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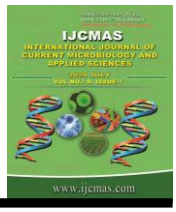

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Effect of Post Emergence Herbicide on Growth, Yield and Economics of Transplanted Rice (*Oryza sativa* L.)

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A B S T R A C T

A field experiment was conducted during *Kharif*- 2018 at Agricultural Research Station, Gangavathi, University of Agricultural Sciences, Raichur, Karnataka to study the effect of weed control practices on growth, yield and economics of transplanted rice. The soil was medium deep black clay with medium fertility. The results of this experiment revealed that hand weeding twice (15 and 45 DAT) recorded significantly higher growth parameters of rice *viz.* number of tillers m^{-2}, LAI and total dry mater production $plant^{-1}$(323.00, 1.40 and 68.71 g, respectively) as compared to weedy check (212.67, 0.24 and 40.92 g, respectively). The highest grain and straw yields were recorded with hand weeding twice at 15 and 45 DAT (5415 and 5783 kg ha^{-1}, respectively) followed by application of pendimethalin 38.7 % CS @ 680 g a.i/ha as PE *fb* bispyribac sodium 10 % SC @ 25 g a.i/ha (4990 kg ha^{-1} and 5433 kg ha^{-1})and bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha (4922 and 5372 kg ha^{-1}, respectively). The benefit cost ratio was significantly higher with bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha(2.62) as compared to weed free check (2.47).

Introduction

Rice (*Oryza sativa* L.) is one of the predominant food crops of the world. It is widely grown in tropical and subtropical regions. According to IRRI, rice is the staple food of more than three billion people in the world, most of who live in Asia. Worldwide rice is grown on an area of 163 million hectare with a production of 741 million tons and with an average productivity of 4.56 tons ha^{-1}. In India, it is grown on nearly 43.39 million hectares with the production of 104.32 million tons triggering productivity of 2404 kg ha^{-1}. In Karnataka, rice covers 1.06 million hectares area with an annual production of 2.7 million tons but the average productivity is 2547 kg ha^{-1} (Anon., 2018). Tunga Bhadra

command in Karnataka state in India is an important rice growing belt covering 3.5 Lakh ha. Traditional transplanting is the major method of crop establishment in the command area. Weed infestation is the major threat to productivity of transplanted rice. Globally, actual rice yield losses due to pests have been estimated at 40 per cent out of which weeds account for 33 per cent. In India, unchecked weed competition causes yield losses to the tune of 50-65 per cent in rice. Weeds by the virtue of their high adaptability and faster growth dominate the crop habitat and reduce the yield potential of the crop. The problem of extensive weed incidence during early stages of rice crop growth cannot be determined which competes with crop plants for moisture, nutrients, light, space and other growth factors. This crop competition leads to significant yield losses to the tune of 35-55 per cent in transplanted rice. Traditionally weed control in rice is done by manual and mechanical means which are most effective and common methods but they are tedious, costly, time taking and are difficult due to continuous rains during *Kharif* season. Besides, adequate labourers are also not available during critical period of crop weed competition. These weeds could be controlled through chemical methods. Sometimes, application of pre-emergence herbicides also is not sufficient to give effective weed control for keeping weeds population up to threshold level. Under such situation post-emergence herbicides remains only the viable option for weed control in transplanted rice. Pre-emergence herbicides are most commonly used against grassy weeds in transplanted rice. But post-emergence herbicides are becoming need of the day due to emergence of weeds at later growth stages of crop. Control of weeds by herbicides is although quite effective but needs proper skill and fidelity. The choice of suitable herbicide is a major problem in many cases. Keeping above facts in views, there is a need to know the effect of post emergence herbicide on growth, yield and economics of transplanted rice (*Oryza sativa* L.).

