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Eco-efficacy of pretilachlor 50% EC in transplanted winter rice and its residual effect on lentil

Dibyendu Mondal*, Anannya Ghosh, Soumen Bera, Ratikanta Ghosh and Pintoo Bandopadhyay

Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741 252, West Bengal, India

**Email: mondal.dibyendu@bckv.edu.in*

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ABSTRACT

A field experiment was conducted during *Kharif* seasons of 2014-15 and 2015-16 at Bidhan Chandra Krishi Viswavidyalaya (BCKV), West Bengal to evaluate the effect of pretilachlor 50% EC on growth of composite weed flora and productivity of winter (*Kharif*) rice (*Oryza sativa* L.). The experiment comprised of eight treatments following a randomized block design with three replications. Experimental findings revealed that hand weeding twice at 15 and 30 DAT effectively controlled the grasses, sedges and broad-leaved weeds, which recorded statistical parity with the application of pretilachlor 50% EC at 750 g/ha followed by its lower dose at 600 g/ha. Grain yield losses amounted to 31.4-50.1% due to uncontrolled weed growth as compared to different weed control treatments. Among the different herbicidal treatments, pretilachlor 50% EC at 750 and 600 g/ha recorded higher weed control efficiency, yield attributes and grain yield (4.25 and 4.20 t/ha, respectively) of rice, which did not affect the germination and seed yield of succeeding lentil crop during both the years. Besides, soil beneficial microflora was not negatively influenced in long run. Considering bio-efficacy, economics and microbial study, pretilachlor 50% EC at 600 g/ha could be a better alternative for weed management and may be recommended for obtaining a higher yield of transplanted winter rice in the Gangetic Inceptisol of West Bengal.

INTRODUCTION

Rice plays an important role in food as well as livelihood security for almost every household, particularly to the farmers of Gangetic Inceptisol of India (Mondal *et al.* 2018). The production of rice in this region plays a vital role in maintaining food sufficiency in India. At the current growth rate of population (1.55%) in India, the requirement of rice by 2020 would be around 120-135 million tonnes (Raj *et al.* 2016). For maintaining food security, it is quite important to lift up the productivity levels of rice and that too by facing the adverse impacts of climate change. Weeds are claimed to be one of the major yield limiting factors in rice crop. It implies a serious negative effect on crop production and responsible for 45-55% reduction of grain yield (Ghosh *et al.* 2013) under severe infestation. If we can minimize this amount of crop losses, the rice productivity could be brought to the desired level. Therefore, weed control measures at critical crop weed competition period are gaining more importance (Mondal *et al.* 2017). Manual weeding is common in India, but its use is declining due to labour scarcity at the critical time of weeding and also for increasing labour wages (Duary *et al.* 2015). Chemical weed management through herbicides is low-cost alternative, but still needs more eco-sustainable and farmers' acceptance. According to Saha (2005), herbicides offer selective and economic control of weeds by giving the crop an advantage of good start and competitive superiority. Several new pre- and post-emergence herbicides are introducing in a regular manner but their ecosafe low-cost efficiency needs to be investigated. Pretilachlor [2-chloro-N-2,6-diethyl-N-(2-propoxyethyl) acetanilide], a chloro-acetanilide herbicide is used for the control of a broad spectrum of weeds in rice fields. In view of the above facts, it would be desirable to find out some alternative herbicides that can provide better control against diverse weed flora (grasses, sedges and broad-leaved) under transplanted condition.

MATERIALS AND METHODS

A field experiment was conducted during 2014-15 and 2015-16 at 'C' Block farm (latitude: 22°57'E, longitude: 88°20'N and altitude: 9.75 m) of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. Each plot size was of 5 × 4m. The experimental soil was well drained, alluvial in nature and sandy loam in texture, having pH 6.91, organic carbon 0.589%, available nitrogen 243.57 kg/ha, available P_2O_5 22.85 kg/ha and available K_2O 238.18 kg/ha (Jackson, 1967).

The treatments comprised of new herbicide formulation pretilachlor 50% EC in different doses (500, 600 and 750 g/ha) along with pretilachlor 37% EW at 650 g/ha, butachlor 50% EC at 1250 g/ha and cyhalofop butyl 10% EC at 80 g/ha. All the herbicides were sprayed as pre-emergence at 3 days after transplanting (DAT) while cyhalofop-butyl was applied as post-emergence at 20 days after transplanting (DAT). Hand weeding twice (15 and 30 DAT) was also included in the experiment besides the un-weeded control (weedy check).

