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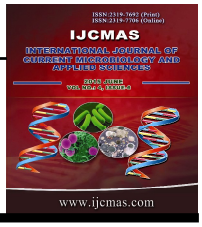

Original Research Article

Weed Management in Transplanted Rice through Bispyribac Sodium 10% SC and its Effect on Soil Microflora and Succeeding Crop – Blackgram

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Keywords

Microflora, Succeeding crop, Post emergence, Weed density, Weed control efficiency

A B S T R A C T

A field experiment was carried out at Kalyani 'C' Block Farm, Bidhan Chandra Krishi Viswavidyalaya during *rabi* seasons of 2011-12 and 2012-13 to study the bioefficacy and phytotoxicity of Bispyribac Sodium 10% SC on transplanted rice cv. Shatabdi (IET 4786) and its residual effect on the succeeding crop black gram cv. Basant bahar (PDU-1) in *Inceptisol* of West Bengal. Based on the experimentation, it was found that post-emergence application of Bispyribac Sodium 10% SC @ 30 g a.i. ha^{-1} followed by @ 25 g a.i. ha^{-1} gave significantly lower total weed density, weed dry weight and higher weed control efficiency at all the stages. Application of Bispyribac Sodium 10% SC @ 20 g a.i. ha^{-1} kept the weed density and dry weight bellow the economic threshold level and increased the grain yield in rice. Succeeding crop black gram sown immediately after the harvest of rice was not affected by the residue of of Bispyribac Sodium at all different doses.

Introduction

Rice is a major crop in the world, it feeds one third of the world population to whom it supplies almost two thirds of the food requirements. From an area of 42.13 million ha, India is producing about 40% of the world rice production. In rice, infestation of all types of monocot and dicot weed flora was observed. Like other cereal crops, rice also suffers severely from weed competition. The diverse weed flora under transplanted conditions (grasses, sedges and broad-leaved weeds) can cause yield reduction up to 76% (Singh et al. 2004). In order to realize maximum benefit of applied monetary inputs, two to three hand weedings (HW) were most effective against all types of weeds in this crop (Halder and Patra, 2007). However, continuous rains during cropping season, scarcity and high wages of labour during weeding peaks particularly at early crop-weed competition make this operation difficult and uneconomic. Therefore,

farmers need alternate weed management methodology and organic safer herbicides are one of the better substitutions of costly hand weeding. But chemicals need to check the ill effect on environment not only in the main crop but their effects on follow up crop. Thus, use of safer organic herbicides is one of the options left with the farmers to eliminate crop weed competition at early growth stages of crop. Among popular post emergence selective herbicides, Bispyribac Sodium in rice field, have the potentiality to keep the weed bellow the economic threshold level. So, Bispyribac Sodium is to be evaluated for their bio-efficacy of controlling wide range of weed flora, better crop growth and yield of rice.

Materials and Methods

Study site: The present investigation was carried out during *Kharif* season 2011-12 and 2012-13 at Kalyani 'C' Block Farm of Bidhan Chandra Krishi Viswavidyalaya. The soil of the experimental field was sandy loam in texture with a soil pH of 6.81 and medium fertility status with low water holding capacity. The crop was grown under irrigated condition.

Treatments: The experiment was laid out in randomized complete block design and replicated thrice with a net plot size of 5m×4m. The treatments were Bispyribac Sodium 10% SC in five doses @ 15, 20, 25, 30, g a.i. ha^{-1} and Butachlor (50% EC) that is already registered in the market, Hand weeding twice at 25 and 50 DAT and Unweeded control. The herbicides as per the treatment schedule were applied as post-emergence by using 500 litres of water ha^{-1} with knapsack sprayer fitted with flat fan deflector nozzle.

Cultivation methods: seeds of variety Shatabdi (IET 4786) were treated with *Trichoderma viride* @ 4 g kg^{-1} of rice seeds, kept under shade for one hour and then sown in the seed bed by manually during second week of August 2011 and 2012. Adequate plant protection measures against insects and diseases were followed. Nitrogen @ 60 kg ha^{-1} through Urea was applied in 4 splits i.e. at 5, 25, 50 and 65 DAT and full Phosphorus through SSP and full Potash through MOP; both @ 30 kg ha^{-1} were applied as basal during final land preparation. After harvesting of rice crop, to know the residual effect of herbicides, without disturbing the layout, each plot was manually prepared for sowing of succeeding crop.

