RESEARCH ARTICLE

ECONOMIC ANALYSIS OF WEED CONTROL IN RICE CROP [*ORYZA SATIVA* L.]

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Abstract: Rice (*Oryza sativa* L.) is a plant belongs to the family of Gramineae (Poaceae) is one of the predominated food crop of the world. Data on weeds (viz., flora, density and dry weight), data on growth parameters, yield attributes (effective tiller/hill, length of panicle/hill, grains/panicle, filled grains/panicle, chaffy grains/panicle, test weight. were taken. Finally, LAI, CGR, RGR, NAR, grain yield, Straw yield, WI, WCE, HI and economic viability of the treatments was also determined in terms of cost of cultivation, GMRs, NMRs and B: C ratio on/hectare basis. Data pertaining to various parameters were tabulated and subjected to statistical analysis for interpretation of results. The results thus obtained are summarized as under. The B:C ratio were the highest under BIL007 (pyribenzoxim) at 35 g/ha closely followed by BIL007 (pyribenzoxim) at 30 g/ha as post emergence to rice.

Keyword: B.C. Ratio, Economic, Gross monetary returns, Net monetary returns, Rice

INTRODUCTION

Control of weeds by herbicides is although quite effective but needs proper skill and fidelity. Generally pre emergence herbicides like pretachlor, butachlor, anilophos and post emergence herbicides like 2,4-D, and Almix are used frequently to control grassy and broad leaf weed in transplanted rice. Continuous application of the herbicides may also results weed flora shift and development of herbicide resistance in weeds. Hence, there is a need to develop appropriate weed management practices through the new and alternate herbicides to overcome the problem of herbicidal resistance in weeds.

Rice is an important staple food crop of India and grown on nearly 43.95 million hectare with the production of 106.54 million tones triggering productivity of 2424 kg ha^{-1}. In Madhya Pradesh, rice covers 1.93 million ha area, with an annual production 2.78 million tones but average productivity is quite low (1438 kg ha^{-1}) as compared to national productivity of rice (2424 kg ha^{-1}) (Anonymous, 2015).

Weed is as old as agriculture, and from the very beginning farmers realized the interference of weed with crop productivity, which led to the co-evolution of agro ecosystems and weed management (Ghersa *et al*., 2004). The risk of yield loss from weeds in direct-seeded rice is greater than transplanted rice (Rao *et al*., 2007).

Review of Literature

Economics

From Hyderabad, Rekha *et al*. (2002) reported lower weed density and dry weight under hand weeding twice (20 and 40 DAS) compared to that of herbicidal treatment and weedy plots. Similarly, Singh et al. (2002) noticed that hand weeding at 20 and 40 DAS resulted in the lowest weed dry matter (78.3 g m-2), highest weed control efficiency (78.3%), grain yield (30.1 q ha-1), straw yield (42.4 q ha-1) and gross income (Rs 15,050 ha-1) in direct seeded rice.

Singh et al. (2004) reported that *Echinochloa colona, Echinochloa crusgalli* and *schaemum rugosum* were effectively controlled by fenoxaprop at 56.25 g ha". Application of fenoxaprop at 56.25 g ha 10 days after rice transplanting also produced significantly more grain yield than application done at 20 days after transplanting.

Subramanyam *et al.* (2007) observed that oxadiargyl 75 g ha-1 supplimented with hand weeding at 40 DAT recorded less weed dry weight (3.83 g m-2) and higher grain yield over herbicide application alone and on a par with hand weeding twice (20 and 40 DAT).

Walia *et al.* (2012) found that pre-emergence application of pendimethalin 0.75 kg ha^{-1} or oxadiargyl 0.90 g ha^{-1} with post-emergence application of bispyribac 25 $kgha^{-1}$, azimsulfuron 20 g ha^{-1} and 2,4-D 0.5 kg ha^{-1} resulted in significant reduction in dry matter of weeds and increased grain yield.

Sah *et al.* (2012) a field experiment was conducted during *Kharif* 2005 & 2006 at Zonal Research Station, Chianki, Palamau (Jharkhand), to evaluate the hand weeding twice (20&40) are give more dry matter accumulation and increasing weed control efficiency & 80.1% increase in grain yield, net returns (Rs. 18070 ha^{-1}) and benefit: cost ratio (1.99) was recorded in two hand-weeding respectively over weedy check. Two hands weeding although significantly reduced weed density & their biomass and increased the grain yield, owing to higher labour cost reduced the benefit: cost ratio.