The experiment was studied in a randomized block design with three replications. All data were analyzed through analysis of variance (ANOVA) using standard variance techniques suggested by Gomez and Gomez (1984). Weed data were subjected to square-root transformation [$(\sqrt{x+1})$] before statistical analysis to improve the homogeneity of variance. Treatment means were separated using least significant difference (LSD) at 5% level of significance ($\sqrt{x+0.5}$).

Rice (variety '*IET-4786*') was transplanted during last week of July in two consecutive years with full doses of phosphorus through single super phosphate and potash through muriate of potash each at 30 kg/ha at basal. The recommended dose of nitrogen at 60 kg/ha through urea was applied in 4 splits at 10, 25, 45 and 65 DAT. All the recommended improved package of practices of transplanted rice was followed in this experiment including the general plant protection measures. The herbicides were applied with a knapsack sprayer having a delivery of about 500 L/ha of spray solution through a flat fan nozzle at a spray pressure of 140 kPa.

The efficacy of the herbicides was evaluated at 20 and 40 days after herbicide application (DAA). At each sampling time, three quadrates of 50 × 50 cm were placed randomly in each plot to determine the density and biomass of weeds. Weeds were uprooted manually, identified and counted into three groups (grasses, sedges, and broad-leaved). Samples were then sun-dried for 24 hours and then oven-dried at 70^{o}C for 72 hours. The dry weight of weeds was then taken and recorded separately. To compare the efficacy of different herbicidal treatments, weed control efficiency (WCE), weed control index (WCI), weed management index (WMI), agronomic management index (AMI), herbicide efficiency index (HEI) and integrated weed management index (IWMI) were calculated using formulae as given by Das (2013).

For microbial study, the requisite composite samples of each treatment from the experimental plots were collected at a depth 0-15 cm at before and after (7, 15, 30 DAA and at harvesting of rice) spraying of herbicides. Enumeration of microbial population was done on agar plate containing appropriate media following serial dilution technique and pour plate method (Pramer and Schmidt, 1965). Plates were incubated at 30ºC and counts were taken on the 3rd day of incubation.

Residual study of tested herbicides was done on follow-up lentil crop (cv. Subrata), grown in the same plot without disturbing the previous field lay-out. Seeds were sown after treated with *Trichoderma viride* at 4 g/kg of seed at a spacing of 30 × 10 cm. All plots received a basal fertilizer application of 20 kg nitrogen/ha as urea, 40 kg phosphorus/ha as single super phosphate and 40 kg potassium/ha as muriate of potash. All the recommended improved package of practices was followed in lentil. Germination% along with the density of lentil crop was recorded at 30 days after sowing (DAS).

RESULTS AND DISCUSSION

Status of the weed flora

In the experimental plots, the dominant weed flora were comprised of *Echinochloa colona*, *Echinocloa formosensis*, *Leersia hexandra* (grassy weeds) and *Cyperus difformis* (sedge), while *Ammania baccifera* and *Alternanthera philoxeroides* were dominant among broad-leaf weeds.

Effect of treatments on weed density

Results showed significant differences among the herbicidal treatments for the weed density of grass, sedge and broad-leaf species at different days of observation **(Table 1)**. Maximum weed density (of all categories as well as total) was recorded in weedy check plots. The weed density showed that the testing pretilachlor 50% EC gave better result in controlling both monocot and dicot weeds very effectively and its efficacy was more with higher doses. Better efficacy was obtained from testing pretilachlor 50% EC at 750 g/ha and was at par with its lower dose at 600 g/ha. The lowest total weed density was recorded in the treatment hand weeding twice at 15 and 30 DAT (4.55 no./m^2 at 20 DAA and 4.58 no./m^2 at 40 DAA) followed by the treatment pretilachlor 50% EC at 750 g/ha (6.01 no./m^2 at 20 DAA and 13.12 no./m^2 at 40 DAA) and its lower doses. Pretilachlor 37% EW at 650 g/ha, butachlor 50% EC at 1250 g/ha and cyhalofop butyl 10% EC at 80 g/ha were also able to minimize total weed density but the population was higher than the treatments treated with pretilachlor 50% EC at 750 and 600 g/ha. The results were in conformity with the findings of Dharumarajan *et al* (2009).

