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Influence of herbicides on growth and profitability of transplanted rice (*Oryza sativa* L.) in Jharkhand

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Abstract
An experiment has been carried out during *kharif*, 2013 at Rice agronomical Farm, Western Section Birsa Agricultural University, Kanke, Ranchi, Jharkhand on clay loam soil having low in organic carbon (0.37%) and available nitrogen (253.4kg/ha) whereas medium in available phosphorus (15.9kg/ha) and potassium (137.5kg/ha) with moderately acidic (pH 6.1). CGR, NAR, dry matter accumulation rate as well as LAI were also high under application of flucetosulfuron 20 or 25g/ha followed by bispyribac sodium 25g/ha throughout the crop period. However, application of flucetosulfuron 20g/ha alone was also being similar to flucetosulfuron 20 or 25g/ha followed by bispyribac sodium 25g/ha recorded comparatively higher CGR, NAR, dry matter accumulation rate and LAI than rest of the chemical weed control treatments as well as mechanical and hand weeding. Grain yield of rice with application of Flucetosulfuron 20 or 25g/ha followed by Bispyribac sodium 25g/ha was as high (54.58 and 55.88q/ha, respectively) as in weed free (58.48q/ha). Further, application of Flucetosulfuron 20g/ha alone at 3 days after transplanting (DAT) produced similar grain yield (52.68q/ha) as in combination with Bispyribac sodium 25g/ha and was significantly higher to application of Bispyribac sodium 25g/ha alone as well as hand weeding to the tune of 11 and 22%, respectively. Application of Flucetosulfuron 20g/ha alone had similar net return (Rs.36750/ha and Rs.39174 respectively) and Beneft: cost ratio (1.46 and 1.38 respectively) as weed free situation. Further, application of Flucetosulfuron 20g/ha alone had significantly higher net return to the tune of 22 and 42% over mechanical and hand weeding, respectively.

Keywords: CGR, NAR, LAI, Benefit:Cost Ratio, Net Return, Rice

Introduction
Globally, rice is cultivated on 164 million hectares with an annual production of 722.8 million tonnes and an average productivity of 4.43 t/ ha during 2013-14. In India, rice is cultivated in diverse ecologies spread over 44.6 million hectare with a production of 104.6 million tonnes of rice having average productivity of 2.96 t/ha 2013-14 (FAOSTAT,2013). Demand for rice is growing every year and it is estimated that by 2025 the requirement would be 130 million tonnes. To sustain present food self sufficiency and to meet future demands, India has to increase its rice productivity by 3% per annum. In Jharkhand, rice is grown in 17.8 lakh hectare with a production of 3.29 million tonnes and productivity 1.84 tonnes per hectare (Directorate of Agril. Govt. of Jharkhand, 2013-2014). The reason for very low productivity in Jharkhand is due to rain dependent rice cultivation which is extremely erratic in onset, distribution, intensity and cessation. With many constraints, producing more rice from the same land to feed additional population is a great challenge. Presence of weeds in rice field reduce the grain yield by 50-70% in upland, 30 % in drilled irrigated and 20-27 % in transplanted rice (Singh *et al*., 2005). Most of the herbicides used in rice field are required in large quantities of active ingredients as Butachlor 1.5 kg/ha, pretilachlor 1.0 kg/ha and these herbicides may leave more residues in the soil which may deteriorate soil and human health. Repeated use of any single herbicide in any crop generates resistant in weed for particular weedicide and a shift in the competition of weed flora leading to dominance of secondary weeds.

Hence, weed management practices may be planned in integrated manner by using limited quantity of high efficacy, eco-friendly and low dose herbicides in puddled condition to suppress weed growth. Some of low dose herbicides are available to control the weeds vary effectively in rice field such as Flucetosulfuron. Flucetosulfuron is sulfonylurea group herbicide used especially to control weeds in rice. Unlike other sulfonylurea herbicides, this herbicide control *Echinochloa crusgalli* very effectively as well as other annual and perennial weeds. This herbicide can be applied on foliage as well as in soil in both premergence to post emergence.

