

Effect of establishment methods, fertility levels and weed-management practices on rice (*Oryza sativa*)

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ABSTRACT

An experiment was conducted during the rainy season of 1996 and 1997 to study the performance of upland rice (*Oryza sativa* L.) under different establishment methods, fertility levels and weed-management practices. Transplanting increased all the growth and yield attributes of rice significantly over dry seeding and puddled sowing of sprouted seeds and recorded the highest grain and straw yields, net monetary return and benefit : cost ratio. Puddle sowing of sprouted seeds was superior to dry seeding in respect of all growth and yield-attributing characters, yield, net monetary return and benefit : cost ratio. Application of 100% recommended dose of fertilizer was most beneficial with maximum yield, monetary return and benefit : cost ratio. Among different weed-control methods, hand-weeding was the best in respect of aforesaid parameters.

Key words : Establishment methods, Upland rice, Fertility levels, Weed management

Rice is grown in entirely different physical condition of soil in case of transplanted rice culture. Puddling and waterlogging needed by transplanted rice destroy the soil structure and it is difficult to obtain a good tilth for the succeeding crop. Sometimes direct-seeded crop equalizes transplanted rice, if weeds are controlled effectively with proper nutrient scheduling. Among the various factors, fertilizer being the costliest input, promotes the growth and development of rice crop. Fertilizer-use efficiency can be increased through its proper scheduling and weed-control measures. Under upland condition

weeds pose serious competition for nutrients, moisture, light and space and cause heavy yield reduction. Keeping in view, the present investigation was undertaken to find out suitable establishment method, fertilizer dose and weed-management practice for upland rice.

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Rajendra Agricultural University, Pusa, Bihar, during rainy season of 1996 and 1997. The soil was silt loam and calcareous with pH 8.5, organic carbon 0.30%, available nitrogen 214.2 kg,

available phosphorus 21.5 kg and available potassium 88.7 kg/ha. The experiment was laid out in split-split plot design, comprising 3 rice-establishment methods (dry drilling, puddle sowing of sprouted seeds and transplanting) in main plots, 3 fertilizer doses [50% of recommended dose (RD), 75% of RD and 100% of RD, i.e. 80:40:20 kg N:P₂O₅:K₂O/ha] in subplot and 4 weed-management practices [weedy check, hand-weeding twice at 20 and 40 days after sowing (DAS)/transplanting (T), butachlor@1.5 kg/ha and anilophos@0.4 kg/ha] in sub-subplots replicated thrice. Rice variety 'Prabhat' (90–95 days) was sown on 5 and 3 July in 1996 and 1997 respectively.

Transplanting was done on 27 and 25 July in the respective years. The seed rate for transplanted rice was 50 kg and for direct-seeded rice cultures it was 80 kg/ha. In transplanted rice spacing was 15 cm × 15 cm and in dry drilling seeding was done in lines maintaining a row-to-row distance of 15 cm, while in puddle seeding sprouted seeds were broadcast evenly. Half of N as per treatment and full dose of P₂O₅ and K₂O were applied in the form of urea, diammonium phosphate and muriate of potash as basal dose at the time of sowing or transplanting. Remaining N was applied in 2 equal splits, at maximum tillering and panicle-initiation stages. Both the herbicides, butachlor and anilophos were applied as pre-emergence 3 days after sowing and 4 days after transplanting. Besides the irrigation required for puddling (as per treatments), 2 irrigations were applied to the crop as per requirement.

RESULTS AND DISCUSSION

Growth attributes

Methods of rice establishment significantly affected plant height, tillers/m², leaf-area index and plant dry weight. Favourable effect of transplanting was well marked over direct-seeding methods. All growth attributes were found to be significantly the highest under transplanting. Puddle sowing of sprouted seeds was the next best treatment in this regard.

Each increment in fertilizer level resulted significant increase in all the growth attributes, with the maximum value at 100% level of fertilizer application. Increasing fertilizer level from 50 to 75% of recommended dose caused greater increase in all the growth attributes than that from 75 to 100% recommended dose.