Effect of treatments on weed biomass

The highest total weed biomass was recorded in the plots that received practically no weed control measures (weedy check), which was significantly differed ($p < 0.05$) from all other herbicidal treatments. Hand-weeding recorded lowest dry matter of weeds probably due to effective control of the first flush of weeds during 15–30 DAT and second flush of weeds from 30 DAT onwards. The findings were in line with the findings of Suganthi *et al.* (2005). Herbicidal weed control treatments significantly affected all categories of weeds (grass, sedge and broad-leaved), and the lowest total weed biomass was recorded **(Table 2)** in the plots that received pretilachlor 50% EC at 750 g/ha (3.27 g/m^2 at 20 DAA and 7.82 g/m^2 at 40 DAA) followed by the treatments treated with pretilachlor 50% EC at 600 g/ha (3.81 g/m^2 at 20 DAT and 9.01 g/m^2 at 40 DAA), pretilachlor 50% EC at 500 g/ha (4.54 g/m^2 at 15 DAA and 10.05 g/m^2 at 30 DAA), butachlor 50% EC at 1250 g/ha (6.42 g/m^2 at 15 DAA and 12.55 g/m^2 at 30 DAA) and cyhalofop butyl 10% EC at 80 g/ha (9.78 g/m^2 at 15 DAA and 17.67 g/m^2 at 30 DAA).

Impact assessment

Weed management indices provide a logistic support in impact assessment, interpretations and drawing appropriate conclusions in weed management research. Here in this experiment, WCE and WCI of different weed control measures was higher during initial stages of growth (20 DAA), and it was declined with time **(Table 3)**. Total WCE was recorded maximum in hand weeding treatment (85.9% at 20 DAA and 75.5% at 40 DAA) compared to other treatments. Among the tested herbicides,

Table 1. Effect of weed control treatments on weed density in rice (pooled over two years)

Treatment	Weed density (no./m^2)							
	20 days after herbicide application				40 days after herbicide application			
	Grass	Sedge	Broad-leaved	Total	Grass	Sedge	Broad-leaved	Total
Pretilachlor 50% EC at 500g/ha	3.2(2.05)	2.2(1.79)	3.0(2.00)	8.4(3.07)	6.2(2.69)	4.0(2.24)	6.9(2.24)	17.1(4.26)
Pretilachlor 50% EC at 600 g/ha	2.4(1.86)	2.0(1.73)	2.7(1.92)	7.1(2.85)	5.2(2.49)	3.7(2.16)	6.1(2.16)	15.0(4.00)
Pretilachlor 50% EC at 750 g/ha	1.9(1.70)	1.9(1.70)	2.2(1.79)	6.0(2.65)	4.4(2.34)	3.2(2.05)	5.4(2.05)	13.1(3.76)
Pretilachlor 37% EW at 650 g/ha	3.9(2.21)	2.6(1.89)	3.8(2.18)	10.2(3.35)	5.7(2.58)	3.9(2.21)	6.4(2.21)	16.0(4.12)
Butachlor 50% EC at 1250 g/ha	5.3(2.52)	2.9(1.97)	5.4(2.54)	13.7(3.83)	8.3(3.06)	4.8(2.40)	9.4(2.40)	22.6(4.85)
Cyhalofop-butyl 10% EC at 80 g/ha	6.6(2.75)	3.9(2.21)	7.0(2.83)	17.4(4.30)	9.3(3.21)	7.9(2.98)	16.7(2.98)	33.9(5.91)
Hand weeding at 15 and 30 DAT	1.3(1.53)	1.4(1.56)	1.8(1.67)	4.5(2.36)	1.5(1.57)	1.2(1.49)	1.9(1.70)	4.6(2.36)
Weedy check	8.6(3.10)	8.9(3.15)	14.7(3.97)	32.3(5.77)	12.3(3.65)	12.7(3.70)	20.3(3.70)	45.3(6.81)
LSD (p=0.05)	0.016	0.014	0.017	0.031	0.023	0.019	0.020	0.043

Data in parentheses are square root transformed value ($\sqrt{x+1}$) and used for statistical analysis

Table 2. Effect of weed control treatments on weed biomass in rice (pooled over two years)

