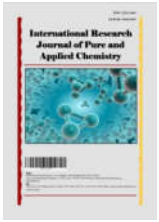

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Effect of Novel Herbicides and Herbicide Mixtures on Yield and Economics of Transplanted Rice

B. Venkatesh[1*], Y. S. Parameswari[2], M. Madhavi[3] and T. Ram Prakash[4]

[1]Department of Agronomy, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana-500 030, India.
[2]Department of Agronomy, College Farm, PJTSAU, Rajendranagar, Hyderabad, Telangana-500 030, India.
[3]Department of Agronomy, AICRP on Weed Management, PJTSAU, Rajendranagar, Hyderabad, Telangana-500 030, India.
[4]Department of Soil Science and Agricultural Chemistry, AICRP on Weed Management, PJTSAU, Rajendranagar, Hyderabad, Telangana-500 030, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author BV designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors YSP and MM managed the analyses of the study. Author TRP managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *kharif,* 2019 at Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The experiment done with twelve treatments and three replications. The study was taken to find out which herbicide mixture most effective in controlling of weeds leads to maximum yields with higher benefit cost ratio. The results revealed that, application of herbicide mixture florpyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g/ha PoE *fb* hand weeding at 40 days after transplanting (DAT) gave higher yields and net returns with high benefit cost ratio (B: C) which was statistically on par with minimum competitive plot. Unweeded plot yield was deviated about 48 % compare to florpyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g/ha PoE *fb* hand weeding at 40 days after transplanting.

**Corresponding author: E-mail: venkateshbathulvenkychinna@gmail.com;*

Keywords: Economics; grain yield; herbicide mixtures; net returns; straw yield; transplanted rice.

1. INTRODUCTION

In India, Rice is generally cultivated by transplanting 25-30 days old seedlings in the puddled field. The advantage of puddling is effective weed control, reduces percolation, improves nutrient availability by creating anaerobic conditions and facilitates easy seedling establishment. Besides these advantages, the main disadvantage is higher requirement of labour to remove heterogeneous type of weed flora Duary et al. [1]. Due to non-availability labour at critical stage of crop-weed competition results in for every one gram of weed biomass increase per square meter yield expected to be reduce by 5.6 kg ha $^{-1}$ Rana et al. [2]. Therefore, timely weed control is important for realise higher productivity. All traditional herbicides were narrow range of weed control. In order to control all types of weed flora we have to concentrate on novel herbicides and herbicide mixtures with multiple modes of action. Novel herbicides nothing but new molecules with variable modes of action. To keep above points in mind the present investigation was carried out.

2. MATERIALS AND METHODS

A field experiment was conducted at College Farm, College of Agriculture Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during *Kharif,*-2019. The farm is geographically situated at 17 ^{0}19' 16.4" North latitude and 78^{0} 24' 43" East longitudes and at an altitude of 542.3 m above mean sea level. According to troll's climatic classification, it falls under semi- arid tropics (SAT). The soil of experimental site was sandy loam in texture with p ^{H} of 7.85, low available nitrogen (235.2), medium phosphorus (38.8) and high potassium content (379). The experiment was consisted of twelve weed management practices laid out in randomized block design with three replications. T_1: penoxsulam 0.97% + butachlor 38.8% SE 820 g ha^{-1} (PE) *fb* hand weeding at 30 DAT, T_2: pyrazosulfuron-ethyl 0.15 % + pretilachlor 6% GR 600g ha^{-1} (PE) *fb* hand weeding at 30 DAT, T_3: orthosulfamuron + pretilachlor 6% GR 600 g ha^{-1} GR (PE) *fb* hand weeding at 30 DAT, T_4: ipfencarbazone 25 % SC 156.25 g ha^{-1} (PE) *fb* hand weeding at 30 DAT, T_5: penoxsulam 2.65 % OD 25 g ha^{-1} (PoE) *fb* hand weeding at 40 DAT, T_6: penoxsulam 1.02 % + cyhalofop butyl 5.1 % OD 150 g ha^{-1} (PoE) *fb* hand weeding at 40 DAT, T_7: pretilachlor 50 % EC 0.75 kg ha^{-1} (PE) *fb* 2,4 D WP 1.0 kg ha^{-1} (PoE), T_8: bispyribac sodium 10 % SC 25 g ha^{-1} (PoE) *fb* hand weeding at 40 DAT, T_9: florpyrauxifen-benzyl + penoxsulam 12% EC 40.64 g ha^{-1} (PoE) *fb* hand weeding at 40 DAT, T_{10}: florpyrauxifen-benzyl + cyhalofop butyl 10 % EC 150 g ha^{-1} (PoE) *fb* hand weeding at 40 DAT, T_{11}: Hand weeding at 20 and 40 DAT and T_{12}: unweeded control. RNR – 15048 (Telangana sona) variety was transplanted in main field on 8 th August at the age of 28 days old seedlings with a spacing of 15 x 10 cm. All pre-emergence herbicides were applied within three days after transplanting and post emergence herbicides treatments were applied at 2 – 3 leaf stage of weeds. During crop growing period (July 10 th to November 17 th) a total rainfall of 693.5 mm received in 45 rainy days. The data on yield was recorded from net plot and gross and net returns were calculated based on existing prices. The data was statistically analysed with help of OP STAT software by feeding three replications data.