Microbial population: Soil samples from the experimental plots were collected from the space between the rows at a depth 0–15 cm on different dates viz. initial (pretreatment), 15 days after application (DAA), 30 DAA and 60 DAA of applying treatments. The soil sample from the different places per replicate for the same weed control treatment were pulled together and then requisite composite samples of each treatment were taken for microbial analysis by dilution plating following standard methods.

Soil dilutions were prepared in sterile distilled water by constant shaking and plating was done separately in replicates in specific media: Total bacteria (Thornton's agar medium at 10^{-6} dilutions), fungi (Martin's rose bengal streptomycin agar medium at 10^{-4} dilutions), actinomycetes (Jensen's agar medium at 10^{-5} dilutions). The enumeration of the microbial population was done on agar plants containing appropriate media following serial dilution technique and pour plate method (Pramer and Schmidt, 1965). Plates were incubated at 30 °C. The counts were taken at the 3rd day of incubation.

Statistical analysis: The data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1984). As the error mean squares of the individual experiments were homogenous, combined analysis over the years were done through unweighted analysis. Here, the interaction between years and treatments were not significant. The values wherever necessary were transformed into square root values as applicable for respective statistical analyses (Panse and Sukhatme, 1978).

Results and Discussion

Effect of weeds: In the experimental plots the dominant grasses were *Echinochloa colona* and *Leersia hexandra* while the sedge was *Cyperus rotundus* and among the broadleaf *Ammania baccifera* was dominant.

Post emergence application of of Bispyribac Sodium 10% SC at 15, 20 25,30 g a.i. ha^{-1} and Butachlor @ 1250 g a.i. ha^{-1} resulted in effective control of broad leaved weeds, grasses and to some extend sedge duo to its broad spectrum action. Application of Bispyribac Sodium at 30 g a.i. ha^{-1} resulted in the weed control of more than 74 per cent of weeds. Halder and Patra (2007) reported similar higher weed control through Bispyribac Sodium as post emergence.

From the table 2, it is very clear that unweeded control treatment (T_7) gave the highest pooled value (55.92) whereas, T_6 recorded the lowest pooled value (0.00) which was closely followed by T_4 (9.08), T_3 (9.37) and T_2 (10.82). Herbicide treatments showed the better weed controlling ability as compared to other treatments and so they facilitated better crop growth and ultimately higher yield in rice and lower weed index value. Similar results were found by Bera et al, 2012.

Effect on crop: Post emergence application of Bispyribac Sodium 10% SC @ 20 g ha^{-1} recorded higher pooled grain yield of 3.84 t ha^{-1}, due to better control of weeds at critical stages thus providing the favourable environment for better growth and development leading to enhanced grain yield. The higher doses of Bispyribac Sodium 10% SC @ 25, 30 g ha^{-1} showed statistical parity in grain yield. Hand weeding was the best treatment compared to other treatments and recorded highest grain yield. The productivity of rice is mainly decided by the weed control efficiency of weed management methods as earlier observed by Singh and Singh (2004). Kathepuri et al. (2007) has shown that grain yield reduction in rice is directly related to increasing weed density, dry weight and intensity of weed interference throughout the crop period. Due to heavy competition of weeds for nutrients, space, water and light lower grain yield in unweeded control plot was obtained.

Microbial properties: The effects of Bispyribac Sodium on population of soil micro-flora viz. total bacteria, actinomycetes and fungi recorded at different time of observation (Initial, 3, 10, 30 and 60 DAA) are discussed below:

Total bacteria (10^6 cfu g^{-1}): Initially, there was no significant influence on the population of total bacteria in rhizosphere of rice. Population Significant varied between the treated and non treated plots after application of the herbicides and the population decreased up to 15 DAA. After 60 DAA, the population increased considerably in the herbicidal treated plots as compared to hand weeding and untreated control plots (Fig. 1). At 60 DAA, herbicidal treatments recorded 21.74% to 93.56% higher population of total bacteria than control.