Treatment	Weed biomass (g/m^2)							
	20 days after herbicide application				40 days after herbicide application			
	Grass	Sedge	Broad-leaved	Total	Grass	Sedge	Broad-leaved	Total
Pretilachlor 50% EC at 500g/ha	1.6(1.60)*	1.1(1.44)	1.9(1.71)	4.5(2.35)	3.5(2.13)	2.2(1.79)	4.3(2.30)	10.1(3.32)
Pretilachlor 50% EC at 600 g/ha	1.3(1.50)	0.9(1.39)	1.6(1.62)	3.8(2.19)	3.0(2.01)	2.0(1.73)	3.9(2.23)	9.0(3.16)
Pretilachlor 50% EC at 750 g/ha	1.1(1.44)	0.8(1.35)	1.4(1.54)	3.3(2.07)	2.7(1.93)	1.9(1.70)	3.2(2.06)	7.8(2.97)
Pretilachlor 37% EW at 650 g/ha	1.3(1.54)	0.9(1.41)	1.7(1.67)	4.1(2.27)	3.1(2.04)	2.1(1.75)	4.1(2.26)	9.3(3.21)
Butachlor 50% EC at 1250 g/ha	2.2(1.80)	1.3(1.52)	2.8(1.97)	6.4(2.73)	4.3(2.31)	2.7(1.91)	5.5(2.56)	12.5(3.68)
Cyhalofop-butyl 10% EC at 80 g/ha	2.4(1.85)	1.7(1.64)	5.7(2.59)	9.7(3.28)	4.6(2.36)	3.8(2.21)	9.2(3.20)	17.6(4.32)
Hand weeding at 15 and 30 DAT	0.9(1.37)	0.6(1.29)	1.2(1.49)	2.7(1.93)	0.9(1.39)	0.7(1.31)	1.5(1.57)	3.1(2.03)
Weedy check	5.4(2.52)	3.9(2.21)	7.5(2.92)	16.7(4.21)	8.6(3.10)	5.8(2.62)	12.3(3.65)	26.7(5.27)
LSD (p=0.05)	0.011	0.007	0.012	0.086	0.017	0.012	0.018	0.028

Data in parentheses are square root transformed value ($\sqrt{x+1}$) and used for statistical analysis

Table 3. Effect of weed control treatments on weed control efficiency and weed control index in rice (mean data of two years)

Treatment	20 days after herbicide application				40 days after herbicide application			
	Grass	Sedge	Broad-leaves	Total	Grass	Sedge	Broad-leaves	Total
Weed control efficiency (%)								
Pretilachlor 50% EC at 500g/ha	62.69	75.14	79.65	73.87	49.59	68.43	66.13	62.27
Pretilachlor 50% EC at 600 g/ha	71.61	77.60	81.89	77.96	57.70	71.03	69.96	66.92
Pretilachlor 50% EC at 750 g/ha	77.98	78.84	84.94	81.39	63.94	74.59	73.21	71.07
Pretilachlor 37% EW at 650 g/ha	55.04	71.33	74.42	68.39	54.05	69.30	68.34	64.72
Butachlor 50% EC at 1250 g/ha	38.12	67.64	63.03	57.65	32.41	62.27	53.59	50.25
Cyhalofop-butyl 10% EC at 80 g/ha	23.99	56.44	52.51	45.98	24.39	37.73	18.04	25.27
Hand weeding at 15 and 30 DAT	84.59	83.87	87.92	85.91	69.37	77.19	78.12	75.48
Weedy check	-	-	-	-	-	-	-	-
Weed control index (%)								
Pretilachlor 50% EC at 500g/ha	70.95	72.54	74.54	72.93	58.72	62.22	65.12	62.43
Pretilachlor 50% EC at 600 g/ha	76.54	76.17	78.38	77.28	64.88	65.81	67.56	66.32
Pretilachlor 50% EC at 750 g/ha	79.89	78.76	81.83	80.50	68.49	67.86	73.74	70.77
Pretilachlor 37% EW at 650 g/ha	74.30	74.61	76.39	75.31	63.26	64.79	66.75	65.20
Butachlor 50% EC at 1250 g/ha	58.47	65.80	61.94	61.72	49.42	54.53	54.96	53.08
Cyhalofop-butyl 10% EC at 80 g/ha	55.12	56.74	24.40	41.68	47.09	33.50	24.96	33.94
Hand weeding at 15 and 30 DAT	83.61	82.64	83.95	83.54	72.09	71.79	75.45	73.57
Weedy check	-	-	-	-	-	-	-	-

Table 4. Bio-efficiency of different weed control treatments in rice (mean data of two years)

