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Effect of Herbicides on Weed and Yield of Transplanted Winter Rice in East and South Eastern Coastal Plain Zone of Odisha

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A B S T R A C T

The field experiment was conducted during *Kharif* season of 2019-20 at farmer's field of Bagoi, Arakhia and Saharadiavillages of Jagatsinghpur district in Odisha to study the effect of herbicides on growth of composite weed flora and productivity of transplanted puddle rice. Three treatments were assigned in randomized block design with seven replications. Results revealed thatpost emergence (PoE) application of Bispyribac sodium 10 SC @ 25 gha^{-1}resulted better weed management and highest grain yield of rice (46.1 qha^{-1}).

Introduction

India is one of the principal rice growing countries accounting for about one-third of the total world acreage. Rice is grown in most of the states of India, which covers more than 30 per cent of the total cultivated area. According to the projections made by the Population Foundation of India, India's population will be 1,546 million by the end of 2030 and it is estimated that the demand for rice will be 121.2 mt (Duttarganvi *et al.*, 2016). In order to achieve this target, the productivity of rice has to be brought to the desired level (Mondal *et al.*, 2017a). One of the foremost delinquents in productivity increase for food security is losses caused by pests in the production system.

Among the different pests, weed caused maximum loss in grain yield of rice (37.02 %)in Gangetic Inceptisol and thus cogitate as the most inaudible burglar in our production system (Mondal *et al.*, 2017b). Therefore, by minimizing the weed pest loss the production can be brought to desirable level. The physical control of weed pests is extreme costlier and having anti-soil conservation

principal. The use of herbicides offers selective control of weeds right from the beginning, giving the crop an advantage of good start and competitive superiority over weeds than the traditional hand weeding (Mahajan and Chauhan 2013). New herbicides are introducing in a regular manner but their ecosafe low cost efficiency needs to be investigated. In view of the above, the present work is undertaken to look out the broad spectrum weed control through use of different herbicides.

Materials and Methods

The field experiment was conducted during *Kharif* season of 2019-20 at farmer's field of Bagoi, Arakhia and Saharadia villages (Kujanga block) of Jagatsinghpur district in Odisha. Six composite GPS based soil samples were collected from Arakhia, Bagoi and Saharadia villages of Kujanga block during 2019-20and analysed for physico-chemical properties. The method involved in analyses of soil samples is depicted in Table 1.

The experimental soil was well drained and sandy loam to clay loan in texture, having pH of soils for all villages were moderately acidic, soil organic carbon and available nitrogen was low, medium in available phosphorus and potassium, available sulphur and boron were below in critical limit and available zinc was below critical limit in Arakhia viilage but Bagoi and Saharadia villages were above critical limit (Table 2).

The treatments comprised of one hand weeding at 30 days after transplanting [T1], post emergence (PoE) application of Bispyribac sodium 10 SC @ 25 gha^{-1}at 25 days after transplanting (DAT) [T2] and early PoE application of Almix 20 WP (metsulfuron methyl 10% + chlorimuron ethyl 10% WP) @ 4 gha^{-1}at 15 DAT [T3]. Treatments were studied in randomized block design with seven replications. Data were analyzed using analysis of variance (ANOVA) to evaluate the differences among treatments while the means were separated using the least significant difference (LSD) test at 5 % level of significance.

Rice variety Swarna sub 1 was transplanted by following soil test based recommendation of nitrogen in the form of DAP and Urea, Phosphorus in the form of DAP and potash in the form of MOP in the month of August with a spacing of 20 cm (P-P) and 15 cm (R-R) taking care against the root damages of the seedlings. All the recommended improved package of practices of transplanted rice were followed in this experiment including the general plant protection measures. For insect and disease control, ecosafe chemicals were applied two weeks after the herbicide application. The herbicides were applied with a knapsack sprayer having a delivery of about 500 L $ha^{-1}$of spray solution through a flat fan nozzle at a spray pressure of 140 kPa.

The efficacy of the herbicides was evaluated at 15 and 30 days after application of tested herbicides (DAA). The data on density of weeds were subjected to square-root transformation and statistically analysed following standard procedure.

Results and Discussion

The dominant weed flora in the experimental plots were comprised of *Echinochloa colona* among the grassy weeds, while *Cyperus rotundus* and *Cyperus iria* among the sedges and *Ludwigia octovulvis* among the broadleaved weeds were dominant.

Table.1 Analytical methodologies

Parameter	Methodology	Citation
Soil analyses		
pH	(in 1:2.5:: Soil : Water)	Jackson (1967)
EC	(in 1:2.5:: Soil : Water)	Jackson (1967)
Organic carbon	Wet oxidation method	Jackson (1973)
Available N	Hot alkaline $KMnO_4$ Method	Subbiah and Asija (1956)
Available P	0.03 N NH4F + 0.025 N HCL (pH 3.5) and 0.5 M $NaHCO_3$ at pH 8.5	Bray and Kurtz (1945) and Olsen *et al.*, (1954)
Available K	Neutral N NH_4OAc extraction	Jackson (1973)
Available S	Extraction with 0.15% CaCl2	Massoumi and Cornfield, (1963)
Available Zn	DTPA extractant	Lindsay&Norvel, (1978)
Available B	Hot water extraction	Berger and Truog (1939)

Table.2 Soil nutrient status in adopted villages of Kujanga block

Soil Parameters	Arakhia	Bagoi	Saharadia
pH (1:2.5)	5.77	5.90	5.58
EC(dSm^{-1})	0.19	0.25	0.03
SOC (%)	0.42	0.48	0.48
Available N($kg\ ha^{-1}$)	189	214	223
Available P ($kg\ ha^{-1}$)	15.87	19.75	19.26
Available K ($kg\ ha^{-1}$)	145	138	129
Available S ($mg\ kg^{-1}$)	7,86	9.15	9.13
Available Zn ($mg\ kg^{-1}$)	0.49	0.75	0.57
Available B ($mg\ kg^{-1}$)	0.35	0.46	0.39

