Journal of Crop and Weed, 12(1):120-124(2016)

Effect of oxadiargyl on weed density, yield and economics in dry seeded rice through front line demonstration

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Received: 28-08-2015, Revised: 08-06-2016, Accepted: 12-06-2016

ABSTRACT

Pre-emergence application of oxadiargyl @ 90 g a.i. ha^{-1} at 2 DAS followed by one hand weeding at 30 DAS recorded higher grain yield (27.36 q ha^{-1}) and effective tillers plant^{-1} (6.67) than farmers practices of one hand weeding with harvest index (43.71 %) over the years of study. The same technology also recorded higher gross return of Rs. 31975.27 ha^{-1} with a benefit cost ratio of 1.64 and additional net return of Rs. 2630.59 ha^{-1} as compared to local check. The improved technology with extension gap 2.95 q ha^{-1} was expanded to 45 hectares and adopted by 125 farmers in 80 villages. Hence, the existing farmers' practices can be replaced by application of pre-emergence application of oxadiagryl @ 90 g a.i. ha^{-1} followed by one hand weeding which was more effective, economic for weed management with higher productivity and income.

Keywords: Dry seeded rice, extension gap, frontline demonstration, hand weeding, oxadiargyl

Rice (*Oryza sativa* L.) is the predominant crop of Odisha with a total coverage of 4.0 million hectare which is about 65% of the total cultivable area of the state. Area under rice crop in Angul district is 0.08 million hectare with a productivity of 9.89 q ha^{-1} which is 48.8 % less than that of state production (Anon., 2012). Weeds rank second to moisture stress in reducing upland rice grain yield and quality (Sankaran and De Dutta, 1985). Weeds do not only compete with rice but also hinder quality (Moody, 1989). Heavy infestation of weeds is one of the major constrains to successful cultivation of direct seeded rice. The yield loss due to weeds is as high as 40-100 per cent under such situation (Choubey *et al*., 2001). Aerobic soil conditions and dry tillage practices in upland rice, besides alternate wetting and drying make the conditions condusive for germination and growth of highly competetive grassess, sedges followed by certain broad leaved weed species which cause a grain yield loss of 50-91% (Paradhakar *et al*., 1997).

Manual weeding is expensive, laborious and time consuming and is very difficult in early stage of crop growth. Application of pre-emergence herbicides has been found effective in early stage, but second flush of weeds after 25-30 DAS becomes problematic. Hence, integrated weed management practices are the only alternative (Mishra *et al*., 2009). Cultivation practices comprised under FLD showed increase in yield of rice from 17.34 % to 53.52% over local check. Technology gap was lowest (555 kg ha^{-1}) and highest (1900 kg ha^{-1}) in summer season. The extension gap in Karjat-3 and Sahyadri hybrid was higher as compared to technology gap (Mandavkar *et al*., 2012). By conduction of front line demonstrations on farmer's field there was significant increase in knowledge level of the farmers and majority of farmer's showed high level of satisfaction about demonstrated technologies (Raj *et al.*, 2014).

The available technology should reach the farmers, the ultimate users through KVK activities and adoption of the technology by the farmers will reflect the feasibility of the technology (Mazumder *et al*., 2012). Keeping in view such problems and after detailed survey the KVK, Angul made an attempt with an objective to study the effect of pre-emergence herbicide (oxadiagryl) on weed dynamics, yield and economics in dry seeded rice through front line demonstration (FLD).