Table.1 Effect of different weed management practices on total weed density m-2 and dry weight (g m-2) in rice

Treatments	Weed density						Weed dry weight					
	15 DAT			30 DAT			15 DAT			30 DAT		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
T_1	7.06(49.78)	7.07(49.96)	7.06(49.87)	6.78 (45.89)	6.78(45.94)	6.78(45.92)	28.75	287.80	28.77	27.94	28.00	27.97
T_2	6.55(42.89)	6.55(42.88)	6.55(42.89)	6.18(38.11)	6.18(38.16)	6.18(38.14)	24.73	24.78	24.76	22.87	22.92	22.90
T_3	6.32(40.00)	6.33(40.12)	6.33(40.06)	5.84(34.11)	5.84(34.14)	5.84(34.13)	22.35	22.38	22.37	20.17	20.22	20.20
T_4	6.17(38.11)	6.18(38.2)	6.18(38.16)	5.68(32.22)	5.69(32.34)	5.68(32.28)	19.61	19.64	19.63	18.54	18.56	18.55
T_5	6.36(40.44)	6.36(40.46)	6.36(40.45)	7.23(52.33)	7.24(52.38)	7.24(52.36)	20.92	20.96	20.94	27.36	27.39	27.38
T_6	4.35(18.89)	4.35(18.96)	4.35(18.93)	8.07(65.11)	8.07(65.16)	8.07(65.14)	14.19	14.26	14.23	29.01	29.04	29.03
T_7	9.85(97.11)	9.86(97.14)	9.86(97.13)	12.09(146.11)	12.09(146.18)	12.09(146.15)	59.37	59.46	59.42	77.26	77.56	77.41
SEm (±)	0.34	0.37	0.41	0.69	0.58	0.75	0.72	0.55	0.68	0.88	0.89	0.87
CD(P=0.05)	1.02	1.12	1.24	2.08	1.76	2.28	2.17	1.68	2.07	2.67	2.71	2.65

T_1- Bispyribac Sodium 10% SC @ 15 g a.i. ha^{-1}, T_2- Bispyribac Sodium 10% SC @ 20 g a.i. ha^{-1}, T_3- Bispyribac Sodium 10% SC @ 25 g a.i. ha^{-1}, T_4- Sodium Bispyribac 10% SC @ 30 g a.i. ha^{-1}, T_5- Butachlor 50% EC @1250 g a.i. ha^{-1}, T_6- Weed free check (Hand weeding/Farmer's Practice), T_7- Weedy check (zero weed control)
*Figures in the parenthesis are original values which are subjected to square root transformation

Table.2 Effect of different weed management practices on weed control efficiency (WCE %) and grain yield of rice

Treatment	WCE (%)						WI (%)			Grain yield (t ha^{-1})			Net production value		
	15 DAT			30 DAT											
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
T_1	51.57	51.92	51.75	63.84	63.92	63.88	29.84	29.96	29.90	2.814	2.816	2.82	2.60	2.64	2.62
T_2	58.35	58.65	58.50	70.40	70.63	70.52	10.75	10.88	10.82	3.834	3.838	3.84	2.73	2.79	2.76
T_3	62.35	62.86	62.61	73.89	73.96	73.93	9.31	9.42	9.37	3.896	3.897	3.90	2.66	2.70	2.68
T_4	64.49	64.87	64.68	74.35	74.46	74.41	9.05	9.10	9.08	3.907	3.908	3.91	2.57	2.63	2.60
T_5	64.76	64.88	64.82	64.59	64.66	64.63	27.21	27.28	27.25	3.127	3.128	3.13	2.44	2.52	2.48
T_6	76.10	76.46	76.28	63.75	63.88	63.82	0.00	0.00	0.00	3.996	3.998	4.00	2.56	2.60	2.58
T_7	0.00	0.00	0.00	0.00	0.00	0.00	55.84	55.92	55.88	1.897	1.899	1.90	1.90	1.94	1.92
SEm (±)	-	-	-	-	-	-	-	-	-	0.89	0.85	0.82	-	-	-
CD(P=0.05)	-	-	-	-	-	-	-	-	-	2.687	2.591	2.483	-	-	-

T_1- Bispyribac Sodium 10% SC @ 15 g a.i. ha^{-1}, T_2- Bispyribac Sodium 10% SC @ 20 g a.i. ha^{-1}, T_3- Bispyribac Sodium 10% SC @ 25 g a.i. ha^{-1}, T_4- Sodium Bispyribac 10% SC @ 30 g a.i. ha^{-1}, T_5- Butachlor 50% EC @1250 g a.i. ha^{-1}, T_6- Weed free check (Hand weeding/Farmer's Practice), T_7- Weedy check (zero weed control)