Materials and Methods

Field experiment was conducted during *Kharif,* 2018 Agricultural Research Station, Gangavathi, Karnataka, situated at an altitude of 406 m (1,332 ft) above mean sea level at 15.43^0 N latitude and 76.53^0E longitude and is located in the Northern Dry Zone of Karnataka. The experiment was laid out in a Randomized Block Design with 12 treatments, replicated three times. The treatments consisted of post emergence herbicides *viz.,* bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha (T_1), bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha (T_2), bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha (T_3), bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha with adjuvant @ 625 ml/ha (T_4), bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha(T_5), bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha with adjuvant @ 625 ml/ha(T_6), bispyribac sodium 10 % SC @ 20 g a.i/ha (T_7), 2,4-D Ethyl ester 38% EC @ 850g a.i/ha (T_8) and penoxsulam21.7 % SC @ 22.5 g a.i/ha (T_9). These were compared with hand weeding twice at 15 and 45 DAT (T_{11}), farmers practice (pendimethalin 38.7 % CS as PE *fb* bispyribac sodium 10 % SC) (T_{10}) and weedy check (T_{12}).The experimental field was ploughed twice with disc harrow and tractor drawn cultivator followed by puddling with rotovator and later levelled uniformly. The seed rate of 25 kg ha^{-1} was used for establishment methods. The most popular and predominant variety BPT-5204 was planted at a spacing of 20 cm X 10 cm at the seedling age of 30 days, the recommended dose of

fertilizer 150:75:75 kg N, P_2O_5 and K_2O ha^{-1} along with 20 kg $ZnSO_4$ was applied. The half of the nitrogen (75 kg N ha^{-1}) and full quantity of phosphoric (75 kg P_2O_5) and potassic (75 kg K_2O) fertilizer were given at the time of transplanting and remaining quantity of nitrogen was given in two equal splits at tillering and panicle stage of the crop, respectively.

The experimental soil was medium black clay in texture, moderately alkaline in reaction (pH 8.12) with an electrical conductivity of 0.46 dSm^{-1}, low in organic carbon (0.58%) and available nitrogen (203.71 kg ha^{-1}), high in available phosphorus (71.27 kg ha^{-1}) and high in exchangeable potassium (364.01 kg ha^{-1}). The gross and net plot sizes were 5.0 m X 4.0 m and 4.2 m X 3.4 m, respectively.

Results and Discussion

Number of tillers m^{-2}

Number of tillers m^{-2} was maximum under hand weeding twice at 15 and 45 DAT (323.00). This was obviously because of efficient control of weeds which in turn helped in better uptake of nutrients and this led to formation of more number of tillers as compared to unweeded control (212.67), where the crop had to face more competition stress by weeds, resulting in lower number of tillers (Table 1).

This was on par with pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb* bispyribac sodium 10% SC @ 25 g a.i/ha (320.00) probably due to reduced competition from weeds at early stages of crop growth with a better weed control efficiency and without injury to the crop providing ideal environment for rice plants to have more pronounced tillers number. Findings of Akabar *et al*., (2011) are in support of these observations.

Leaf Area Index (LAI)

Hand weeding recorded significantly higher (1.40) LAI which was followed by bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha (1.06) but remained on par with pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb*bispyribac sodium 10% SC @ 25 g a.i/ha (1.16) (Table 1).This was attributed to the availability of optimum growth factors for enhancing the assimilatory surface area. The weed free environment provides more chance for leaves to expand and cover the area by its canopy in an appreciable manner.

Total dry matter production (g $plant^{-1}$)

Significantly higher total dry matter production was recorded under hand weeding twice at 15 and 45 DAT (68.71 g $plant^{-1}$) as compared to weedy check (40.92 g $plant^{-1}$) (Table 1). Among the herbicide, pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb* bispyribac sodium 10% SC @ 25 g a.i/ha recorded higher dry weight (66.83 g $plant^{-1}$) and was on par with bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha (63.31 g $plant^{-1}$). This might be due to weed free environment helps the crop for better plant dry matter production. Similar view was expressed by Uma *et al.,* (2014).

Yield attributing characters as influenced by different weed management practices

Weed management practices had significant influence on panicle length, number of panicles m^{-2}, grains $panicle^{-1}$ and test weight (Table 2). Hand weeding twice at 15 and 45 DAT recorded the highest panicle length (19.80 cm), number of panicles m^{-2} (323.00), grains $panicle^{-1}$ (231.00) and test weight (21.17 g) which was on par with pendimethalin 38.7% CS @ 680g a.i/ha as PE

fb bispyribac sodium 10% SC @ 25 g a.i/ha (19.2 cm, 317.00, 221 and 18.89 g, respectively) followed by bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha (18.8 cm, 312.00, 211.00 and 18.78 g, respectively). In contrast, unweeded control recorded significantly lower panicle length (12.00 cm, 209.00, 122.00 and 17.02 g, respectively).