MATERIALS AND METHODS

The study was carried out through front line demonstration during *kharif* 2010, 2011 and 2012 in the Baragaunia village of Angul district in Odisha. The soil of the study area was sandy loam in texture with slightly acidic in reaction (pH-5.1-5.9), medium organic carbon content (0.43-0.61 %), medium in available nitrogen (282-315 kg ha^{-1}), low in phosphorus (9.5-11.2 kg ha^{-1}) and medium in potassium (142-188.2 kg ha^{-1}) content. Forty five different farmers each having 0.20 hectare of land cultivated the HYV rice cv. Khandagiri adopting recommended package of practices over the years. They were supplied with pre-emergence herbicide

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oxadiargyl 80% WP (Top Star) for application at 2 DAS. Besides farmers' practice 1 hand weeding (HW) at 30 DAS was given as a local check. A weedy check plot was selected for comparison of weed control efficiency. The rice crop was sown during 3rd week of June and harvested during 4th week of September over the years. The required quantities of herbicide were applied with manually operated knapsack sprayer using a spray volume of 500 litres water per hectare. Weed counts per m^{-2} was sampled randomly at ten places using $1m^2$ quadrates at 60 DAS and weed dry weight per m^{-2} were recorded.

The weed control efficiency was worked out through following formula:

$$WCE = [(DWC - DWT) / DWC] \times 100$$

Where; DWC = Dry weight of weeds under control plot, DWT = Dry weight of weeds under treated plot.

Observations on different yield parameters were taken and economic analysis was done by calculating cost of cultivation, gross return, net return and B:C ratio. Final crop yield (grain & straw) were recorded and the gross return were calculated on the basis of prevailing market price of the produce. Harvest index is the relationship between economic yield and biological yield (Gardner *et al.,* 1985).

It was calculated by using the following formula:

$$\textbf{Harvest index (\%)} = \frac{\textbf{Economic yield}}{\textbf{Biological yield}} \times \textbf{100}$$

For the introduction of the technology, different extension approaches through regular field visit & interpersonal communication were made by the scientists of Krishi Vigyan Kendra, Angul. Trainings on farmers and farm women were conducted for the awareness among the farmers and field days were celebrated for the horizontal spread of technology. Also leaflets and pamphlet on integrated weed management in upland paddy were distributed among the farmers in the villages. Further study on extension gap was calculated by the formula as suggested by Sharma *et al*. (2004).

Extension gap = Demonstration yield-Farmers' yield

Tabular analysis involving simple statistical tools like mean was done by standard formula to analyze the data and draw conclusions and implications.

Pre-emergence application of oxadiagryl @ 90 g *a.i.* ha^{-1} at 0-3 DAS followed by one hand weeding at 30 DAS effectively controls weeds in dry seeded rice. Keeping this in view the technology has been recommended for weed control in district.

RESULTS AND DISCUSSION

The floristic composition of the study area was dominated with grasses i.e. *Panicum repens, Cynodon dactylon* and broad leaved weeds *i.e* Commelina *bengahalensis*, *Ageratum conyzoides* and sedge, *Cyperus rotundus* over the years. At 60 DAS, grasses, broadleaved and sedges on an average constituted 36.7, 54.0 and 9.3% of total weed population respectively (Table 1). The front line demonstration at 60 DAS recorded the population of grassy weeds (25.34 to 118.59 m^{-2}), broad leaved weed (36.70 to 169.78 m^{-2}) and sedges (6.34 - 29.75 m^{-2}). However, at 60 DAS oxadiargyl @ 90 g *a.i.* ha^{-1} at 2 DAS followed by one hand weeding at 30 DAS recorded the minimum weed density (68.38 m^{-2}). This was due to application of herbicides which might have prevented the germination of susceptible weed species and also reduced the growth of germinated weeds by inhibiting the process of photosynthesis (Muzik, 1970). Weedy check recorded the maximum weed density (318.12 m^{-2}) at 60 DAS followed by farmers' practices of one hand weeding (95.12).

The dry weed biomass at 60 DAS in weedy check was maximum (295.68 g m^{-2}) which was higher than farmers' practices and improved technology because of higher weed intensity and its dominance in utilizing the sunlight, nutrients, moisture etc. The lowest dry weed biomass (Table 2) was found in oxadiagryl @ 90 g *a.i.* ha^{-1} at 2 DAS with one hand weeding at 30 DAS (81.43 g m^{-2}) where as farmers practice recorded the dry weed biomass (105.72 g m^{-2}). That might be due to effective control of weeds during early stages of crop growth by herbicides and in later stages removal of both intra and inters row weeds by hand weeding. This observation is in agreement with the findings of Singh *et al.* (1992).