Materials and Method

A field experiment was conducted a Western Section of Rice Agronomical Research Farm, Birsa Agricultural University, Ranchi, Jharkhand (Lat:23°17'N, Long:83°19'E, Alt:625 m above MSL) in *Kharif* 2013. on clay loam soil (38.4% sand, silt 30.4% and clay 31.2%). The mean rainfall of Ranchi is 1440 mm and more than 80% generally occurs during the south-west monsoon (June-September) The soil was acidic in reaction (pH 6.1), low in organic carbon (0.37%) and available nitrogen (253.4 kg/ha) whereas medium in available phosphorus (15.9 kg/ha) and potassium (137.5 kg/ha).The gross plot size of each treatment was 17.6m^2 and the net plot size was 9.6 m^2. The rice variety 'PHB-71was grown with spacing of 20cmx 15cm. Recommended dose of chemical fertilizer 150 kg N + 70 kg P_2O_5 + 90 kg K_2O/ha was applied through urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively. The experiment was laid out in a randomized block design with 10 treatments replicated four times *viz.*, T_1- Flucetosulfuron 20g/ha at 3 DAT; T_2- Flucetosulfuron 25g/ha at 3 DAT ; T_3- Flucetosulfuron 20g/ha at 3DAT fb Bispyribac sodium 25g/ha at 15 DAT; T_4- Flucetosulfuron 25g/ha at 3DAT fb Bispyribac sodium 25g/ha at 15 DAT; T_5- Bispyribac sodium 25g/ha at 15 DAT; T_6- Botachlor at 1.5kg/ha at 7 DAT; T_7- Weed free; T_8- Mechanical weeding(rotary weeder at 20 and 40 DAT); T_9- Hand weeding (20 and 40 DAT) and T_{10}-Weedy check. Rice seeds were treated with 10% salt solution in order to select the healthy seeds. The seeds settled at the bottom were thoroughly rinsed with water twice and used for nursery raising. In order to prevent the crop from seed borne diseases, the seeds were treated with carbendazim @ 2 g/ kg seed. The field was prepared by ploughing and cross ploughing with the help of cultivator. The field was puddled by tractor drawn puddler in presence of 8-10 cm standing water and leveled by planker. As per the treatments, the exact required quantity of herbicides was taken and mixed in water to prepare stock solution, which was equally distributed. Application of herbicides was carried out in the morning time with the help of Knapsack sprayer manually. All the growth parameters like plant height, plant population, leaf stem ratio, number of tillers per m row length, number of leaves plant-1 were taken and yield attributes like effective tillers per hill, panicle length (cm), panicle weight (g), number of filled and unfilled grains per panicle, test weight and grain yield and straw yield were recorded and economics was calculated and computations were done.Half dose of nitrogen, full amount phosphorus and two third of potassium were applied as basal and rest amount of nitrogen was top dressed in two equal installment at active tillering and panicle initiation stage. The one third of potash was applied split at time of panicle initiation.

Result and Discussion

Growth parameter:

Application of flucetosulfuron 20 or 25g/ha followed by bispyribac sodium 25g/ha being similar and recorded as taller plant as weed free and significantly superior to rest of the weed control measures (Table.1). The taller plant under these two treatments was might be due to the fact that plant faced least crop weed competition thus plant got maximum availability of nutrient, sunlight and moisture which helped the plants to grow more vigorously. This is in agreement with findings of Sunil *et al.* (2010) and Kiran *et al*.(2010). Application of flucetosulfuron 20 or 25g/ha followed by bispyribac sodium 25g/ha recorded as high dry matter as weed free at all the progressive growth stages of crop (Table.2). Greater dry matter accumulation was due to lower weed competition and plant attained lush growth due to elimination of weeds from inter and intra row spaces besides better aeration thus more space, water, light and nutrients were available to rice plants to accumulate dry matter in greater quantity.Net assimilation rate (NAR) of rice crop with the application of flucetosulfuron 20 or 25g/ha followed by bispyribac sodium 25g/ha at 15 DAT as well as flucetosulfuron20g/ha at 3DAT alone was as high as weed free(Table 1). Crop growth rate as well as leaf area index were also high under application of flucetosulfuron 20 or 25g/ha followed by bispyribac sodium 25g/ha throughout the crop period (Table.1). However, application of flucetosulfuron 20g/ha alone was also being similar to flucetosulfuron 20 or 25g/ha followed by bispyribac sodium 25g/ha recorded comparatively higher CGR and LAI than rest of the chemical weed control treatments as well as mechanical and hand weeding. This might be due to effective control of weeds in critical periods that accelerated photosynthetic activity ultimately leading to higher leaf area index. Thus, it can be inferred that application of flucetosulfuron 20g/ha either alone or in combination with bispyribac sodium 25g/ha were efficient in controlling weeds and provided ample opportunity to utilize available resources more efficiently. Similar findings were also been reported by Kiran *et al*.(2010) and Singh *etal*.(2009)

Grain yield (q/ha)

Weed free (upto 60DAT) registered significantly highest grain yield (58.5q/ha) over rest of the treatments except, Flucetosulfuron 20 or 25g/ha followed by Bispyribac sodium 25g/ha treatments (54.6 and 55.9q/ha respectively) (Table 3). The lowest grain yield was recorded under unweeded check(30.6q/ha).Grain production, which is the final product of growth and development, is controlled by growth and yield attributing characters such as effective tillers, dry matter accumulation and test weight etc. Growth and all yield attributing characters are more in weed free (upto 60DAT) because of less crop-weed competition, Similarly environmental conditions were favorable for better crop growth resulted in higher photosynthesis and ultimately higher grain yield in this treatment. The lower grain yield under unweeded check may be due to the high weed interference and less yield attributing characters. Unweeded check plot compete with rice plants for light, nutrients and moisture resulting reduction in grain yield. These results are in conformity with Kiran *et al.* (2010), Veeraputhiran *et al.* (2013), Murali et al.(2012), Rawat *et al*.(2012) and Kumar etal.(2013)

Profitability

Application of Flucetosulfuron 20 or 25 g/ha at 3 DAT followed by Bispyribac sodium 25g/ha at 15 DAT or Flucetosulfuron 20g/ha alone at 3 DAT recorded as high gross return (Rs 63430, 63415 and 61775/ha, respectively) as weed free (67639/ha) (Table 3). While, application of Flucetosulfuron 20 g/ha alone at 3 DAT recorded highest net return (36750/ha) and was significantly higher than bispyribac sodium 25g/ha alone (Rs. 27963/ha) as well as mechanical weeding (Rs. 28885/ha) and hand weeding (Rs 21372/ha).Benefit: cost ratio (B: C) of rice was significantly influenced by weed control measures. Application of flucetosulfuron 20g/ha alone recorded maximum and significantly higher benefit: cost ratio (1.46) than bispyribac sodium 25g/ha (1.08), mechanical weeding (1.05) and hand

weeding (0.77) (Table 3)

Conclusion

Based on one year of experimentation It may be concluded that pre emergence herbicide Flucetosulfuron 20g/ha at 3DAT alone produced almost similar plant height CGR,LAI,NAR Dry matter accumulation grain yield, net return and benefit: cost ratio as under weed free situation up to 60 days after transplanting.

Table 1: Periodic CGR,NAR and plant height of rice as influenced by weed control measures**.**