Treatment	Herbicide efficiency index	Weed management index	Agronomic management index	Integrated weed management index	Weed persistence index
Pretilachlor 50% EC at 500 g/ha	1.12	1.60	0.60	1.10	1.02
Pretilachlor 50% EC at 600 g/ha	1.33	1.64	0.64	1.14	1.03
Pretilachlor 50% EC at 750 g/ha	1.56	1.66	0.66	1.16	1.03
Pretilachlor 37% EW at 650 g/ha	1.24	1.63	0.63	1.13	0.92
Butachlor 50% EC at 1250 g/ha	0.78	1.52	0.52	1.02	0.93
Cyhalofop-butyl 10% EC at 80 g/ha	0.50	1.46	0.46	0.96	0.95
Hand weeding at 15 and 30 DAT	1.80	1.68	0.68	1.18	1.12
Weedy check	-	-	-	-	1.00

pretilachlor 50% EC at 750 g/ha recorded maximum WCE (total) 81.4% and 71.1% at 20 and 40 DAA respectively, which was closely followed by its next dose pretilachlor 50% EC at 600 g/ha and these treatments were superior to all other treatments with respect to WCE. These findings were in line with the findings of Narayanan *et al.* (2000), Suganthi *et al.* (2005) and Kumar *et al.* (2007). WCI was derived on the basis of weed dry weight. Therefore, WCI obtained initially was higher and then decreases as the crop growth advances towards maturity. This all happens due to dry weight normally goes on increasing over time at the later stage of crop growth under herbicide-treated plot, since during this period herbicide loss its bio-efficacy. Among the herbicidal treatments, pretilachlor 50% EC at 750 g/ha exhibited higher HEI, WMI, AMI **(Table 4)** as compared to other tested herbicides which was closely followed by its next dose at 600 g/ha. That means the above treatment showed higher bio-efficacy in controlling different categories of weeds in rice ecosystem resulting higher IWMI.

Effect of herbicides on phytotoxicity

No phytotoxic symptoms such as epinasty/ hyponasty, leaf yellowing, necrosis, stunting growth, wilting etc were found in rice as well as succeeding lentil crop.

Effects on yield attributes and yield of rice

All weed management treatments showed significantly higher values of yield attributes and yield over the weedy check due to the effective suppression of weeds resulting in more soil aeration, enhanced uptake of inputs like nutrients, light, moisture by crop and lesser weed competition during critical crop weed competition period (Mondal *et al.* 2017). Yield attributes like number effective panicles/ m^{-2} (338 and 318 numbers during 2014-15 and 2015-16 respectively) and number of filled grains/panicle (85.33 and 84.33 numbers during 2014-15 and 2015-16 respectively) were found higher under hand weeded treatment which was closely followed by the treatment treated with pretilachlor 50% EC at 750 and

600 g/ha **(Table 5)**. Similar result was also observed by Suganthi *et al.* (2005). Grain yield losses amounted to 31.4-50.1% due to uncontrolled weed growth as compared to different weed control treatments. Similar yield reduction in rice due to weed competition in the Gangetic alluvial zone of West Bengal was also reported by Mondal *et al.* (2018) and Duary (2014). Hand weeding (4.44 and 4.18 t/ha during 2014-15 and 2015-16, respectively) treatment recorded maximum grain yield of rice followed by pretilachlor 50% EC at 750 g/ha (4.34 and 4.16 t/ha during 2014-15 and 2015-16, respectively) and pretilachlor 50% EC at 600 g/ha (4.26 and 4.14 t/ha during 2014-15 and 2015-16, respectively). Similar trend was also followed in straw yield of rice. The higher assimilation of photosynthates in herbicide treated plots may be the reason for higher yield attributes and ultimately higher yield in rice under transplanted condition (Dharumarajan *et al.* 2009 and Mondal *et al.* 2017).

Economics

Pretilachlor 50% EC recorded higher benefit: cost ratio than other herbicidal treatments along with twice hand weeding **(Table 5)**. Among the weed-control treatments, pretilachlor 50% EC at 600 g/ha (1.91 and 1.89 during 2014-15 and 2015-16, respectively) recorded maximum benefit: cost ratio followed by pretilachlor 50% EC at 750 g/ha (1.82 and 1.84 during 2014-15 and 2015-16, respectively). Though twice hand weeding topped in grain yield but ever increasing rate of labour wages makes this treatment costly and it fetched significantly lower benefit:cost ratio (1.25 and 1.19 during 2014-15 and 2015-16, respectively) as compared to herbicidal treatments. The higher benefit: cost ratio under these testing herbicide treatments was mainly owing to more grain yield and comparatively lower variable cost of cultivation compared to manual weeding and the other herbicidal treatments (Kashid *et al.* 2016).

