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Effect of Weed Management Practices on Crop Productivity and Economics in Dry-Direct Seeded Rice under Hill and Plateau Region of Eastern India

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ABSTRACT

In direct seeded rice (DSR), weeds are the major problems limiting the crop productivity. Sesbania with DSR as well as seeding rates of rice affects the weed density by smothering effect and therefore, it can be a better weed management practice. Two year on farm trials were conducted at the Kusma, Boarijore Block and Bhaluka, Sundarpahadi block of Godda from 2020 and 2021 to assess the effect of weed management on yields and economics in DSR. The results revealed that significantly the lowest density of grasses, broad leaved weeds (BLWs), sedges, total weed density, total weed dry weight and the highest weed control efficiency were recorded with DSR + Sesbania over DSR (pre-sowing irrigation followed by tillage and rice seeding) followed by first post-sowing irrigation at 15 DAS and the farmer's practice. Weed management practice, DSR + Sesbania was significantly higher grain yield, gross returns, net returns, B: C ratio, production and economic efficiency followed by first post sowing irrigation at 15 DAS and farmer's practice. While the farmer's practice was recorded significantaly higher weed index and the lowest weed control efficiency. Thus, on the basis of the present study, it may be concluded that weed management practice i.e. growing of DSR along with Sesbania could be a better option to reduced the weed infestation as well as improves the crop productivity of DSR in rainfed agro-ecosystem of Jharkhand.

KEYWORDS

Direct seeded rice, Economics, grain yield, Weed control efficiency, Weed density, Sesbania

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INTRODUCTION

Direct-seeded rice (DSR) is emerging as a profitable and sustainable rice production system to address the mounting scarcity of water, labour and energy in agriculture sector. Dry seeding of rice avoids need for ponding water vis-à-vis transplanting, thus it requires ~36% less water and ~60% less labour compared to traditionally grown puddled transplanted rice (TPR), depending on season and types of DSR (Kumar *et al*, 2017). Despite of various advantages, main constraints of DSR production systems are weeds infestation which ultimately decrease grain yield of rice (Mahajan and Chauhan, 2013) and yield reduction upto 90% if weeds are not managed timely (Chauhan and Johnson, 2010; Mandal *et al*, 2011a). Many alternatives are available for management of weeds in DSR, application of herbicides seems to be the most common, but it can cause risk of herbicide resistance problem and environmental contamination. Thus, integrated weed management (IWM) strategies that includes the preventive, cultural and chemical weed control methods are desirable in DSR (Bhagat *et al*, 2018). Some cultural weed management method i.e. includes use of a stale seedbed method, cultivars possessing the weed competitive characters, mulches and brown manuring, high seeding rates, proper sowing time and methods (Kaur and Singh, 2017; Mandal *et al*, 2011b). Brown manuring, is a method of seeding Sesbania with direct seeded rice and after 30 days and knockdown by applying 2, 4-D @ 400-500 g/ha, which as smothering effect on weeds, help to conserves the soil moisture and increase nitrogen content of soil (Gill and Walia, 2014) and also reduces density of weeds to about half of its population (Singh *et al*, 2016). In Jharkhand now-a-days there is much scarcity of agricultural workers due to migration of rural labours to multi-cities for industrial work which has resulted in scarcity of labours in rice growing season. But in DSR system, labour requirements are less and crop matures at least seven to ten days earlier as compared

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to conventional transplanting system, which ultimately facilitates timely planting of succeeding crops (Ahmed *et al*, 2014). Some cultural weed management method includes use of a stale seedbed method, cultivars possessing weed competitive characters, mulches and brown manuring, high seeding rates, proper sowing time and methods. Therefore, in this study, an attempt was made to find out the weed management practices at the farmer's fields and to validate the production technology of DSR over traditional farmer's practice.