All the weed-control treatments increased the growth attributes significantly over weedy check. Hand-weeding was superior to the chemical weed-control treatments for all the growth attributes.

Effect on weeds

Methods of rice establishment had marked effect on weed count/m² and weed dry weight (g/m²). Transplanting recorded the lowest values, followed by puddle sowing of sprouted seeds and dry drilling. Gogoi (1986) also obtained similar results.

Increase in fertilizer dose increased the weed count as well as the weed-dry weight, with highest values at higher doses.

Weed-management practices significantly affected the weed parameters with its lowest values under hand-weeded plots, followed by anilophos and butachlor. Her-

bicides reduced the weed dry weight due to their selective nature and both killing and suppressing effects owing to lower weed population and their stunted growth resulted in lower weed dry weight. Similar observations were reported by Gogoi (1986) and Chandar and Pandey (1997).

Yield and yield attributes

Yield-attributing characters, viz. panicles/m², filled grains/panicle and 1,000-grain weight, were better under transplanting than under direct seeding. Puddling has great significance in rice culture. It facilitates transplanting, increases the availability of nutrients, ensures better germination or plant establishment, kills the weeds and helps the plants to grow vigorously. Transplanted rice hence superseded the direct-seeded rice. The results confirm the findings of Purohit *et al.* (1988) and Chandar and Pandey (1997). Between 2 direct-seeding methods, puddle sowing of sprouted seeds resulted in significantly higher yield attributes than dry drilling. Rice grain and straw yields are the cumulative out-come of all growth and yield attributes. All these were higher under puddle sowing condition than dry drilling, hence the yields were higher.

All the yield attributes increased significantly owing to increase in level of fertilizer. Maximum values were obtained at 100% dose, while the minimum with 50% dose. Increase in yield attributes because of increase in level of fertilizer was owing to adequate nutrient availability since early growth stages and enhanced photosynthetic efficiency. Hence the yield was higher at 100% dose than that 75 and

50% doses. The results are in line with the findings of Prasad *et al.* (1992).

All the yield-attributing parameters were significantly affected by weed-management practices. In hand-weeded plots, yield attributes were highest followed by herbicide-treated plots. The weedy check recorded the lowest values of all the yield attributes. Hand-weeded and herbicide-treated plots liberally enjoyed the applied nutrients as well as other growth factors and hence all the yield attributes were higher, reflecting the higher yields also. Kalia and Bindra (1996) and Muthukrishnan (1996) also reported similar results. Both the herbicides have similar effect on yield attributes.

Economics

Transplanting gave significantly higher net return and benefit : cost ratio than dry drilling and puddle sowing of sprouted seeds. This was owing to higher income from biological (grain + straw) yield of rice despite a higher cost of cultivation. Broadcasting of sprouted seeds on puddled soil being the next best was significantly superior to dry drilling. Puddled rice superseded dry drilling for yield and hence the net return and benefit : cost ratio were also higher.

Increasing levels of fertilizers significantly increased the net return as well as benefit : cost ratio. The maximum net profit and benefit : cost ratio were obtained with the application of fertilizer at recommended level. This clearly indicated that the economic level of fertilizer was 80 kg N + 40 kg P₂O₅ + 20 kg K₂O for upland rice. Thakur (1984) and Gogoi (1986) also got

Table 1. Growth and weed parameters, yield attributes, yield and economics of upland rice as influenced by establishment methods, fertility levels and weed-management practices (mean data of 2 years).