The weed control efficiency (WCE) at 60 DAS was higher with oxadiagryl @ 90g *a.i.* ha^{-1} at 2 DAS followed by one hand weeding at 30 DAS (72.46 %) and lower with farmers' practice of one hand weeding (64.25 %). This might be due to effect of weed during initial stages of crop growth with herbicide application. Similar findings were reported by Hasanuzzaman *et al*. (2007).

The improved technology of application of oxadiargyl @ 90 g *a.i.* ha^{-1} at 2 DAS followed by one hand weeding recorded grain yield 27.36 q ha^{-1} which is 12.08 % higher as compared to the farmers' practices of one hand weeding (Table 3) . This might be due to the production of higher number of effective tillers $plant^{-1}$

(6.67) due to effective control of weeds in early stage which was in conformity with Bajpai and Singh (1992). The improved practices also produced the higher straw yield (35.23 q ha^{-1}) with harvest index (43.71 %) as compared to local check (Raju *et al*., 2002). Thus the FLD might have a positive impact on farming community in the district over local check.

The front line demonstration recorded the mean extension gap over the years of study 2.95 q ha^{-1} with maximum (3.21 q ha^{-1}) during 2010 and lowest (2.72 q ha^{-1}) during 2011 (Table 3). More and more use of latest production technologies will subsequently change this alarming trend of galloping extension gap. The new improved technologies will eventually lead to the farmers to discontinue the traditional practice and to adopt new technology. Similar results were reported by Sharma *et al*. (2011). Extension gap reflected that there is a need to educate farmers for adoption of improved technology to reverse the trend. Wider adoption of a technology may reduce the extension gap (Mitra *et al*., 2014).

The improved practice of pre- emergence application of oxadiargyl @ 90 g *a.i.* ha^{-1} at 2 DAS with one hand weeding at 30 DAS recorded the higher gross return of Rs. 31975.27 ha^{-1} with additional net return of Rs. 2630.59 ha^{-1} over farmers practice (Table 4).

Table 1: Effect of front line demonstration on weed composition m^{-2} at 60 DAS (Pooled)

Weed species	Improved practices	Local check	Control
Grasses			
Cynodon dactylon	6.73	10.73	29.75
Panicum repens	10.03	17.11	49.31
Digitaria ciliaris	4.49	0.00	19.16
Saccharum officinarum	4.09	4.64	20.37
Total monocot	**25.34**	**32.48**	**118.59**
Broad leaved weed			
Ageratum conyzoides	12.14	20.01	58.69
Commelina bengahalensis	15.97	21.46	68.88
Amarantus spinosus	8.58	11.89	42.08
Total dicot	**36.70**	**53.36**	**169.78**
Sedge			
Cyperus rotundus	6.34	9.28	29.75
Grand total	**68.38**	**95.12**	**318.12**

Table 2: Effect of FLD on weed density, dry weed biomass and weed control efficiency (pooled)

Frontline demonstration	Weed density m^{-2} at 60 DAS			Dryweed biomass at 60 DAS ($g\ m^{-2}$)	Weed control efficiency at 60 DAS (%)
	M	D	S		
Oxadiargyl @ 90 g *a.i.* ha^{-1} at 2 DAS followed by 1 HW	25.34	36.70	6.34	81.43	72.46
1 HWat 30 DAS	32.48	53.36	9.28	105.72	64.25
Weedy check	118.69	169.78	29.75	295.68	

Note: M=monocot, D= dicot, S=sedges, DAS=days after sowing

Highest B:C ratio (1.64) was found in improved technology due to higher net return as compared to local check (1.52) owing to higher yield due to weed control by herbicide in the early growth stage. These results are similar with the findings of Ram *et al.* (2004).