METERIALS AND METHODS

An on farm trial was conducted during the kharif season of 2020 and 2021 at two locations Kusma, Boarijore Block and Bhaluka, Sundarpahadi block of Godda (24°41' 29.62"N and 87°11'1.5"E, a MSL 87 m). Initially Participatory Rural Appraisal (PRA) was done to identify the main the causes of low yield of rice and cost of production. It was found that heavy infestation by weeds particularly *Cynodon dactylon, Echinochloa crusgalli, Digitaria sanguinalis, Brachiaria ramosa,* sedges like *Cyperus iria* and broadleaved weeds like *Amaranthus viridis, Solanum nigram, Euphorbia hirta, Physalis minima, Commelia diffusa, Phylanthus niruri, Alternanthera sp.* and *Polygonum sp.* which pose the serious constraint in Godda, Jharkhand. The on farm trial comprised 3 treatment viz., farmer's practice (DSR in dry soil), DSR (Pre-sowing irrigation followed by tillage followed rice seeding) followed by first post sowing irrigation at 15 days after sowing and DSR + Sesbania (Sesbania broadcasted on same day DSR is established. Sesbania was killed by application of 2, 4-D @ 500 g *a.i.* /ha at 25-30 DAS) were carried out in randomized block design with 10-farmer's field and each treatment provided area of 0.1 ha. *Sesbania rostrata* (50 kg seed/ha) was grown for brown manuring and Paddy variety 'Sahbhagi' was sown by using seed rate of 40 kg/ha during second week of June during both the years. Crop was fertilized with recommended doses of fertilizers viz., 100, 40, 40 kg N, P_2O_5 and K_2O/ha. Full dose of P and K and half dose of N were applied at basal application and remaining N was applied in 2 equal splits at tillering and booting stage. Composite soil sample was collected before sowing and analyzed. Soil of the sites was light sandy loam in texture, with pH 7.2 and low in available N (292.4 kg/ha), medium in P (17.1 kg/ha) and K (183.7 kg/ha). 2, 4-D was applied for *Sesbania rostrata* knockdown in rice field with manually operated knapsack sprayer delivering a spray volume of 500 l/ha through flat-fan nozzle at 30 DAS. For weed density and weed dry weight, data was recorded at 45 DAS, an area of 0.25 m^2 was selected randomly by a metallic quadrate of size 50 $\times$ 50 cm at two places before treatment application. Data on weed density (no./m^2) and weed dry weight (g/m^2) were subjected to square-root ($\sqrt{X} + 0.5$) transformation before statistical analysis. Crop was harvested manually in first week of November during both the years. Average annual rainfall is 1062 mm but crop received only 32 mm during entire growth period, as most of which occurs during monsoon. Economics were calculated using prevailing market price of inputs. All the data on weed density and weed dry matter values were analyzed with 'Statistix 8.1' for analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Effect on weed

The common weeds were recorded in the farm trial; grasses like *Cynodon dactylon, Echinochloa crusgalli, Digitaria sanguinalis, Brachiaria ramosa,* sedges like *Cyperus iria* and broadleaved weeds like *Amaranthus viridis, Solanum nigram, Euphorbia hirta, Physalis minima, Commelia diffusa, Phylanthus niruri, Alternanthera sp.* and *Polygonum sp.* Emergence of these weeds was observed 20 DAS and thereafter it continuously emerged during crop growth stages. Results obtained from on farm trial revealed that relative abundance of BLWs, grassy weed and sedges were higher observed in farmers' practice and lowest found in DSR + Sesbania (Table 1). Sesbania was able to reduce the weed pressure as brown manuring which acts as a cover crop and suppressed the weed growth effectively at the initial growth stage (Singh *et al*, 2019).

Effect on growth and yield attributes

The growth attributes markedly influenced with weed management practice (Table 2). Tallest plant (89.9 cm) and tiller/m^2 (335) were recorded significantly with DSR + Sesbania (Sesbania broadcasted on the same day DSR is established and Sesbania killed by application of 2, 4-D @ 500 g *a.i.* /ha at 25-30 DAS) over farmer' practice. Plant height and tillers/m^2has often been described as one of the most important factors for weed competitive ability of crops (Kumar *et al*, 2016b) . Taller plant and tillers/plant contributes significant weed competitive ability. This might be due to intense weeds loads restricted to proper use of space, nutrient and moisture for better crops (Kumar *et al*, 2017). Yield attributes like panicle length, grains/panicle and 1000-grain weight were significantly influenced by weed management practice . These attributes had higher values in DSR + Sesbania and increase to the tune of 36.0, 33.7 and 9.4% compared to farmers' practice. Similar findings were also made by Kumawat *et al* (2018) and Sen *et al* (2020).

Effect on yields and harvest index

Yield is an important indicator to access competitive ability of DSR. DSR + Sesbania (Sesbania broadcasted on the same day DSR is established and Sesbania killed by application of 2, 4-D @ 500 g a.i. /ha at 25-30 DAS) produce more grain yield (26.03 %), straw yield (40.8 %) and biological yield (34.6%) in comparision to farmer' practice (Table 2). This might be due to higher grain and total biomass yields produced and less infestation of weeds due to better control of weeds under DSR+Sesbania. Similar results are also reported by Kumar *et al* (2016a), Kumar *et al* (2017) , Kumar *et al* (2017) and Kumar *et al* (2020).