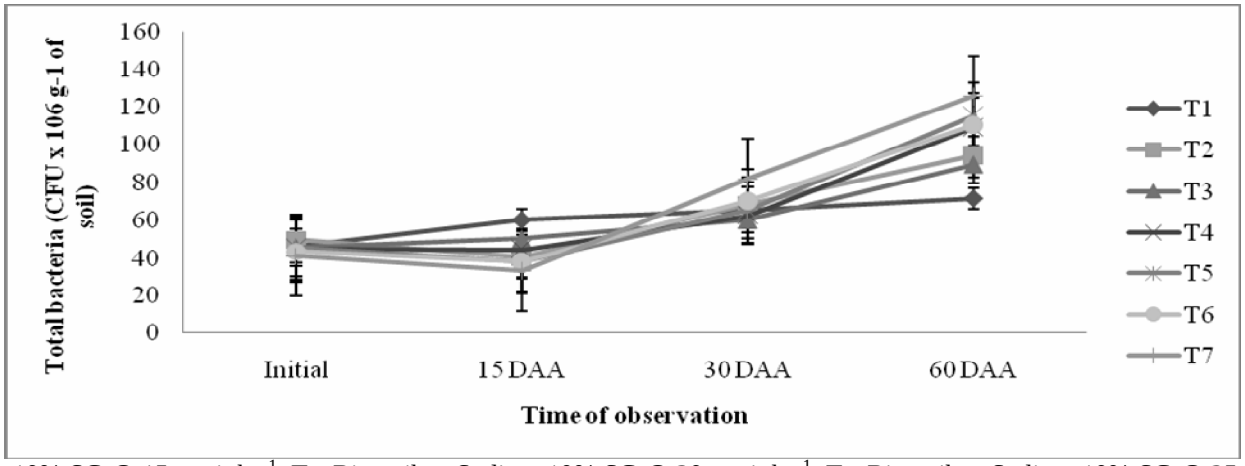
Table.3 Residual effect of Bispyribac Sodium and Butachlor on the population and seed yield and stover yield of succeeding crop (black gram) of Rice

Treatment	Population m^{-2} at 30 DAS			Seed yield (t ha^{-1})			Stover yield (t ha^{-1})		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
T_1	5.57(31.00)	5.74(33.00)	5.66 (32.00)	1.019	1.024	1.022	2.174	2.093	2.134
T_2	5.57(31.00)	5.74 (33.00)	5.66(32.00)	1.024	1.028	1.026	2.238	2.238	2.238
T_3	5.74(33.00)	5.57(31.00)	5.66 (32.00)	1.029	1.032	1.031	2.274	2.289	2.281
T_4	5.66(32.00)	5.57(31.00)	5.61(31.50)	1.034	1.038	1.036	2.391	2.331	2.361
T_5	5.57(31.00)	5.57(31.00)	5.57(31.00)	1.089	1.094	1.092	2.463	2.375	2.419
T_6	5.74(33.00)	5.74(33.00)	5.74(33.00)	1.042	1.050	1.046	2.103	2.063	2.083
T_7	5.57(31.00)	5.57(31.00)	5.57(31.00)	0.819	0.825	0.822	2.078	2.166	2.122
SEm (±)	0.68	0.59	0.61	0.108	0.089	0.943	0.214	0.302	0.275
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

T_1- Bispyribac Sodium 10% SC @ 15 g a.i. ha^{-1}, T_2- Bispyribac Sodium 10% SC @ 20 g a.i. ha^{-1}, T_3- Bispyribac Sodium 10% SC @ 25 g a.i. ha^{-1}, T_4- Sodium Bispyribac 10% SC @ 30 g a.i. ha^{-1}, T_5- Butachlor 50% EC @1250 g a.i. ha^{-1}, T_6- Weed free check (Hand weeding/Farmer's Practice), T_7- Weedy check (zero weed control)