Treatments	Days after transplanting					
	CGR(g/m2/day			NAR(g/m2/day		Plant Height(cm)
	30-60	60-90	9 90-Maturity	3 30-60	60-90	Maturity
T1- Flucetosulfuron 20 g /ha at 3 DAT	14.6	27.5	13.8	4.7	6.8	104
T2- Flucetosulfuron 25 g /ha at 3 DAT	14.1	26.1	12.9	4.7	7.7	103
T3-T1 *fb* Bispyribac Na 25 g /ha at 15 DAT	15.8	29.4	14.8	4.9	7.4	109
T4- T2 *fb* Bispyribac Na 25 g/ha at 15 DAT	16.0	31.0	15.6	5.1	7.6	107
T5-Bispyribac Na 25 g /ha at 15 DAT	12.7	22.3	10.7	4.5	6.3	105
T T6-Butachlor 1.5kg/ha at 7 DAT	14.1	26.0	12.6	4.7	6.8	105
T7- Weed free upto 60 DAT	16.6	32.1	16.3	5.1	7.7	112
T8-Mechanical weeding (20 and 40 DAT)	13.5	24.2	11.8	4.6	6.5	103
T9-Hand weeding (20 and 40 DAT)	12.4	21.4	10.3	4.4	6.1	104
T10-Weedy check	10.7	18.0	8.8	4.3	5.9	98
SEm±	0.6	0.9	1.2	0.2	0.3	2.3
CD(0.05)	0.8	2.7	3.6	0.6	0.8	6.6

Table 2: Periodic leaf area index and dry matter accumulation of rice as influenced by weed control measures

Treatments	Days after transplanting(DAT)						
	30	60	90	30	60	90	At maturity
	LAI			Periodic dry matter accumulation (g/m^2)			
T1-Fluetosulfuron 20 g /ha at 3 DAT	2.6	3.7	4.2	78.3	517.3	1343.4	1757.8
T2-Fluctosulfuron 25 g /ha at 3 DAT	2.5	3.6	4.1	76.1	498.6	1280.4	1668.5
T3-T1 *fb*Bispyribac Na 25 g /ha at 15 DAT	2.6	3.7	4.2	81.1	544.9	1425.8	1869.9
T4-T2*fb*+BispyribacNa 25 g/ha at 15 DAT	2.6	3.8	4.3	83.4	563.8	1495.1	1962.8
T5-Bispyribac Na 25 g /ha at 15 DAT	2.4	3.3	3.7	69.0	448.9	1117.9	1438.4
T6-Butchlor 1.5kg/ha at 7 DAT	2.5	3.5	4.1	75.9	497.9	1277.6	1654.5
T7-Weed free upto 60 DAT	27	3.9	4.4	85.8	582.6	1544.2	2034.3
T8-Mechanical Weeding (20 &40 DAT)	2.4	3.5	4.0	72.50	77.01	1203.58	1557.4
T9-Hand weeding (20 and 40 DAT)	2.4	3.3	3.71	69.25	40.02	1081.56	1390.5
T10-Weedy check	2.1	2.9	3.22	63.68	86.21	925.20	1189.1
SEm±	0.07	0.08	0.09	2.62	17.17	21.95	30.35
CD(0.05)	0.2	0.25	0.28	7.61	49.82	63.69	88.06

Table 3: Grain yield, cost of cultivation, net return and benefit: Cost ratio of rice as influenced by weed control measures

Treatments	Grain yield(q/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio
T1-Flucetosulfuron 20 g /ha at 3 DAT	52.7	25025	36750	1.46
T2-Flucetosulfuron 25 g /ha at 3 DAT	48.7	25325	31605	1.24
T3-T1*fb* Bispyribac Na 25 g /ha at 15 DAT	54.6	27185	36245	1.33
T4-T2 *fb* Bispyribac Na 25 g/ha at 15 DAT	55.9	27485	35930	1.30
T5-Bispyribac Na 25 g /ha at 15 DAT	47.1	25825	27963	1.08
T6-Butachlor 1.5kg/ha at 7 DAT	48.9	24575	33085	1.34
T7-Weed free upto 60 DAT	58.5	28465	39174	1.38
T8-Mechanical weeding (20 and 40 DAT)	48.3	27505	28885	1.05
T9-Hand weeding (20 and 40 DAT)	41.1	27665	21372	0.77
T10-Weedy check	30.6	23665	9600	0.44
SEm±	1.87		2012	1.72
CD(0.05)	5.4		5841	5.02

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