Treatment	Plant height (cm)	Tillers/m ²	Leaf-area index	Plant dry weight (g/m ²)	Panicles/m ²	Filled grains/panicle	1,000-grain weight (g)	Weed count/m ²	Weed dry matter (g/m ²)	Grain yield (q/ha)	Straw yield (q/ha)	Net return (q/ha)	Benefit : cost (Rs/Re)
<i>Establishment method</i>													
Dry drilling	58.9	184.5	2.90	209.0	163.7	49.5	20.0	254.9	93.5	14.97	19.16	987	0.12
Puddle sowing	61.7	229.6	3.60	323.8	214.8	64.4	20.3	220.4	79.4	23.16	30.54	4,792	0.72
Transplanting	64.6	271.6	4.21	401.3	259.0	76.5	20.9	63.5	24.1	30.04	40.85	7,092	0.92
CD (P=0.05)	1.3	9.5	0.05	10.9	7.0	3.8	0.4	13.1	5.4	2.00	3.03	992	0.10
<i>Fertilizer level</i>													
50% of RD	58.4	201.8	2.68	240.1	184.0	55.0	20.1	113.3	42.0	18.44	23.48	2,499	0.36
75% of RD	62.0	236.9	3.54	331.4	219.9	65.8	20.4	179.6	65.6	23.71	31.40	4,763	0.66
100% of RD	64.7	246.8	4.51	362.5	234.6	69.5	20.7	246.0	90.0	26.03	35.68	5,610	0.75
CD (P=0.05)	1.8	2.8	0.06	8.8	5.3	2.7	0.3	7.7	3.0	1.10	1.45	520.3	0.08
<i>Weed-management method</i>													
Weedy check	60.3	192.4	3.02	216.0	174.7	50.2	19.9	338.1	129.8	15.98	20.92	1,668	0.24
2 hand-weedings	62.4	259.6	4.11	407.8	243.0	74.3	20.8	77.0	27.5	28.76	38.65	6,39	0.83
Butachlor @ 1.5 kg/ha	62.0	229.7	3.56	306.6	216.7	63.5	20.5	155.0	53.9	22.67	29.89	4,255	0.59
Anilophos @ 0.4 kg/ha	62.1	232.5	3.61	315.1	218.1	65.8	20.5	148.3	52.8	23.48	31.28	4,849	0.70
CD (P=0.05)	NS	6.9	0.10	10.7	4.9	2.4	0.3	6.4	2.8	1.24	1.76	622.5	0.09

Table 2. Interaction effect of establishment methods and fertility levels and establishment methods and weed-management methods on rice yield

Treatment	Fertility level			Weed-management practice			
	50% of RD	75% of RD	100% of RD	Weedy check	2 hand-weedings	Butachlor@ 1.5 kg/ha	Anilophos@ 0.4 kg/ha
<i>Establishment method</i>							
Dry drilling	12.89	15.56	16.44	8.00	24.32	13.48	14.06
Puddle sowing	18.56	24.23	26.67	17.39	28.55	22.72	23.98
Transplanting	23.85	31.32	34.96	22.54	33.43	31.81	32.38
CD (P=0.05)		1.90					
<i>Straw yield (q/ha)</i>							
Dry drilling	15.50	19.94	22.02	9.86	31.78	17.10	17.88
Puddle sowing	23.55	32.02	36.08	22.51	38.27	29.78	31.73
Transplanting	31.41	42.22	48.93	30.39	45.94	42.88	44.25
CD (P=0.05)		2.51			3.06		

RD, Recommended dose of fertilizer

similar results.

The magnitude of net return and net return/rupee investment increased significantly with the adoption of different weed-control methods. Hand-weeding fetched more values than herbicidal weed control. Between the 2 herbicides, anilophos had an edge over butachlor but both were statistically at par with each other. Patil and Sabale (1990) also observed cultural treatments to be more profitable than the use of herbicides.

Interaction effect

The grain and straw increased significantly with the increase in fertilizer doses up to the highest level, i.e. 100% of recommended dose in transplanting and puddled sowing. In dry drilling the grain and straw yields increased significantly up to 75% of recommended dose only. Transplanted rice with 100% recommended dose of fertilizer yielded the highest.

In both the direct-seeded rice cultures, the highest grain and straw yields were noted from the plots hand-weeded twice while in transplanted rice, herbicidal treatments were at par with hand-weeding. The highest grain and straw yields were recorded from transplanting with 2 hand-weedings.

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