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Effect of Different Pre and Post Emergence Herbicides on Yield and Economics of Direct Sown Rice

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ABSTRACT

A field experiment was conducted for two consecutive years (2015-16 and 2016-17) at Agricultural College Farm, Bapatla to find out the efficacy of different weed control methods on yield and economics of direct-sown rice. Fourteen treatments were tested in randomized block design with three replications. Among all the herbicidal treatments, pre emergence application of bensulfuron methyl @ 60 g a.i. ha^{-1} + pretilachlor with safener @ 500 g a.i. ha^{-1} *fb* post emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS *fb* post emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS (T_9) realized the highest grain yield of 5107 and 5313 kg ha^{-1}, net returns of Rs. 42513 and Rs. 47801 ha^{-1} and return per rupee investment of 1.12 and 1.22 during 2015-16 and 2016-17

Keywords: *Direct sown rice, Yield, net returns, Gross returns and Return per rupee investment*

Rice is cultivated by three principal methods *viz.,* transplanting, dry direct sowing and wet direct sowing. Transplanting a traditional system of rice cultivation is in vogue in many rice growing areas. Un availability of irrigation water for transplanting at right time besides vagaries in monsoon onset resulting in undependable rainfall on one hand and high field labour cost for transplanting operation on the other are a few reasons that encouraged rice farmers to shift from transplanting to direct sowing. The method of direct-sowing avoids the transplanting and puddling operations and is an attractive and sustainable alternative to traditional transplanting of rice. Dry direct sowing of rice offers advantages such as faster and easier planting, reduced labour, earlier crop maturity by 7–10 days and high water use efficiency (Ladha *et al.* 2015) and often higher profit in areas with an assured water supply (Balasubramanian and Hill 2002). However, for cultivation of direct-seeded rice, weeds are a major hurdle as nearly all *kharif* season weeds depending upon seed bank in the field infest this crop. Direct seeding of rice is possible only when there is an adequate weed control method to keep the crop free from weeds traditional method of weed management practices are tedious, time consuming, labour intensive, costly and not possible to practice over an extensive area, due to labour scarcity and high labour input costs. Due to rapid industrialization and urbanization, traditional weed management practices are being impracticable. Herbicide usage for control of weeds in crop lands has been proved successful in many advanced countries and is gaining importance in Indian agriculture as well. Weed management with herbicides is more economical, less time consuming and when advocated at the right time, establishes a weed free environment. Hence, present study was carried out to evaluate the efficacy of different chemical and mechanical weed control methods and its economics in direct sown rice.

MATERIAL AND METHODS

The study was conducted at Agricultural College Farm, Bapatla, Guntur, Andhra Pradesh. The experiment was conducted during *Kharif* 2015 and 2016 and laid out in randomized complete block design with three replications and fourteen treatments as follows.

T_1 Pre-emergence application of pyrazosulfuron ethyl @ 25 g a.i. ha^{-1} *fb* post-emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS

T_2 Pre-emergence application of pyrazosulfuron ethyl @ 25 g a.i. ha^{-1} *fb* Post-emergence application of bispyribac-sodium @ 25 g a.i. ha^{-1} at 25 DAS

T_3 Pre-emergence application of bensulfuron methyl @ 60 g a.i. ha^{-1} + Pretilachlor with safener at 500 g a.i. ha^{-1} *fb* post-emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS

T_4 Pre-emergence application of bensulfuron methyl @ 60 g a.i. ha^{-1} + pretilachlor with safener at 500 g a.i. ha^{-1} *fb* post-emergence application of bispyribac-sodium @ 25 g a.i. ha^{-1} at 25 DAS

T_5 Pre-emergence application of oxadiargyl @ 75 g a.i. ha^{-1} *fb* post-emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS

T_6 Pre-emergence application of oxadiargyl @ 75 g a.i. ha^{-1} *fb* post-emergence application of bispyribac-sodium @ 25 g a.i. ha^{-1} at 25 DAS

T_7 Pre-emergence application of pyrazosulfuron ethyl @ 25 g a.i. ha^{-1} *fb* post-emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS *fb* post-emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS

T_8 Pre-emergence application of pyrazosulfuron ethyl @ 25 g a.i. ha^{-1} *fb* post-emergence application of bispyribac-sodium @ 25 g a.i. ha^{-1} at 25 DAS *fb* post-emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS

T_9 Pre-emergence application of bensulfuron methyl @ 60 g a.i. ha^{-1} + pretilachlor with safener at 500 g a.i. ha^{-1} *fb* post-emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS *fb* post-emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS

T_{10} Pre-emergence application of bensulfuron methyl @ 60 g a.i. ha^{-1} + pretilachlor with safener at 500 g a.i. ha^{-1} *fb* post-emergence application of bispyribac-sodium @ 25 g a.i. ha^{-1} at 25 DAS *fb* post-emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS

T_{11} Pre-emergence application of oxadiargyl @ 75 g a.i. ha^{-1} *fb* post-emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS *fb* post-emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS

T_{12} Pre-emergence application of oxadiargyl @ 75 g a.i. ha^{-1} *fb* post-emergence application of bispyribac-sodium @ 25 g a.i. ha^{-1} at 25 DAS *fb* post-emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS

T_{13} Weed free

T_{14} Weedy check

Rice variety BPT-5204 (Samba Mahsuri) was sown at a row spacing of 25 cm and the crop was raised with recommended package of practices. Pre emergence herbicides (Pyrazosulfuron ethyl and oxadiargyl) were applied uniformly at 3 DAS by using knapsack sprayer mixed in water @ 500 l ha^{-1}. Bensulfuron methyl + pretilachlor with safener applied uniformly at 3 days after sowing (DAS) by mixing the herbicide with dry sand at 50 kg ha^{-1} and broadcasted uniformly under thin film of water. The post-emergence herbicide *i.e.* azimsulfuron, bispyribac-sodium were applied at 25 DAS, and metsulfuron methyl + chlorimuron ethyl was applied at 45 DAS by using knapsack sprayer mixed in water @ 500 l ha^{-1}.

The gross returns from each treatment during both the years of the study was worked out with the then prevailing market prices of rice including rice straw. The net returns from each treatment were arrived at by deducting the cost of cultivation worked out with the then prevailing costs of inputs and labour wages. Return per rupee for all the treatments was worked out on the basis of net returns in terms of rupees after deducting the cost of treatments from gross returns.

Gross returns = Value of the product (Grain + Straw)

Net returns = Gross returns – Total cost of cultivation

$$\text{Return per rupee Rs.} = \frac{\text{Net returns (Rs.)}}{\text{Total operational cost (Rs.)}}$$

The data were analyzed by using standard statistical procedures and comparisons were made at 5% level of significance (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Grain and Straw yield (kg ha^{-1})

Among the herbicidal treatments highest grain (5107 and 5313 kg ha^{-1} during 2015-16 and 2016-17) and straw (5840 and 6828 kg ha^{-1} during 2015-

16 and 2016-17, respectively) yield recorded in plots treated with pre emergence application of bensulfuron methyl + pretilachlor with safener *fb* post emergence application of azimsulfuron *fb* post emergence application of metsulfuron methyl and chlorimuron ethyl applied at 45 DAS (T_9). The increase in grain yield was due to the fact that the weed population and weed growth remained suppressed during crop growth period, resulting in reduced weed competition which ultimately resulted in higher drymatter accumulation and translocation of more assimilates ultimately enhanced the yields of rice. These results are in agreement with the findings of Subhalakshmi and Venkataramana, (2008), Naseeruddin and Subramanyam (2013), Hossain and Mondal (2014), Rammu Lodhi, (2016), and and Ajay Singh *et al.* (2017).

Economics of Rice Cultivation

The adoption of any technology in general and weed management in particular in the modern agriculture can only be feasible and acceptable to farmers if it is economically viable. The practical utility such as weed management measures can be best judged on the basis of its return per rupee investment. The gross returns, net returns and the return per rupee investment were worked out for rice as influenced by sequential application of herbicides on direct sown rice crop by taking into consideration the monetary values of inputs used and the crop produce obtained during both the years of investigation.

