 DEE treatment, which were 48.1% and 38.9% higher over weedy check respectively. Among the herbicidal treatments, clodinafop + 2,4 DEE yielded maximum followed by sulfosulfuron, isoproturon, pendimethalin respectively. Straw yield exhibited similar trend for all the treatments.

Soil micro flora

There was an overall reduction in microbial population at 15 DAA of chemicals i.e., herbicide and gradually recovers with the progress of the crop. The population of non-symbiotic N fixing bacteria and PSB were significantly higher in weedy check and hand weeded plots in comparison to herbicide treated plots. The number of microbial population was maximum in Sulfosulfuron treated plots in all dates of observation. At 15 DAA, the reduction in non-symbiotic N fixing bacteria was lowest in isoproturon followed by 2,4-DEE but their recovery was faster in 2,4-DEE. Both the treatments were at per and less harmful over herbicidal treatments. At 15 DAA , 2,4-DEE ,clodinafop, isoproturon showed smaller reaction on PSB population over other herbicides and the recovery was faster at 45 DAA. Sulfosulfuron exhibited the lowest PSB population in all dates of observation.

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Table 1 Effect of treatments on weed population, weed dry weight and Weed Control Efficiency (WCE) at 50 DAS

Treatment	Weed density (No.m^2)		Weed dry weight (gm^2)		WCE (%)	
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Trifluralin	12.05 (146.3)	11.75 (138.7)	10.65 (113.81)	10.22 (104.75)	38.72	50.88
Pendimethalin	10.42 (109.7)	10.97 (121.3)	9.12 (83.64)	9.33 (87.27)	54.96	59.07
Sulfosulfuron	9.67 (93.3)	9.90 (98.7)	7.88 (62.27)	7.44 (59.94)	66.47	71.89
2,4-DEE	12.74 (163.3)	12.36 (154.7)	11.16 (125.53)	10.80 (116.78)	32.41	45.24
Clodinafop	10.77 (115.0)	10.16 (102.3)	9.37 (87.89)	9.07 (82.30)	52.67	61.40
Fenoxaprop-p-ethyl	12.52 (157.0)	11.70 (138.0)	10.53 (111.32)	10.32 (106.63)	40.06	50.00
Isoproturon	10.60 (112.7)	10.20 (104.7)	9.57 (91.94)	8.58 (73.72)	50.49	65.43
Clodinafop+ 2,4-DEE	7.99 (63.3)	7.05 (48.7)	5.38 (28.71)	4.61 (21.38)	84.54	89.97
HW 20 & 40 DAS	5.10 (26.7)	4.32 (18.3)	2.50 (6.35)	2.41 (5.94)	96.58	97.21
Weedy check	14.60 (213.7)	17.20 (295.3)	13.62 (185.71)	14.63 (213.24)	-	-
CD at 5%	2.84	1.63	3.18	2.72		

Data in the parentheses indicate the original values

Table 2 Effect of different weed management treatments on yield components and yield of wheat (pooled of two years)

Treatment	No. of effective tillers m^{-2}	Length of the spike (cm)	Spike weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Trifluralin	242	9.87	1.41	26.55 (24.4)	37.23
Pendimethalin	259	10.02	1.64	28.33 (32.8)	39.14
Sulfosulfuron	265	10.08	1.67	29.00 (35.9)	39.52
2,4-DEE	239	9.68	1.32	25.32 (18.7)	35.86
Clodinafop	246	9.83	1.46	27.67 (29.7)	38.14
Fenoxaprop-p-ethyl	248	9.72	1.58	27.82 (30.4)	38.00
Isoproturon	256	9.93	1.74	28.53 (33.7)	39.29
Clodinafop+ 2,4-DEE	272	10.06	1.61	29.64 (38.9)	39.93
HW 20 & 40 DAS	289	10.12	1.76	31.61 (48.1)	42.34
Weedy check	207	8.14	1.02	21.34	30.27
CD at 5%	21.03	0.67	0.24	5.26	6.11

Data in parentheses indicates the yield increment over weedy check

Table 3 Effect of treatments on the population of soil micro-flora (pooled of two year)

Treatment	Microbial population (CFU x 10^4 g^{-1} of soil)			
	Non-symbiotic N-fixing bacteria		Phosphate solubilising bacteria	
	15 DAA	45 DAA	15 DAA	45 DAA
Trifluralin	55.33	79.33	19.67	34.33
Pendimethalin	64.00	84.67	18.00	33.33
Sulfosulfuron	52.33	71.67	12.33	29.00
2,4-DEE	72.67	98.33	22.00	38.00
Clodinafop	62.33	84.33	21.33	38.67
Fenoxaprop-p-ethyl	68.00	93.33	19.00	36.33
Isoproturon	74.67	96.00	21.67	35.67
Clodinafop+ 2,4-DEE	56.33	79.00	18.33	31.67
HW 20 & 40 DAS	85.33	108.33	26.33	41.33
Weedy check	87.00	102.67	25.67	40.33
CD at 5%	4.16	6.53	2.33	3.11