Appreciably lowest effective tiller and panicle length were noted under weedy check plots. This was because of heavy weed competition which hampered the supply of growth resources below the demand resulting in poor vegetative growth and reduced assimilatory area per unit of ground area. These results are in accordance with the findings of Patra *et al.*, (2016).Significantly higher number of grains per panicle and test weight were noted under hand weeding twice and pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb* bispyribac sodium 10% SC @ 25 g a.i/ha. This was due to better suppression of weeds and the weed free environment to the crop, gave more room for formation and development of grains which led to register the superior values of total and sound grains per panicle under aforesaid treatments. Similar findings were also reported by Kumar *etal*. (2010).

Grain and straw yields

The highest grain and straw yield was obtained under hand weeding twice (5415 and 5783 kg ha^{-1}), which was on par with pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb*bispyribac sodium 10% SC @ 25 g a.i/ha (4990 and 5433 kg ha^{-1}) and bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha(4922 and 5372 kg ha^{-1}) as compared to weedy check (2137 and 2713 kg ha^{-1}) (Table 3). The enhanced yields under these treatments was because of elimination of weeds which helped in enhancing the availability of nutrients, space, sunlight and water resulting in better growth and development of crop plants. This caused better yield attributing characters and accumulation of more dry matter in leaves, stem and ultimately the highest yields. These results are in collaboration with the findings of Singh *et al*., (2017).

Economics

The economics of crops was measured in terms of gross return, net return and B: C ratio as shown in Table3. Data recorded under different components revealed that gross return was increased with increasing biological yield of transplanted rice obtained under different treatments. Hand weeding at 15 and 45 DAT fetched significantly higher gross returns (Rs. 112030 ha^{-1}) over weedy check (Rs. 45427 ha^{-1}) and was on par with pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb* bispyribac sodium 10% SC @ 25 g a.i/ha(Rs. 105235 ha^{-1}) followed by bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+ 678.75) g a.i/ha with adjuvant @ 625 ml/ha (Rs.103819 ha^{-1}) and bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha with adjuvant @ 625 ml/ha (Rs. 96437 ha^{-1}). The values of gross returns was minimum in weedy check plot and maximum under hand weeding twice, these variations were due to differences in economical yield (grain and straw) under the treatments.

The highest net returns was recorded with hand weeding twice at 15 and 45 DAT (Rs. 66715 ha^{-1}) than weedy check (Rs. 7612 ha^{-1}) and was on par with bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha (RS. 64129 ha^{-1}) followed by pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb* bispyribac sodium 10% SC @ 25 g a.i/ha (Rs. 63900 ha^{-1}).

Table.1 Plant height, number of tillers per square meter, Leaf Area Index and total dry matter production as influenced by weed control treatments in transplanted rice

Treatment	Number of tillers m^{-2}	Leaf Area Index	Total dry matter production (g $plant^{-1}$)
T_1 - Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha	294.00	0.54	51.48
T_2 -Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha	298.00	0.58	52.41
T_3 -Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha	292.00	0.53	50.79
T_4-Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha with adjuvant @ 625 ml/ha	301.33	0.85	56.32
T_5- Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha	315.00	1.06	63.31
T_6-Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha with adjuvant @ 625 ml/ha	302.33	0.81	56.32
T_7-Bispyribac sodium 10 % SC @ 20 g a.i/ha	275.00	0.59	48.24
T_8- 2,4-D Ethyl ester 38% EC @ 850 ga.i/ha	272.33	0.56	47.14
T_9-Penoxsulam 21.7 % SC @ 22.5 g a.i/ha	270.00	0.54	46.45
T_{10}- Pendimethalin 38.7 % CS @ 680 g a.i/ha as PE *fb* Bispyribac sodium 10 % SC @ 25 g a.i/ha	320.00	1.16	66.83
T_{11}- Weed free check (Hand weeding at 15 and 45 DAT)	323.00	1.40	68.71
T_{12}- Weedy check (Untreated control)	212.67	0.24	40.92
S.Em±	1.53	0.06	1.76
C.D. = (0.05)	4.48	0.16	5.17