For weed management in dry seeded upland rice, different extension approaches were made and interested farmers were supplied with herbicide by Krishi Vigyan Kendra, Angul. During *kharif*'2011, the area under weed management with herbicides oxadiargyl followed by hand weeding expanded horizontally to 13 hectares from a mere 3.0 hectares during first year of introduction and during *kharif*' 2012 it was expands to 45 hectares and adopted by 125 farmers in 80 villages (Table 5).

Table 3: Effect of FLD on tillers plant^{-1}, grain and straw yield, harvest index and extension gap

Year	No. of effective tillers plant^{-1}		Grain Yield (q ha^{-1})		% increase in grain	Straw Yield(q ha^{-1}) gap		Harvest index		Extension
	Improved technology	Local check	Improved technology	Local check	Yield over local check	Improved technology	Local check	Improved technology	Local check	(q ha^{-1})
2010	8	6	30.46	27.25	11.78	33.38	35.26	44.25	43.59	3.21
2011	7	5	27.85	25.13	10.82	35.93	33.67	43.67	42.74	2.72
2012	5	3	23.78	20.86	14.0	31.39	32.45	43.10	39.13	2.92
Mean	**6.67**	**4.66**	**27.36**	**24.41**	**12.08**	**35.23**	**33.79**	**43.71**	**41.94**	**2.95**

Table 4: Effect of FLD cost of cultivation, gross return, net return and B:C ratio (pooled)

Year	Cost of cultivation (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	Improved technology	Local check	Improved technology	Local check	Improved technology	Local check	Improved technology	Local check
2010	18670.25	18170.45	32129.00	29013.00	13458.75	10842.55	1.72	1.60
2011	19520.46	18920.26	31874.50	28823.9	12354.04	9903.64	1.63	1.52
2012	20480.78	19730.15	31922.30	28346.50	11441.52	8616.35	1.56	1.44
Mean	**19557.16**	**18940.29**	**31975.27**	**28727.80**	**12418.10**	**9787.51**	**1.64**	**1.52**

**Sale price of paddy seed Rs.1000, Rs. 1080, Rs.1250 q^{-1}and paddy straw Rs.100q^{-1} for the year 2010, 2011 and 2012*

Table 5: Effect of front line demonstration on transfer of technology

Year	Area (ha)	No of Farmers	Horizontal spread of technology			% adoption of technology
			No of villages adopted	No of farmers adopted	Area (ha)	
2010	3.0	15	-	-	-	-
2011	3.0	15	25	80	13	0.3
2012	3.0	15	80	125	45	0.5
Mean	**-**	**-**	**105**	**205**	**58**	**0.4**

Heavy infestation of weeds during the early stage of the crops, delayed sowing due to irregular onset of monsoon and non availability of quality seed of suitable variety cause yield reduction in rice. Nonjudicious application of fertilizers and hand weeding by the farmers also cause the lower yield in rice. Small and marginal farmers are resource poor having less risk bearing ability and do not dare to invest in the costly input which is an obstacle in adoption of proven technology. Traditional implements and tools of poor working efficiency are still in practice due to small holding. The lack of modern implements and tools like knapsack sprayer for small holding also a hindrance to the adoption of improved technology (Samant, 2014).

Application of oxadiargyl @ 90 g *a.i.* ha^{-1} at 2 DAS followed by one hand weeding at 30 DAS effectively controlled the grassy weeds and hand weeding controls the rest of weeds in dry seeded upland rice for higher productivity and income.

The study over three years showed that extension or horizontal spread of area from 13 hectare in 2011 to 45 hectare in 2012 due to adoption of improved technology. It Improves weed control practices and enhances productivity of dry seeded upland rice. Besides it recorded higher yield and increased B:C Ratio over local check proves that application of Oxadiargyl with hand weeding is economically viable .

Thus , the existing weed management practices by farmers can be replaced with improved practice of pre-emergence application of Oxadiargyl @ 90 g *a.i.* ha^{-1} at 2 DAS with one hand weeding at 30 DAS which was more effective and economic for weed management with higher productivity , income and found to be suitable as it had been appreciated by the farmers.

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