3. RESULTS AND DISCUSSION

3.1 Effect on Weed Density and Weed Dry Weight

Lower total weed density and total weed dry weight at 60 DAT, was observed with florpyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g ha $^{-1}$ (PoE) *fb* handweeding at 40 DAT, penoxsulam 1.02% @ 20 g ha $^{-1}$ + cyhalofop butyl 5.1 % OD @ 100 g ha $^{-1}$ (PoE) *fb* hand weeding at 40 DAT and florpyrauxifen-benzyl + penoxsulam 12 % EC @ 40.64 g ha $^{-1}$ (PoE) *fb* hand weeding at 40 DAT, which was statistically comparable to the hand weeding at 20 and 40 DAT. Higher weed density and weed dry weight was recorded with un weeded control over all the treatments. Lower weed density in different weed management practices might be due to effective control of weeds. Hossain and Mondal [3] and Yadav et al. [4].

Table 1. Effect of novel herbicides and herbicide mixtures on weed control

Treatment	Weed density (no./m^2)(60 DAT)			Total weed density (no./m^2) (60 DAT)	Total weed dry weight (g/m^2) (60DAT)
	Grasses	Sedges	BLW		
Penoxsulam 0.97% + butachlor 38.8% SE 820 g/ha PE *fb* HW at 30 DAT	4.2(16.7)	4.5(19.7)	3.2(9.0)	6.8 (45.3)	6.1(35.7)
Pyrazosulfuron-ethyl 0.15% + pretilachlor 6% GR 600 g/ha PE *fb* HW at 30 DAT	3.9(14.3)	4.5(19.0)	3.2(7.0)	6.4 (40.3)	5.7(32.0)
Orthosulfamuron + pretilachlor 6% GR 600 g/ha PE *fb* HW at 30 DAT	4.1(15.7)	4.5(19.3)	3.1(8.0)	6.6 (43.0)	5.9(34.0)
Ipfencarbazone 25% SC 156.25 g/ha PE *fb* HW at 30 DAT	4.1(16.3)	4.8(22.0)	3.6(9.3)	7.0 (47.7)	6.2(37.0)
Penoxsulam 2.65% OD 25 g/ha PoE *fb* HW at 40 DAT	3.1(8.7)	3.3(10.0)	3.0(8.0)	5.3 (26.7)	4.0(15.3)
Penoxsulam 1.02% + cyhalofop-butyl 5.1% OD 150 g/ha (PoE) *fb* HW at 40 DAT	3.2(9.3)	3.3(9.7)	1.7(4.0)	4.9 (23.0)	3.8(13.3)
Pretilachlor 50 % EC 0.75 kg/ha PE *fb* 2,4 D 1.0 kg/ha PoE	6.0(35.3)	6.3(38.3)	2.4(4.7)	8.9 (78.3)	7.7(58.0)
Bispyribac-sodium 10% SC 25 g/ha PoE *fb* HW at 40 DAT	3.6(11.7)	3.0 (8.0)	3.5(8.3)	5.3 (28.7)	4.1(16.7)
Florpyrauxifen-benzyl + penoxsulam 12% EC 40.64 g/ha (PoE) *fb* HW at 40 DAT	3.7(12.7)	2.9(7.7)	2.5(5.3)	5.2 (25.7)	3.9(14.3)
Florpyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g/ha PoE *fb* HW at 40 DAT	3.3(10.3)	3.0(8.3)	2.2(4.0)	4.8 (20.7)	3.7(13.0)
Hand weeding at 20 and 40 DAT	3.2(9.3)	2.8 (7.0)	2.2(4.0)	4.6 (20.3)	3.6(12.0)
Unweeded control	7.8(60.0)	8.3(67.3)	5.3(27.3)	12.5	12.1(144.)
SE(m)±	0.17	0.16	0.24	0.31	0.29
CD (P=0.05)	0.51	0.47	0.70	0.91	0.87

** Values in the parentheses are original and (√x+1) transformed, SE(m): Standard error of mean*
CD: Critical difference

Table 2. Effect of novel herbicides and herbicide mixtures on yield

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Penoxsulam 0.97% + butachlor 38.8% SE 820 g/ha PE *fb* HW at 30 DAT	5931	7004	45.9
Pyrazosulfuron-ethyl 0.15% + pretilachlor 6% GR 600 g/ha PE *fb* HW at 30 DAT	6016	7045	46.1
Orthosulfamuron + pretilachlor 6% GR 600 g/ha PE *fb* HW at 30 DAT	5977	7015	46.0
Ipfencarbazone 25% SC 156.25 g/ha PE *fb* HW at 30 DAT	5524	6471	46.1
Penoxsulam 2.65% OD 25 g/ha PoE *fb* HW at 40 DAT	5497	6425	46.1
Penoxsulam 1.02% + cyhalofop-butyl 5.1% OD 150 g/ha (PoE) *fb* HW at 40 DAT	6985	7818	47.2
Pretilachlor 50 % EC 0.75 kg/ha PE *fb* 2,4 D 1.0 kg/ha PoE	5262	6187	46.0
Bispyribac-sodium 10% SC 25 g/ha PoE *fb* HW at 40 DAT	5333	6282	45.9
Florpyrauxifen-benzyl + penoxsulam 12% EC 40.64 g/ha (PoE) *fb* HW at 40 DAT	6867	7715	47.1
Florpyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g/ha PoE *fb* HW at 40 DAT	7045	7921	47.1
Hand weeding at 20 and 40 DAT	7120	7992	47.1
Unweeded control	3110	4219	42.4
SE(m)±	146.3	171.5	1.43
CD (P=0.05)	429.0	503.0	NS