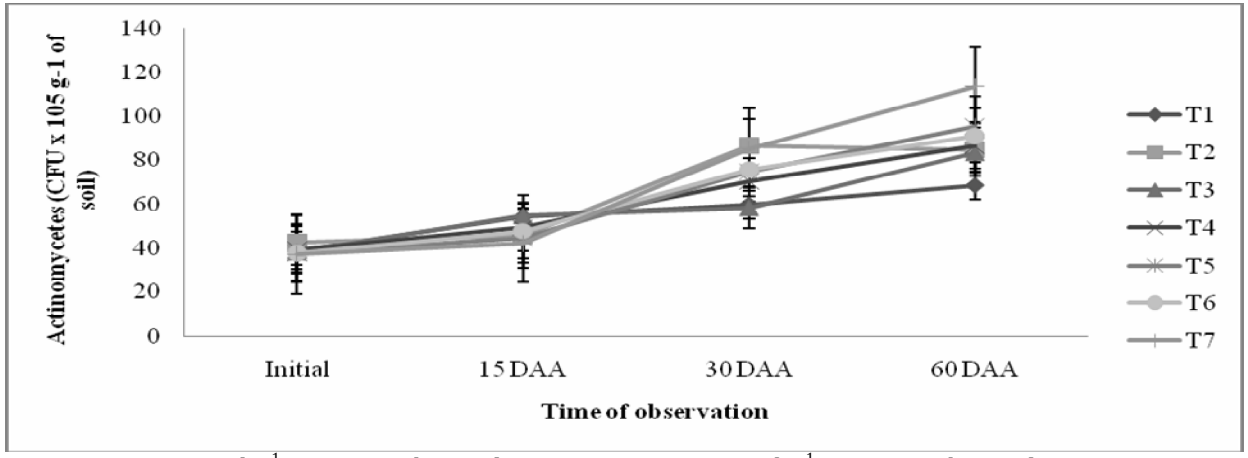
*Figures in the parenthesis are original values which are subjected to square root transformation

Fig.1 Influence of treatments on total bacteria (CFU x 10^6 g-1 of soil)



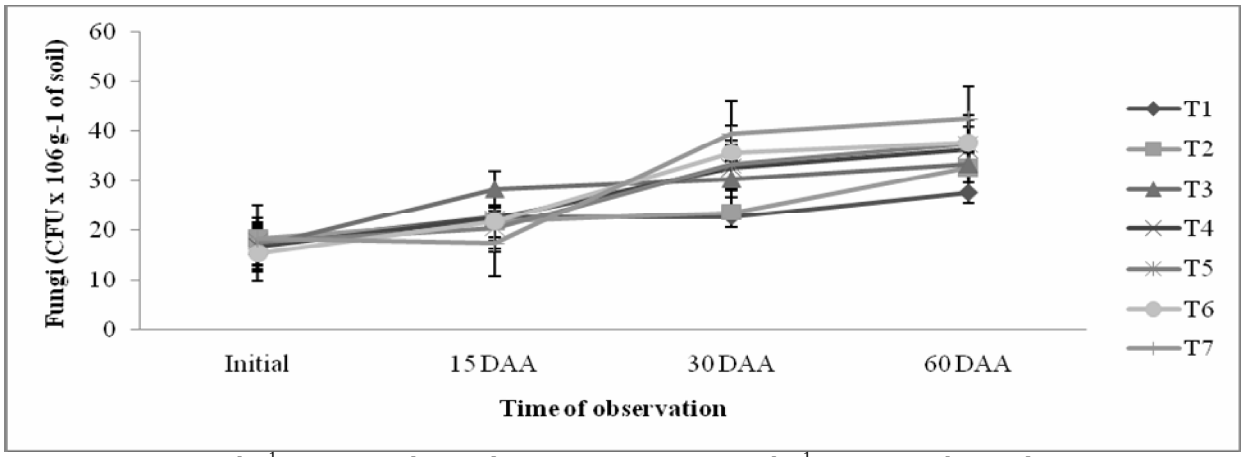
T_1- Bispyribac Sodium 10% SC @ 15 g a.i. ha^{-1}, T_2- Bispyribac Sodium 10% SC @ 20 g a.i. ha^{-1}, T_3- Bispyribac Sodium 10% SC @ 25 g a.i. ha^{-1}, T_4- Sodium Bispyribac 10% SC @ 30 g a.i. ha^{-1}, T_5- Butachlor 50% EC @1250 g a.i. ha^{-1}, T_6- Weed free check (Hand weeding/Farmer's Practice), T_7- Weedy check (zero weed control).*Bars represent the standard error.