Among the weed management practices, the highest gross returns (Rs. 85497 and Rs. 89262 ha^{-1} during 2015-16 and 2016-17, respectively) were realized with the treatment T_{13} (weed free). While, the lowest gross returns (Rs. 35026 and Rs. 42331 ha^{-1}) was observed with weedy check.

Of all treatments, pre emergence application of bensulfuron methyl @ 60 g a.i. ha^{-1} + pretilachlor with safener @ 500 g a.i. ha^{-1} *fb* post emergence application of azimsulfuron @ 20 g a.i. ha^{-1} at 25 DAS *fb* post emergence application of metsulfuron methyl and chlorimuron ethyl @ 4 g a.i. ha^{-1} applied at 45 DAS (T_9) realized the highest net returns of Rs. 42513 and Rs. 47801 ha^{-1} and return per rupee investment of 1.12 and 1.22 during 2015-16 and 2016-17, closely followed by the treatment T_{10}, treatment T_7 and treatment T_{11}.

The highest net returns and return per rupee investment obtained under treatments T_9, T_{10}, T_7 and T_{11} might be due to low production cost and higher grain and straw yield compared to other treatments. Though, weed free (T_{13}) treatment resulted in realizing higher yield compared to other weed management treatments, the net returns and return investment was the lowest. This is mainly because of higher labour cost involved in manual hand weeding, which could not compensate the additional grain yield obtained in weed free (T_{13}) treatment resulting in low returns per rupee invested during both the years of study. Use of herbicides was found to be cheaper and effective in controlling the weeds and reducing the total energy required for rice cultivation as projected in the present investigation also conforms the findings reported by Walia *et al.* (2012), Kumar *et al.* (2014), Hossain and Mondal., (2014), Rammu Lodhi, (2016), Ajay Singh *et al.* (2017) and Jyothi Basu *et al.* (2020).

It can be concluded from the analysis that, the treatment T_9 has shown consistently higher profits with more yield, net returns and return per rupee investment during both the seasons.

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Table 1. Grain yield and straw yield of direct seeded rice as influenced by weed management practices during *kharif* 2015-16 and 2016-17

Treatments	Dose (g ha^{-1})	Time (DAS)	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
			2015	2016	2015	2016
T_1. Pyrazosulfuron ethyl *fb* Azimsulfuron	25 *fb* 20	Pre *fb* Post	3844	3619	4917	4782
T_2. Pyrazosulfuron ethyl *fb* Bispyribac-sodium	25 *fb* 25	Pre *fb* Post	3604	3521	4799	5085
T_3. Bensulfuron methyl + Pretilachlor with safener *fb* Azimsulfuron	60 + 500 *fb* 20	Pre *fb* Post	4118	4203	5017	5623
T_4. Bensulfuron methyl + Pretilachlor with safener *fb* Bispyribac-sodium	60 + 500 *fb* 25	Pre *fb* Post	3674	3923	4766	6045
T_5. Oxadiargyl *fb* Azimsulfuron	75 *fb* 20	Pre *fb* Post	3593	3423	4754	4970
T_6. Oxadiargyl *fb* Bispyribac-sodium	75 *fb* 25	Pre *fb* Post	3302	3261	4500	4861
T_7. Pyrazosulfuron ethyl *fb* Azimsulfuron *fb* Metsulfuron methyl + Chlorimuron ethyl	25 *fb* 20 *fb* 4	Pre *fb* Post *fb* Post	4714	4687	5672	6411
T_8. Pyrazosulfuron ethyl *fb* Bispyribac-sodium *fb* Metsulfuron methyl + Chlorimuron ethyl	25 *fb* 25 *fb* 4	Pre *fb* Post *fb* Post	4599	4661	5479	6585
T_9. Bensulfuron methyl + Pretilachlor with safener *fb* Azimsulfuron *fb* Metsulfuron methyl + Chlorimuron ethyl	60 + 500 *fb* 20 *fb* 4	Pre *fb* Post *fb* Post	5107	5313	5840	6828
T_{10}. Bensulfuron methyl + Pretilachlor with safener *fb* Bispyribac-sodium *fb* Metsulfuron methyl + Chlorimuron ethyl	60 + 500 *fb* 25 *fb* 4	Pre *fb* Post *fb* Post	4828	5014	5774	6706
T_{11}. Oxadiargyl *fb* Azimsulfuron *fb* Metsulfuron methyl + Chlorimuron ethyl	75 *fb* 20 *fb* 4	Pre *fb* Post *fb* Post	4666	4601	5811	6056
T_{12}. Oxadiargyl *fb* Bispyribac-sodium *fb* Metsulfuron methyl + Chlorimuron ethyl	75 *fb* 25 *fb* 4	Pre *fb* Post *fb* Post	4371	4437	5633	6378
T_{13}. Weed free	-	-	5450	5455	5925	6893
T_{14}. Weedy check	-	-	2159	2529	3506	4145
SEm ±	-	-	233	298	239	453
CD (P = 0.05)	-	-	678	865	694	1316