Jacob *et al.* (2014) conducted field experiment during rabi season in a farmer's field in the Kole lands at Pullu in Thrissur district during the period

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November 2012 to March 2013. The treatments included application of post emergence herbicides. The herbicides cyhalofop butyl, fenoxaprop- p-ethyl, metamifop, penoxsulam, bispyribac sodium and azimsulfuron, are post emergence in action and were sprayed at 20 DAS. Hand weeded (hand weeding at 20 and 40 DAS) and unweeded controls were also included for comparison with the herbicide treatments. The best herbicide for control of grassy weeds was fenoxaprop-p-ethyl @ 60 g a.i. ha-1 applied at 20 DAS. Broad spectrum weed control can be made possible by spraying herbicide combinations that could give higher yield and B:C ratio.

MATERIALS AND METHODS

The present investigation entitled "Evaluation of weed control spectrum of BIL007 (pyribenzoxim) in transplanted rice". was conducted during *kharif* 2016 under edaphic and climatic conditions of Jabalpur (M.P.). The material used and methodology adopted during the course of investigation are presented in this chapter under the appropriate heads.

Experimental site

The experiment was conducted at the: Krishi Nagar Research Farm, Department of Agronomy, JNKVV, Jabalpur during *kharif* season 2016. The topography of experimental field was fairly uniform. The field selected for experimentation was uniformly infested with localized specific weeds.

Climate and Weather Conditions

Jabalpur is situated at $23^0$09' North latitude and $79^0$58' East longitude with an altitude of 411.78 metre above the mean sea level. The climate of locality is characterized as typically semi humid and tropical, which is featured by hot dry summer and cool dry winter. It is classified as "Kymore Plateau and Satpura Hills'' agro-climatic zone, as per norms of National Agriculture Research Programme. According to National Bureau of soil survey and land use planning (NBSS & LUP), Nagpur, this area belongs to agro ecological region number 10, named as Central High Land (Malwa and Bundelkhand) sub region named as hot sub-humid (dry) eco-region (Malwa plateau, Vindhayanchal Scarp land and Narmada Valley).

The annual average rainfall of Jabalpur is 1350 mm, mostly received between mid-June to end of September with a little and occasional rains in remaining parts of the year. The mean monthly temperature goes down to the extent of 4 ^{0}C during winter, while the maximum temperature reaches as high as 45 ^{0}C during the summer. Generally, relative humidity remains very low during summer (15 to 30%), moderate during winter (60 to 75%) and attains higher values (80 to 95%) during rainy season.

Meteorological Data

Table 1. Weekly meteorological parameters during crop season (*Kharif* 2016)

Months	Metrological Weeks	Temperature (^{o}C)		Relative humidity (%)		Sunshine (hrs/Day)	Rainfall (mm)	No.of rainy days
		Max.	Min.	Mor.	Eve.			
June	26.0	35.8	24.9	87.0	55.0	6.6	66.6	03
July	27.0	29.5	23.1	94.0	81.0	2.6	37.3	07
	28.0	31.1	24.5	93.0	79.0	3.0	83.6	05
	29.0	30.4	24.0	91.0	69.0	3.9	63.6	03
	30.0	31.7	24.0	91.0	67.0	4.7	61.8	03
	31.0	31.0	23.3	91.0	77.0	2.9	196.4	05
Aug	32.0	28.6	23.6	93.0	82.0	1.3	132.8	04
	33.0	27.0	23.0	93.0	91.0	0.0	182.9	07
	34.0	28.8	22.1	90.0	76.0	6.1	263.2	06
	35.0	32.2	23.7	90.0	70.0	6.1	35.2	04
Sept	36.0	30.6	23.0	87.0	63.0	4.5	17.6	02
	37.0	31.7	23.6	89.0	65.0	1.9	18.0	01
	38.0	33.0	23.9	92.0	64.0	6.7	3.8	00
	39.0	29.9	23.5	94.0	83.0	4.6	52.4	03

Oct	40.0	31.9	23.9	93.0	64.0	7.3	24.2	02
	41.0	31.5	21.3	88.0	51.0	8.0	0.0	00
	42.0	31.5	15.4	91.0	32.0	9.3	0.0	00
	43.0	31.7	15.6	82.0	29.0	8.8	0.0	00
	44.0	29.7	12.3	87.0	34.0	8.7	0.0	00
Nov	45.0	29.7	10.6	91.0	24.0	8.1	0.0	00
	46.0	28.3	8.1	88.0	24.0	8.1	0.0	00
	47.0	28.8	8.4	87.0	23.0	8.3	0.0	00
	48.0	28.8	8.7	89.0	27.0	8.7	0.0	00
Total	–	–	–	–	–	–	**1239.4**	**55**

Source: Deptt. of Physics and Agro-meteorology, College of Agricultural Engineering, J.N.K.V.V., Jabalpur (M.P.).