Table.2 Panicle length, number of panicles per sq.m, number of grains per panicle and test weight as influenced by weed control treatments in transplanted rice

Treatment	Panicle length (cm)	No. of panicles m^{-2}	No. of grains $panicle^{-1}$	Test weight (g)
T_1 - Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha	17.5	291	175	18.24
T_2 -Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha	17.6	295	182	18.57
T_3 -Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha	17.2	289	170	18.09
T_4-Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha with adjuvant @ 625 ml/ha	18.3	298	208	18.75
T_5- Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha	18.8	312	211	18.78
T_6-Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha with adjuvant @ 625 ml/ha	18.0	299	199	18.56
T_7-Bispyribac sodium 10 % SC @ 20 g a.i/ha	16.4	272	160	17.65
T_8- 2,4-D Ethyl ester 38% EC @ 850 ga.i/ha	16.3	269	158	17.58
T_9-Penoxsulam 21.7 % SC @ 22.5 g a.i/ha	16.3	267	152	17.43
T_{10}- Pendimethalin 38.7 % CS @ 680 g a.i/ha as PE *fb* Bispyribac sodium 10 % SC @ 25 g a.i/ha	19.2	317	221	18.89
T_{11}- Weed free check (Hand weeding at 15 and 45 DAT)	19.8	323	231	21.17
T_{12}- Weedy check (Untreated control)	12.0	209	122	17.02
S.Em±	0.84	2.15	3.43	0.38
C.D. = (0.05)	4.47	6.30	10.07	1.10

Table.3 Grain yield, straw yield, cost of cultivation, gross returns, net returns and B:C ratio of rice as influenced by different weed management practices

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C
T_1 - Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha	4260	4777	39215	89984	50769	2.29
T_2 -Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha	4317	4816	39565	91163	51598	2.30
T_3 -Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha	4254	4774	39915	89854	49939	2.25
T_4-Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha with adjuvant @ 625 ml/ha	4569	5044	39340	96437	57097	2.45
T_5- Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha	4922	5372	39690	103819	64129	2.62
T_6-Bispyribac sodium 2%+ 2,4-D sodium salt 54.3% SP @ (30+814.5) g a.i/ha with adjuvant @ 625 ml/ha	4524	5011	40040	95504	55464	2.39
T_7-Bispyribac sodium 10 % SC @ 20 g a.i/ha	3624	4155	38915	76642	37727	1.97
T_8- 2,4-D Ethyl ester 38% EC @ 850 ga.i/ha	3468	3994	38940	73354	34414	1.88
T_9-Penoxsulam 21.7 % SC @ 22.5 g a.i/ha	3559	4086	39595	75266	35671	1.90
T_{10}- Pendimethalin 38.7 % CS @ 680 g a.i/ha as PE *fb* Bispyribac sodium 10 % SC @ 25 g a.i/ha	4990	5433	41335	105235	63900	2.55
T_{11}- Weed free check (Hand weeding at 15 and 45 DAT)	5415	5783	45315	112030	66715	2.47
T_{12}- Weedy check (Untreated control)	2137	2713	37815	45427	7612	1.20
S.Em±	137	185		2796		0.07
C.D. = (0.05)	403	544		8201		0.21

The maximum net returns under these treatments were due to higher grain and straw yields. Similar findings were also reported by Uma *et al*., (2014).

Bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha recorded significantly higher B:C ratio (2.62) over unwedded control (1.20) and on par with pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb* bispyribac sodium 10% SC @ 25 g a.i/ha (2.55), weed free control (2.47), bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (20+543) g a.i/ha with adjuvant @ 625 ml/ha (2.45). Though some herbicides recorded with higher grain yield and gross returns, the net returns observed was less than that of hand weeding which was due to the high cost of herbicides. These findings are in parallel with the previous results Singh *etal*. (2017).

It was concluded that, hand weeding twice at 15 and 45 DAT recorded significantly higher growth and yield attributing characters, gross returns and net returns as compared to other treatment which was on par with pendimethalin 38.7% CS @ 680 g a.i/ha as PE *fb*bispyribac sodium 10% SC @ 25 g a.i/ha where as significantly higher B:C recorded with bispyribac sodium 2% + 2,4-D sodium salt 54.3% SP @ (25+678.75) g a.i/ha with adjuvant @ 625 ml/ha.

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