Fig.2 Influence of treatments on actinomycetes (CFU x 10^5 g-1 of soil)



T_1- Bispyribac Sodium 10% SC @ 15 g a.i. ha^{-1}, T_2- Bispyribac Sodium 10% SC @ 20 g a.i. ha^{-1}, T_3- Bispyribac Sodium 10% SC @ 25 g a.i. ha^{-1}, T_4- Sodium Bispyribac 10% SC @ 30 g a.i. ha^{-1}, T_5- Butachlor 50% EC @1250 g a.i. ha^{-1}, T_6- Weed free check (Hand weeding/Farmer's Practice), T_7- Weedy check (zero weed control).**Bars represent the standard error.

Fig.3 Influence of treatments on fungi (CFU x 10^4 g-1 of soil)



T_1- Bispyribac Sodium 10% SC @ 15 g a.i. ha^{-1}, T_2- Bispyribac Sodium 10% SC @ 20 g a.i. ha^{-1}, T_3- Bispyribac Sodium 10% SC @ 25 g a.i. ha^{-1}, T_4- Sodium Bispyribac 10% SC @ 30 g a.i. ha^{-1}, T_5- Butachlor 50% EC @1250 g a.i. ha^{-1}, T_6- Weed free check (Hand weeding/Farmer's Practice), T_7- Weedy check (zero weed control).**Bars represent the standard error

Actinomycetes (10^5 cfu g^{-1}): Similar types of variations in actinomycetes population were recorded between the herbicide treated plots and the hand weeding and control plots after application of herbicides (Fig. 2). At 60 DAA, herbicidal treatments recorded 15.79% to 34.12% higher population of actinomycetes than control. Similar findings were reported by Sapundjieva et al. (2008).

Fungi (10^4 cfu g^{-1}): Up to 15 days after application of the herbicides, slight adverse effect on the population of fungi in rhizosphere region was observed. The data showed that population started to increase from 30 DAA. Further all the herbicide treated plots recorded higher fungi population than hand weeding and untreated control plots (Fig. 3). Herbicidal treatments recorded 18.47% to 71.23 % higher population of fungi than control at 60 DAA.

However, initially total bacteria, fungi and actinomycetes did not vary significantly in all the doses of the herbicide Bispyribac Sodium and Butachlor but after herbicide application, they differ for a short period of time. Having the ablity to degrade herbicides, microorganisms utilize them as a source of biogenic elements for their own physiological processes. As herbicides have toxic effects on microorganisms; they reduce their abundance, activity and consequently, the diversity of their communities before degradation. Immediately after application, the toxicity of herbicides is normally most severe as their concentration in soil is highest. With advancement of time, microorganisms degraded the herbicides and their concentration gradually reduced up to half-life. After that, carbon released from degraded organic herbicide leads to an increase of the soil microflora population (Bera and Ghosh, 2013).

Net production value (NPV): Highest NPV was noted under Bispyribac sodium 10 SC @ 20 g ha^{-1} (pooled NPV = 2.76) owing to higher seed yield and comparatively lower cost under this treatment (Table 2). Whereas the lowest NPV was noted in control (pooled NPV = 1.92). Though twice hand weeding treatment recorded highest yield but it failed to obtain most profitable result with respect to net production value (pooled NPV = 2.58) due to higher labour wages and this might be due to twice hand weeding is laborious, costly and non-availability of labours at the critical crop-weed competition period.

Effect on succeeding crop: Result revealed that the population of succeeding black gram recorded at 30 DAS was not significantly affected by residual effect of herbicide. Yield of black gram showed no distinct variation due to different dose of Bispyribac Sodium. It might be shown that new formulation of Bispyribac Sodium with different doses could be very effective against most of the broad leaved and grassy weeds in rice.

From this experiment, it may be suggested that rice - blackgram crop sequence can be grown in Gangetic medium land of south West Bengal and Bispyribac sodium 10 SC @ 20 g ha^{-1} could be used for an alternative weed management measure in rice as this treatment (NPV= 2.78) is superior over the hand weeding twice is (T_7) (1.98) though T_7 gives slighter higher yield (4.17%). Application of this safer organic chemical also proved higher productivity in follow up crop blackgram by reducing the weed competition and without affecting the soil microflora status.

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