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Improving productivity and profitability of rice-wheat cropping system through different methods of crop establishment

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ABSTRACT

Five rice establishment methods viz., line transplanting, random transplanting, throwing of seedlings, drum seeding under puddled field, direct dry manual line sowing; 3 methods of wheat establishment viz., manual line sowing, sowing with zero-till drill and conventional sowing were evaluated to assess the productivity and profitability of rice-wheat system to find out the suitable alternative to the random transplanting method commonly being followed by the farmers. Line transplanting of rice resulted in significantly higher grain yield (5.59 t ha^{-1}) followed by drum seeding under puddled field (5.32 t ha^{-1}). Manual line sown wheat produced 7 and 11 per cent more grain yield as compared to conventional sowing and sowing with zero-till drilled wheat, respectively. Considering the rice-wheat system as whole, line transplanted rice followed by manual line sowing of wheat resulted in highest net returns (₹ 30,577 ha^{-1}) and benefit: cost ratio (1.75). Line transplanted rice followed by wheat sown with zero-till drill accrued almost similar net returns (₹ 29,800) and second highest benefit: cost ratio (1.68). Random transplanting followed by conventionally sown wheat can be profitably replaced with line transplanted rice with subsequent wheat established either by manual line sowing or sowing with zero-till drill.

Key words: *rice, wheat, cropping system, crop establishment methods*

Rice-wheat is one of the major cropping systems in India covering about 10-12 million hectare area and contributes to 22 per cent of total food grain production (Sharma, 2005). As per Chatrath and Singh (2010) rice-wheat system is predominant in northern plains in which Uttar Pradesh occupy maximum area (4.61 m ha) followed by Bihar (1.88 m ha) and Punjab (1.72 m ha). This system now occupies 12.33 m ha and providing food and livelihoods for many millions of which about 10.0 m ha is in the Indo-Gangetic plains, where it covers 75% of the total rice area and 63% wheat area. Although manual transplanting in puddled soil has been a major traditional method of rice establishment in India. Economic factors and recent changes in rice production technology have improved the desirability of direct-seeding methods. The timely availability of labour and their rising cost for transplanting is a big problem in most areas. Direct seeding of rice seeds either by sowing dry seeds on dry (unsaturated) soils or wet seeding using pre germinated seeds in wet (saturated) puddled soils by drilling ensure better plant population and staggered use of labour. Under puddled conditions, though rice yield is higher it has its own limitations and ill-effects on soil health. Besides, sowing of wheat is also delayed that results in linear decline in productivity (Timsina and Conner 2001). Sowing of wheat by traditional method requires excessive tillage, but that can be accomplished efficiently with the use of improved devices to save time and energy. Therefore, experiments were planned to work out the productivity and profitability of rice-wheat cropping system under different methods of crop establishment.

MATERIALS AND METHODS

A field experiment was conducted for 3 years during 2003-04 to 2006-07 at Patna. The experimental soil was silty clay loam analyzing low in organic carbon (0.56), medium in available N (296 kg ha^{-1}) and P_2O_5 (28 kg ha^{-1}) but high in K_2O (375 kg ha^{-1}) with pH 6.8. The top 15 cm soil layer had bulk density of 1.51 g cm^{-3},

field capacity 36.0% and permanent wilting point of 16% on oven-dry basis. The rice and wheat crops received dose of 100, 60 and 40 kg of N, P_2O_5 and K_2O ha^{-1} respectively. The experiment was laid out in split-plot design. The main plot (36 m x 18 m) treatments consisted of 5 methods of rice (BPT 5204) crop establishment, viz., line transplanting, random transplanting, throwing of seedlings, drum seeding under puddled field, direct dry manual line sowing. After the rice harvest in post-rainy season, each main plot was divided into 3 subplots (12 m x 6 m) to facilitate wheat (PBW 443) sowing by 15th November, under 3 methods of establishment, viz., manual line sowing, sowing with zero-till drill and conventional sowing, replicated 4 times. Direct seeding of rice in treatments drum seeding under puddled field and direct dry manual line sowing was done on 1st June whereas transplanting of 30 days old seedlings was done 1 month later in treatments line transplanting, random transplanting and throwing of seedlings. The seed rate for direct seeding was 75 kg ha^{-1} and 60 kg ha^{-1} under direct dry manual line sowing and drum seeding under puddled field, respectively, whereas for transplanting, it was only 25 kg ha^{-1}. Tillage operations in transplanting and drum seeding under puddled field consisted of 2 dry harrowing, 2 puddlings and 1 planking, whereas the plots direct dry manual line sowing were ploughed thrice with harrow and once with cultivator, followed by planking. For efficient weed control in direct dry manual line sowing, Pendimethalin @ 1.0 kg a.i. ha^{-1} (pre-emergence) 4 days after sowing was applied, whereas Butachlor @ 1.5 kg a.i. ha^{-1}(pre-emergence) was applied for weed control in plots where rice was transplanted or drum seeded under puddled field. This was supplemented by hand-weeding twice at 20 and 40 days in direct dry manual line sown plots and at 40 days in plots seeded or transplanted in puddled condition. The direct dry manual line sowing plots received a pre-sowing irrigation and irrigation soon after sowing for seed germination. In drum seeding under puddled field, irrigation for puddling was given. Both the direct seeded plots received frequent irrigations to keep the soil wet. For transplanted crop, irrigation was applied for puddling, there after; uniform irrigations were applied to all the treatments. After harvesting of rice, a pre-sowing irrigation was given to all the main plots to ensure optimum moisture for sowing of wheat. The conventional sowing in wheat involved 2 harrows, 2 cultivators, 1 shallow harrow before seeding and planking. Weed control in wheat was ensured by the tank mix application of Isoproturon 1.0 kg ha^{-1} + 2, 4-D @ 0.5 kg ha^{-1} applied 35 days after sowing. Furthermore, one hand weeding was also done to keep the crop free from weeds. Data on growth, Yield attributes and yield were statistically analysed by using randomized block design and split-plot design for rice and wheat respectively.