The meteorological data are presented in Table 3.1 and Fig. 1 which was obtained from Department of Physics and Agro-meteorology, College of Agricultural Engineering, J.N.K.V.V., Jabalpur (M.P.). It consists of rainfall, rainy days, relative humidity (morning and evening), maximum and minimum temperature, wind velocity and sunshine hours occurred during the cropping season.

Weather Conditions during Crop Season

Seasonal variations prevailing during the growth period play an important role not only in the growth and development of the crop, but also in the intensity of weeds which ultimately influence the final yield of crop. The weekly meteorological data during crop season were recorded at Meteorological Observatory, College of Agriculture Engineering, Jabalpur.

It is evident from the data that weather conditions were favorable for the growth and development of the rice crop. The monsoon commenced in the first week of June and terminated in the last week of October and mostly concentrated during the period from (July to September). The total rainfall received during the crop season was 1239.45 mm, which was received in 55 rainy days from June to last week of October. During crop season, minimum and maximum temperatures observed was 8.1 ^{0}C and 35.8 ^{0}C. During this period, the average relative humidity was 82 to 94 percent in the morning and 23 to 91 percent in evening. Sunshine hours ranged from 0.0 to 9.3 hours per day.

Soil

Prior to start of the experiment representative soil samples were drawn from 0-15 cm depth with the help of soil auger to know the textural class and inherent fertility status of the experimental field. These soil samples were then thoroughly mixed to get the composite sample. Requisite quantity of the soil from the composite samples was dried in sun and grinded with the help of mortar and pestle. Then these samples were subjected to analysis for physico-chemical properties of the soil as per standard methods adopted in the laboratory of Department of Agronomy, College of Agriculture, JNKVV, Jabalpur.

Experimental details

Location : Krishi Nagar Research Farm Departant of Agronomy, JNKVV, Jabalpur (M.P.)

Economics

The cost of production involved in each treatment was determined on the basis of per hectare area. Existing market price of inputs used and outputs obtained were taken into account. The details are given in Appendix I. The net return per hectare was calculated by subtracting the cost of cultivation from the gross monetary returns (value of grain + straw) under a particular treatment while the benefit-cost ratio (profitability) under each treatment was computed as under

$$\text{Benefit: cost ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

RESULTS

Economic Analysis of the Treatments

The economic analysis of weed control treatments were determined on per hectare area basis, which includes cost of cultivation, gross monetary returns, net monetary returns and benefit cost ratio (profit over per rupee investment) under treatments imposed.

Cost of cultivation

Cost of cultivation was determined treatment wise on the basis of present market price of various common and variable agro-inputs used (Appendix-I). The values thus obtained are given in Table 4.7 and graphically depicted through Fig. 4.7. Data indicates that weedy check plots had the lowest cost of cultivation (Rs 32385 ha^{-1}), which increased in the range of Rs 33535 to Rs 34585 ha^{-1} with the increase

in dose of BIL 007@ 25, 30, 35, 40, 45 and 60 g a.i. ha^{-1} as post-emergence. Whereas, hand weeding twice (15 and 35 DAT) had the highest cost of cultivation (Rs 44385)

Gross monetary returns

The value of economic produce (grain and straw) as per the existing market rates was taken into consideration for determining the gross monetary returns (GMR) under a particular treatment. The GMR was minimum (Rs 42525 ha-1) in weedy check plot which increased under all the plots receiving weed control treatments Table 4.7 and Fig. 4.7. The plots receiving two hand weeding fetched the higher GMR (Rs 95331 ha^{-1}) followed by BIL 007 @ 35 g a.i. ha^{-1} (Rs 83149 ha^{-1}) and BIL 007 @ 30 g a.i.ha^{-1} (Rs 76126 ha^{-1}).

Net monetary returns

The net monetary return (NMR) under each treatment was determined by subtracting the cost of cultivation from GMR of the particular treatment. The treatment wise values, thus obtained, are presented in Table 4.4.7 and Fig. 4.7. It is obvious from the data that NMR was (10140) ha^{-1} when crop was not weeded during crop season. However, it was increased with adoption of weed control treatments. The NMR was maximum (Rs 50946 ha^{-1}) under hand weeding twice followed by BIL 007 @ 35 g a.i. ha^{-1} (Rs 49314 ha^{-1}) suggesting that weed control with BIL 007 @ 35 g a.i. ha^{-1} was more profitable than hand weeding twice which required the highest investment on weeding i.e. Rs 10550 ha^{-1} more than BIL 007 @ 35 g a.i. $ha^{-1.}$

Benefit-cost ratio

It refers to net monetary gain under a particular treatment with each rupee of investment. The benefit-cost ratio as affected by different treatments is given in Table 4.11. It is evident from the data that B:C ratio was maximum under BIL 007 @35 g a.i. ha^{-1} (2.46) followed by equally BIL 007@ 30 g a.i. ha^{-1} (2.26) and hand weeding twice at 15 and 35 DAT (2.15). However, the benefit per rupee of investment was comparatively less when lower dose BIL 007 @ 25 g a.i. ha-1 (2.87) and higher(double) dosage of BIL007@ 60 g a.i.ha^{-1} (1.47) and check herbicide Oxadiargyl @ 100 g a.i. ha^{-1} (2.19 %) and Fenoxaprop-p-ethyal @ 56.95 g a.i. ha^{-1} (1.66 %).