Table 2. Economics of direct seeded rice as influenced by weed management practices during *kharif* 2015-16 and 2016-17

Treatments	Dose (g ha^{-1})	Time (DAS)	2015-16			2016-17		
			Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Return per rupee investment	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Return per rupee investment
$T_{1.}$ Pyrazosulfuron ethyl *fb* Azimsulfuron	25 *fb* 20	Pre *fb* Post	61032	28801	0.89	59423	25841	0.77
$T_{2.}$ Pyrazosulfuron ethyl *fb* Bispyribac-sodium	25 *fb* 25	Pre *fb* Post	57424	24534	0.75	58259	24019	0.70
$T_{3.}$ Bensulfuron methyl + Pretilachlor with safener *fb* Azimsulfuron	60 + 500 *fb* 20	Pre *fb* Post	65133	31036	0.91	69091	33644	0.95
$T_{4.}$ Bensulfuron methyl + Pretilachlor with safener *fb* Bispyribac-sodium	60 + 500 *fb* 25	Pre *fb* Post	58404	23649	0.68	65281	29176	0.81
$T_{5.}$ Oxadiargyl *fb* Azimsulfuron	75 *fb* 20	Pre *fb* Post	57209	24718	0.76	56652	22811	0.67
$T_{6.}$ Oxadiargyl *fb* Bispyribac-sodium	75 *fb* 25	Pre *fb* Post	52705	19556	0.59	54098	19599	0.57
$T_{7.}$ Pyrazosulfuron ethyl *fb* Azimsulfuron *fb* Metsulfuron methyl + Chlorimuron ethyl	25 *fb* 20 *fb* 4	Pre *fb* Post *fb* Post	74491	38460	1.07	77192	39810	1.06
$T_{8.}$ Pyrazosulfuron ethyl *fb* Bispyribac-sodium *fb* Metsulfuron methyl + Chlorimuron ethyl	25 *fb* 25 *fb* 4	Pre *fb* Post *fb* Post	72617	35927	0.98	76973	38933	1.02
$T_{9.}$ Bensulfuron methyl + Pretilachlor with safener *fb* Azimsulfuron *fb* Metsulfuron methyl + Chlorimuron ethyl	60 + 500 *fb* 20 *fb* 4	Pre *fb* Post *fb* Post	80409	42513	1.12	87048	47801	1.22
$T_{10.}$ Bensulfuron methyl + Pretilachlor with safener *fb* Bispyribac-sodium *fb* Metsulfuron methyl + Chlorimuron ethyl	60 + 500 *fb* 25 *fb* 4	Pre *fb* Post *fb* Post	76270	37715	0.98	82413	42508	1.07
$T_{11.}$ Oxadiargyl *fb* Azimsulfuron *fb* Metsulfuron methyl + Chlorimuron ethyl	75 *fb* 20 *fb* 4	Pre *fb* Post *fb* Post	73935	37645	1.04	75536	37896	1.01
$T_{12.}$ Oxadiargyl *fb* Bispyribac-sodium *fb* Metsulfuron methyl + Chlorimuron ethyl	75 *fb* 25 *fb* 4	Pre *fb* Post *fb* Post	69454	32505	0.88	73372	35073	0.92
$T_{13.}$ Weed free	-	-	85497	37517	0.78	89262	39932	0.81
$T_{14.}$ Weedy check	-	-	35026	5046	0.17	42331	11001	0.35

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