Table 5. Effect of weed control treatments on yield attributes, yield and economics of rice

Treatment	No. of effective panicle/m^{-2}		No. of filled prains/ panicle		Grain yield (t/ha)		Straw yield (t/ha)		Benefit: Cost Ratio	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Pretilachlor 50% EC at 500 g/ha	320	302	79.33	78.00	4.13	4.05	5.23	4.75	1.63	1.65
Pretilachlor 50% EC at 600 g/ha	328	306	80.33	82.33	4.26	4.14	5.31	5.19	1.91	1.89
Pretilachlor 50% EC at 750 g/ha	334	310	82.67	83.99	4.34	4.16	5.57	5.39	1.82	1.84
Pretilachlor 37% EW at 650 g/ha	322	304	79.67	81.67	4.22	4.10	5.18	5.06	1.70	1.66
Butachlor 50% EC at 1250 g/ha	312	292	75.67	74.99	3.91	3.87	4.65	4.61	1.53	1.51
Cyhalofop butyl 10% EC at 80 g/ha	298	276	70.67	73.99	3.82	3.64	4.38	4.20	1.38	1.40
Hand weeding at 15 and 30 DAT	338	318	85.33	84.33	4.44	4.18	5.95	5.43	1.25	1.19
Weedy check	209	233	54.33	67.00	2.71	2.41	2.99	2.69	0.97	0.97
LSD (p=0.05)	7.79	5.07	0.79	0.47	0.10	0.11	0.17	0.16	-	-

Table 6. Correlation matrix among the weed density and dry weight and yield components of rice (mean data of two years)

	Weed density (no./m^2)	Weed biomass (g/m^2)	Effective panicles (no./m^2)	Filled grains (no./ panicle)	Grain yield (t/ha)	Straw yield (t/ha)
Weed density (no./m^2)	1					
Weed biomass (g/m^2)	0.997**	1				
No. effective panicles/m^2	-0.979**	-0.987**	1			
No of filled grains/panicle	-0.991**	-0.990**	0.982**	1		
Grain yield (t/ha)	-0.971**	-0.982**	0.998**	0.978**	1	
Straw yield (t/ha)	-0.990**	-0.989**	0.988**	0.999**	0.982**	1

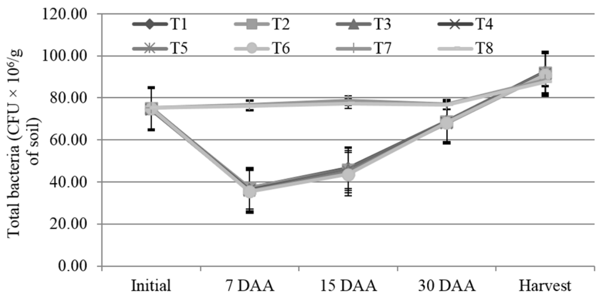
**Correlation is significant at the 0.01 level (2-tailed)

Correlation matrix

Weed density and biomass had registered significantly negative correlation with all the yield attributes and yield of rice **(Table 6)**. While the entire yield attributes (number of effective panicles/m^{-2}, number of filled grains/panicle) and biological yield parameters (grain and straw yield) were significantly positively correlated among themselves. Weed density and biomass had a strong negative correlation with grain yield (r=-0.917** and r=-0.982** respectively) of rice. These findings were in line with the findings of Mondal *et al.* (2018).

Effect on soil microorganism

Soil microorganisms *viz.* total bacteria, fungi and actinomycetes **(Figure 1-3)** did not show any significant influence on the population in *Rhizosphere* soil at initial stage. Though after the application of the chemicals significant variations were found between



T_1= Pretilachlor at 500 g/ha; T_2= Pretilachlor at 600 g/ha; T_3= Pretilachlor at 750 g/ha; T_4= Pretilachlor at 650 g/ha; T_5= Butachlor at 1250 g/ha; T_6= Cyhalofop-butyl at 80 g/ha; T_7= Hand weeding at 15 and 30 DAT; T_8= Weedy check

Figure 1. Effect of weed control treatment on total bacteria (CFU × 10^6/g of soil) population