Table 1: Effect of weed management practices on relative abundance (%) weed density and weed dry weight of DSR (Mean data of two years)

Treatments	Relative abundance (%)			Weed density (Nos./m^2)				Weed dry weight (g/m^2)
	BLWs	Grasses	Sedges	BLWs	Grasses	Sedges	Total	
Farmers' practice (FP): DSR under dry soil	35.16	43.89	21.00	24.00* (576)	26.81 (719)	18.56 (344)	40.48 (1638)	10.46 (109)
DSR (Pre-sowing irrigation followed by tillage followed rice seeding) followed by first post-sowing irrigation at 15 DAS	35.27	42.66	22.07	19.56 (382)	21.49 (462)	15.47 (239)	32.91 (1083)	7.91 (62)
DSR + Sesbania (Sesbania broadcasted on the same day DSR is established and Sesbania killed by application of 2,4-D @ 500 g a.i. /ha at 25-30 DAS	36.23	40.00	23.96	13.86 (192)	14.56 (212)	11.27 (127)	23.03 (530)	5.24 (27)
SEm±	-	-	-	0.45	0.51	0.34	0.76	0.24
LSD (p=0.05)	-	-	-	1.34	1.52	1.02	2.27	0.71

*Data subjected to square root transformation ($\sqrt{X+0.5}$), Values in parentheses are original

Table 2: Effect of weed management practices on growth, yield attributes, yield and harvest index of DSR (Mean data of two years)

Treatments	Plant height (cm)	Effective tillers/m^2	Panicle length (cm)	Grains /panicle	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Farmers' practice (FP): DSR in dry soil	82.7	268	10.9	50.2	23.4	2677	3745	6422	41.7
DSR	87.1	293	13.6	63.4	24.8	3202	4899	8101	39.5
DSR + Sesbania	89.9	335	14.8	67.1	25.6	3374	5272	8645	39.0
SEm±	1.29	4.06	0.16	0.67	0.37	36	64	109	0.8
LSD (p=0.05)	3.84	12.06	0.49	1.99	1.08	107	191	324	2.3

Effect on economics, weed control efficiency and weed index

DSR + Sesbania (Sesbania broadcasted on the same day DSR is established and Sesbania killed by application of 2, 4-D @ 500 g a.i. /ha at 25-30 DAS) fetched significantly higher gross returns, net returns and benefit: cost ratio over farmer's practice (Table 3). Initial suppressed the BLWs and sedges, due to Sesbania known down by application of 2, 4-D @ 500 g a.i. /ha at 25-30 DAS then provide the favorable environment of growth and development of DSR. Kaur and Singh (2017) found that maximum gross returns were observed in weed free treatment due to effective weed control. While the highest net returns and B: C ratio was recorded with treatment DSR + Sesbania may be due to higher yield.

Maximum economic and production efficiency were obtained with DSR + Sesbania (Sesbania broadcasted on same day DSR is established and Sesbania killed by application of 2, 4-D @ 500 g a.i. /ha at 25-30 DAS), i.e. INR 123.8/day/ha and 30.7 kg/day/ha, respectively being higher over of DSR (Pre-sowing irrigation followed by tillage followed rice seeding) followed by first post sowing irrigation at 15 days after sowing as well as farmer's practice (Table 3). The lowest weed control efficiency and highest weed index was recorded in farmer's practice. This is in agreement with Singh et al, (2016a) and Sen *et al* (2020).

CONCLUSION

On the basis of two years on farm trial data, it can be concluded that DSR + Sesbania (Sesbania broadcasted on the same day DSR is established and Sesbania killed by application of 2, 4-D @ 500 g a.i. /ha at 25-30 DAS) is a better option to reduce the weed infestation and improves crop productivity of DSR in rainfed agro-ecosystem of Jharkhand.

Table 3: Effect of weed management practices on economics, weed control efficiency and weed index (Mean data of two years)

Treatment	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio	Economic efficiency (Rs/ha/day)	Production efficiency (kg/ha/day)	Weed control efficiency (%)	Weed index
Farmers' practice (FP): DSR in dry soil	48250	50933	2683	1.06	24.4	24.3	0.0	26.0
DSR	49450	60927	11477	1.23	104.3	29.1	75.8	5.4
DSR + Sesbania	50575	64195	13620	1.27	123.8	30.7	303.7	0.0
SEm±	761	685	175	0.014	1.60	0.43	-	-
LSD (p=0.05)	2260	2034	521	0.047	4.76	1.28	-	-

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