Table 2. Economic analysis of different weed control treatments

T.No.	Treatment	Dose (g a.i./ha)	Cost of cultivation (Rs ha^{-1})	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	B:C Ratio
T_1	Bill007	25	33535	50519	16984	1.51
T_2	Bill007	30	33685	76126	42441	2.26
T_3	Bill007	35	33835	83149	49314	2.46
T_4	Bill007	40	33985	70349	36364	2.07
T_5	Bill007	45	34135	61929	27794	1.81
T_6	Bill007	60	34585	50748	16163	1.47
T_7	Fenoxaprop p-ethyal	56.95	33848	56220	22372	1.66
T_8	Oxadiargyl	100	33785	74114	40329	2.19
T_9	Hand Weeding	15 & 35 DAT	44385	95331	50946	2.15
T_{10}	Weedy check	-	32385	42525	10140	1.31

DISCUSSION

Economic viability of treatments

Economic evaluation of the treatments is also important to know the practical utility of a treatment to the farmers. The cost of cultivation was maximum under hand weeding twice owing to an additional expenditure of Rs 12000 ha^{-1} on weeding. This in general is not feasible to farmers due to high investment and also unavailability of adequate laborers at peak period of demand. The different doses of BIL 007 (Pyribenzoxim) required lesser investment as compared to hand weeding twice.

Gross Monetary Returns (GMR)

The values of Gross monetary returns were minimum (Rs 42525 ha^{-1}) in weedy check plot and maximum (Rs 95331 ha^{-1}) under hand weeding twice. It was noticed that application of BIL 007 (Pyribenzoxim) @ (35) g a.i. ha^{-1} could not compensate the GMR as obtained with hand weeding twice but the later treatment (i.e. hand weeding twice) had the higher investment. These variations were due to differences in economical yield (grain and straw) under the treatments.

Net Monetary Returns (NMR)

The net monetary returns (NMR) was also minimum (Rs 10140 ha^{-1}) under weedy check, which increased to the range of Rs 16984 to 49314 ha^{-1} under those treatments where weeds were controlled by herbicides. The NMR under BIL 007 (Pyribenzoxim)@(35) g a.i. ha^{-1} was Rs 49314 ha^{-1}, which was followed by BIL 007 (Pyribenzoxim)@ (30) g a.i. ha^{-1} Rs 42441 ha^{-1}. It is noteworthy that although the hand weeding fetched the highest GMR and the NMR (Rs 50946 ha^{-1}), because of higher grain yield Similar results were also reported by Sah et al. (2012)

Benefit-cost ratio

It represents the profitability or monetary gain under a particular treatment with each rupee of investment. The ratio was minimal (1.31 under weedy check plots. It being the higher (2.46) when BIL 007 (Pyribenzoxim)@(35) g a.i. ha^{-1} fallowed by BIL 007 (Pyribenzoxim)@(30) g a.i. ha^{-1}due to proportionate increase in economical yield because of effective control of weeds. But B:C ratio under hand weeding twice was less thanBIL 007 (Pyribenzoxim)@(35) g a.i. ha^{-1} because of high cost of cultivation under hand weeding. Similar results were also reported by Jacob et al (2014) and Sah et al (2012).

SUMMARY, CONCLUSION AND SUGGESTION FOR FURTHER WORK

Economic viability of treatments

BIL 007 (Pyribenzoxim) @ (35) g a.i. ha^{-1} was the economically viable treatment among all the weed control treatments. The cost of cultivation was maximum under hand weeding twice owing to an additional expenditure of Rs 12000 ha^{-1} on weeding, showing that control of weeds through hand weeding was more expensive than the use of herbicide in rice crop. Although the gross monetary returns and net monetary returns was maximum in hand weeding twice among all the treatments. Whereas, the B:C ratio were maximum under BIL 007 (Pyribenzoxim) @ (35) g a.i. ha^{-1} as post-emergence to rice followed by BIL 007 (Pyribenzoxim) @ (30) g a.i. ha^{-1}.

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