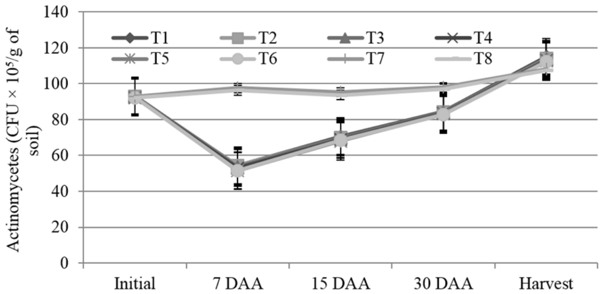


Figure 2. Effect of weed control treatment on actinomycetes (CFU × 10^5/g of soil) population

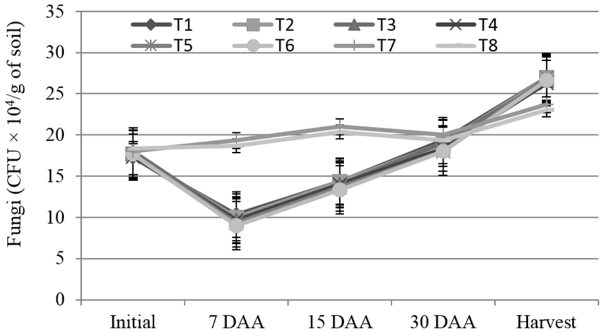


Figure 3. Effect of weed control treatment on fungi (CFU × 10^4/g of soil) population

the treated and non-treated plotsdue to competitive influence and the toxic effect as well as different persistence periods of different chemical herbicides in different soil ecosystems. In addition, the increase was affected by the commensalic or proto-cooperative influence of various microorganisms on total bacteria in the rhizosphere of rice. For all the cases of herbicidal treatments, total bacteria recovered from initial loss and exceeded the initial counts (Ghosh *et al.* 2012). Regarding actinomycetes, the results might be due to the competitive influence of various microorganisms on the population of actinomycetes in the rhizosphere of rice as well as toxic effect of the chemicals applied (Sapundjieva *et al.* 2008). The pattern of population change of fungi might be due to the toxic effect or competitive influence of various microorganisms on the population of fungi in the rhizosphere soil of rice. But at harvesting the recorded population again did not differ significantly. Murato *et al.* (2004) observed that pretilachlor at 0.45 kg/ha was not appreciably affect the soil microbial communities.

Microorganisms are able to degrade herbicides and utilize them as a source of biogenic elements for their own physiological processes. However, before degradation, herbicides have toxic effects on microorganisms, reducing their abundance, activity and consequently, the diversity of their communities. The toxic effects of herbicides are normally most severe immediately after application, when their concentrations in soil are the highest. Later on, microorganisms take part in a degradation process, and herbicide concentration and its toxic effect gradually decline up to half-life. Then the degraded organic herbicide provides the substrate with carbon, which leads to an increase of the soil microflora.

Effect on succeeding crop

Germination percentage and population density and of lentil crop was recorded at 30 DAS **(Table 7)**. The recorded data did not show any significant variation among the treatments used in the previous rice crop. The seed yield data **(Table 7)** also did not vary significantly among the treatments where the pretilachlor 50% EC was used in different doses at 500, 600 and 750 g/ha in the previous crop.

So, from the above study, it may be concluded that pretilachlor 50% EC at 600 g/ha can profitably and safely be used to replace the tedious,time consuming and expensive handweeding practice for weed control in transplanted winter rice in the Gangetic Inceptisol of West Bengal.

Table 7. Effect of weed control treatments on succeeding lentil crop (pooled over two years)

Treatment	Effect of herbicides on succeeding lentil		
	Germination (%)	Population/ m^2 at 30 DAS	Seed yield (t/ha)
Pretilachlor at 500 g/ha	32.33	88.0	0.86
Pretilachlor at 600 g/ha	34.00	88.0	0.88
Pretilachlor at 750 g/ha	33.33	87.0	0.90
Pretilachlor at 650 g/ha	33.00	87.5	0.88
Butachlor at 1250 g/ha	33.67	86.5	0.84
Cyhalofop-butyl at 80 g/ha	32.00	87.0	0.84
Hand weeding at 15 and 30 DAT	34.00	88.0	0.93
Weedy check	33.67	88.5	0.83
LSD (p=0.05)	NS	NS	NS

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