Table.3 Effect of treatments on weed population and growth attributes of rice crop

Treatments	Weed Population (Numberm^{-2})						Growth attributes	
	Grass		Sedge		Broadleaf		Plant height (cm)	Leaf area index
	15 DAA	30 DAA	15 DAA	30 DAA	15 DAA	30 DAA		
T_1	2.41 (1.85)*	4.55 (2.36)	1.67 (1.64)	3.89 (2.21)	2.70 (1.59)	9.23 (2.20)	91.0	4.02
T_2	1.08 (1.44)	2.71 (1.93)	0.82 (1.35)	1.88 (1.70)	1.37 (1.54)	3.23 (2.06)	98.2	4.42
T_3	2.23 (1.80)	4.35 (2.31)	1.32 (1.52)	2.66 (1.91)	2.87 (1.97)	5.54 (2.56)	97.1	4.30
SEm (±)	0.046	0.048	0.031	0.052	0.047	0.053	0.785	0.042
LSD at 5%	0.14	0.13	0.09	0.16	0.14	0.16	2.45	0.13

*Data in parentheses are transformed [$\sqrt{(x+1)}$]values which were used for statistical analysis
T1: Hand weeding at 30 DAT (Farmer's Practice) T_2: Post emergence (PoE) application application of Bispyribac sodium 10 SC @ 25 gha^{-1} T_3: Early PoE application of Almix 20 WP (metsulfuron methyl 10% + chlorimuron ethyl 10% WP) @ 4 gha^{-1}.

Table.4 Effect of treatments on yield attributes, yield and economics of rice crop

Treatments	Crop yield attributes			Grain yield (qha^{-1})	Net return (Rs.ha^{-1})	BC ratio
	Effective panicles m^{-2}	Grainspanicle^{-1}	Test Weight (g)			
T_1	336	162	22.1	38.4	21320	1.53
T_2	482	203	22.2	46.1	34160	1.86
T_3	398	182	22.2	42.8	30380	1.79
SEm (±)	14.83	4.151	0.011	0.783	-	-
LSD at 5%	46.22	12.93	NS	2.44	-	-

T1: Hand weeding at 30 DAT (Farmer's Practice) T_2: Post emergence (PoE) application application of Bispyribac sodium 10 SC @ 25 gha^{-1} T_3: Early PoE application of Almix 20 WP (metsulfuron methyl 10% + chlorimuron ethyl 10% WP) @ 4 gha^{-1}.

All the weed-control treatments significantly reduced the weed density compared to Farmers practice (Tables 3). Lowestgrassy weed density was recorded in the plots that received Bispyribac sodium 10 SC @ 25 gha^{-1} (1.44 and 1.93 no.m^{-2} at 15 and 30 DAA respectively) followed by Almix 20 WP (metsulfuron methyl 10% + chlorimuron ethyl 10% WP) @ 4 gha^{-1} and Farmers practice (hand weeding at 30 days after transplanting). Similar trend was also observed in sedge and broadleaf weeds.

Bispyribac-sodium is a selective, systemic herbicide, absorbed by foliage and roots widely used for weed control in rice. It can control a wide range of weeds under rice ecosystem. It control the weeds through inhibition of the branched amino acid biosynthesis. Bispyribac sodium is a group B herbicide with aceto lactase inhibitory effects.

Plant height (98.2 cm at 60 DAT) and leaf area index (4.42 at 60 DAT) was found highest (Table 3) in the plots treated with

Bispyribac sodium 10 SC @ 25 g ha^{-1} applied as post emergence at 25 DAT which ultimately helped in gaining better yield attributes and yield of rice.As the rice plants in herbicide treated plots were kept almost weed free, had a better utilization of available resources like, nutrients, space and water. More competition from weed flora in the critical phase of crop–weed completion increases the growth attributes of rice (Ghosh *et al.,* 2019).

All herbicidal treatments showed significantly higher number of yield and yield attributes (Table 4) over the farmers practice due to less competition for moisture, light and nutrient uptake by the crop plants. Significantly higher number of panicles m^{-2} (482 no. m^{-2}) and number of grains $panicle^{-1}$ (203), grain yield (46.1 qha^{-1}) were observed in plots treated with Bispyribac sodium 10 SC @ 25 gha^{-1}. All the weed control treatments significantly reduced the weed growth as compared to Farmer's practice, and thus recorded higher grain yield of rice. Mondal *et al.,* (2018) concluded that effective and timely weed management under the herbicidal treatments at critical crop-weed competition period reduced the density and biomass of weeds which facilitated the crop plants to have sufficient space, light, nutrient and moisture and thus the number of effective panicles m^{-2}, number of filled grains $panicle^{-1}$ and finally the yield were increased in a sustainable manner to the desired level.

Among the different treatments Bispyribac sodium 10 SC @ 25 gha^{-1} recorded highest (Table 4) net return (Rs. 34160ha^{-1}) and B:C ratio (1.86) followed by Almix 20 WP (metsulfuron methyl 10% + chlorimuron ethyl 10% WP) @ 4 gha^{-1} and farmer's practice. According to Mondal *et al.,* (2019) 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.

Based on present investigation, it could be inferred that application of Bispyribac sodium 10 SC @ 25 gha^{-1} as post emergence is very effective against the composite weed flora and they registered a higher grain yield of rice and can attend crops where pre-emergent herbicide application could not be taken up owing to abiotic factors.

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