Table 3 Effect of novel herbicides and herbicide mixtures on economics (₹ ha $^{-1}$)

Treatment	Cost of cultivation	Gross returns	Net returns	B:C ratio
Penoxsulam 0.97 % + butachlor 38.8 % SE 820 g/ha PE *fb* HW at 30 DAT	51640	115838	64197	2.24
Pyrazosulfuron-ethyl 0.15 % + pretilachlor 6 % GR 600 g/ha PE *fb* HW at 30 DAT	50860	117439	66578	2.31
Orthosulfamuron + pretilachlor 6% GR 600 g/ha PE *fb* HW at 30 DAT	50825	116687	65861	2.30
Ipfencarbazone 25 % SC 156.25 g/ha PE *fb* HW at 30 DAT	50840	107837	56996	2.12
Penoxsulam 2.65 % OD 25 g/ha PoE *fb* HW at 40 DAT	50840	107295	56455	2.11
Penoxsulam 1.02% + cyhalofop-butyl 5.1 % OD 150 g/ha (PoE) *fb* HW at 40 DAT	50640	135993	85353	2.69
Pretilachlor 50 % EC 0.75 kg/ha PE *fb* 2,4 D 1.0 kg/ha PoE	51560	102745	51184	1.99
Bispyribac-sodium 10 % SC 25 g/ha PoE *fb* HW at 40 DAT	51790	104149	52358	2.01
Florpyrauxifen-benzyl + penoxsulam 12 % EC 40.64 g/ha (PoE) *fb* HW at 40 DAT	51040	133724	82684	2.62
Florpyrauxifen-benzyl + cyhalofop-butyl 10 % EC 150 g/ha PoE fb HW at 40 DAT	50460	137197	86737	2.72
Hand weeding at 20 and 40 DAT	61540	138644	77104	2.25
Unweeded control	47540	61288	13747	1.29
SE(m)±		2797	1827	
CD (P=0.05)		8257	5393	

**Prevailing market price of grain 18 ₹ kg $^{-1}$ and straw 1 ₹zkg $^{-1}$, SE(m): Standard error of mean*
CD: Critical difference

3.2 Effect on Grain and Straw Yield

Grain and straw yield was significantly influenced by different weed management practices. The data related to grain and straw yield presented in Table 2. Higher grain and straw yield was recorded with florpyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g ha $^{-1}$ (PoE) *fb* handweeding at 40 DAT, penoxsulam 1.02% @ 20 g ha $^{-1}$ + cyhalofop butyl 5.1 % OD @ 100 g ha $^{-1}$ (PoE) *fb* hand weeding at 40 DAT and florpyrauxifen-benzyl + penoxsulam 12 % EC @ 40.64 g ha $^{-1}$ (PoE) *fb* hand weeding at 40 DAT, which were statistically comparable to the hand weeding at 20 and 40 DAT. Higher yields were obtained with herbicide mixtures compared to single herbicides

due to, multiple modes of action resulted in effective control of all types of weeds resulted in higher yields were recorded. Similar type findings were reported by Singh et al. [5] and Ramesha et al. [6].

3.3 Effect on Economics

Ultimate decision of herbicide selection will depend on economics. So, to know the economically viable weed management practice by calculating the gross, net returns and benefit cost ratio. Gross returns were calculated based on minimum support price of grain and straw price. From this net returns were obtained by deducting cost cultivation. And Benefit cost ratio was obtained by dividing net returns with cost of cultivation. Among the different herbicide mixtures higher gross, net returns and B: C ratio was recorded with florpyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g ha $^{-1}$ (PoE) *fb* handweeding at 40 DAT, penoxsulam 1.02% @ 20 g ha $^{-1}$ + cyhalofop butyl 5.1 % OD @ 100 g ha $^{-1}$ (PoE) *fb* hand weeding at 40 DAT. The increased monetary benefits in this treatment was mainly attributed to higher grain yield and reduced labour cost due to effective control of all types of weeds. Similar findings have been also reported by Ramachandra et al. [7] Yadav et al. [8] and Yogananda et al. [9].

4. CONCLUSION

It was concluded that, post-emergence application of flopyrauxifen-benzyl + cyhalofop-butyl 10% EC 150 g ha $^{-1}$ (PoE) *fb* handweeding at 40 DAT, found most effective and economical in controlling the weeds in transplanted rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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