RESULTS AND DISCUSSION

Methods of rice establishment significantly influenced plant growth (plant height) and the entire yield attributes viz., panicle m^{-2}, panicle weight, grains panicle^{-1} and 1000 grain weight and yield of rice (Table 1). On mean basis line transplanted rice owing to its better growth and yield attributes resulted in significantly higher grain yield (5.59 t ha^{-1}), being at par with drum seeding under puddled field (5.32 t ha^{-1}). As puddling increases the availability of water and nutrients, ensures better germination/ crop establishment, kills weeds and helps plants to grow vigorously (Prasad *et al.* 2001). Direct dry manual line sowing maintained third position recording 3.39 t ha^{-1} grain yield which was significantly

Table 1. Effect of method of rice establishment on growth, yield attributes and yield of rice in rice-wheat cropping system (pooled data of 3 years)

Methods of rice establishment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Plant height (cm)	Panicle (m^{-2})	Panicle weight (g)	Grains panicle^{-1}	1000 grain weight (g)
Line transplanting	5.59	7.15	77	285	2.50	108.7	14.9
Random transplanting	2.42	3.38	67	270	2.00	62.3	13.5
Throwing of seedlings	2.07	3.00	65	258	1.85	59.5	13.3
Drum seeding under puddled field	5.32	6.70	75	282	2.40	106.3	14.5
Direct dry manual line sowing	3.39	4.50	70	277	2.15	69.3	13.7
CD (P=0.05)	0.38	0.62	3.2	15.4	0.25	7.5	0.5

lower than line transplanting and drum seeding under puddled field. Over crowding in drum seeding in puddled field and direct dry manual line sowing methods might have increased inter and intra-plant competition for resources. The results corroborated with those of Sharma *et al.* (2002) and Jaiswal and Singh (2001).

wheat were influenced significantly due to different methods of establishment of preceding rice (Table 2). Plant height, ears m^{-2}, grains^{-1}, grain and straw yield were found to be significantly higher when the wheat was grown after direct dry manual line sown rice than after puddled rice (line transplanting, random

Table 2. Effect of methods of establishment of rice and wheat on yield attributes and yield of wheat (pooled data of 3 years).

Methods of establishment	Plant height (cm)	Ears m^{-2}	Grains ear $^{-1}$	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Rice						
Line transplanting	78.3	280	37	36.6	2.98	4.11
Random transplanting	80.0	410	44	36.6	3.45	4.82
Throwing of seedlings	78.7	305	39	36.6	3.10	4.37
Drum seeding under puddled field	79.5	315	40	36.8	3.20	4.73
Direct dry manual line Sowing	82.0	430	39	36.9	3.86	5.59
CD (P=0.05)	1.0	12.5	1.8	NS	0.39	0.35
Wheat						
Manual line sowing	80.7	370	42	36.7	3.67	5.00
Sowing with zero – till drill	79.1	334	38	36.5	3.10	4.50
Conventional sowing	79.4	340	39	36.6	3.16	4.66
CD (p = 0.05)	0.7	8.6	1.3	NS	0.27	0.30

Rice yields in random transplanting and throwing of seedlings recorded lowest grain yield of 2.42 and 2.07 t ha^{-1} respectively due to non uniform crop geometry and were at par with each other. Due to more tillers per unit area and plant height, the straw yield was more in line transplanting and drums seeding under puddled field.

Pooled analysis of the three years data revealed that the plant height, yield attributes and grain yield of

transplanting, throwing of seedlings and drum seeding under puddled field). This could be owing to better seed-bed for wheat sowing available after direct dry manual line sown rice which resulted in better growth and yield of wheat (Sharma *et al.,* 2002). Irrespective of the various crop-establishment methods in rice, manually line sown wheat increased plant height, ears m^{-2}, grains^{-1}, grain and straw yield significantly over either conventional sowing or sowing with zero-till drilled

Table 3. Mean net returns and benefit : cost ratio of rice-wheat cropping system as influenced by methods of crop establishment

Method of rice establishment	Method of wheat establishment		
	Manual line sowing	Sowing with zero-till drill	Conventional sowing
Net Returns (₹ ha^{-1})			
Line transplanting	30, 577	29, 800	26, 900
Random transplanting	21, 555	19, 950	18, 833
Throwing of seedlings	22, 476	20, 666	19, 500
Drum seeding under puddled field	28,300	27, 373	25,600
Direct dry manual line sowing	25, 420	23, 350	22,000
Benefit : cost ratio			
Line transplanting	1.75	1.68	1.50
Random transplanting	1.17	1.15	1.00
Throwing of seedlings	1.22	1.20	1.10
Drum seeding under puddled field	1.66	1.62	1.42
Direct dry manual line sowing	1.38	1.32	1.15

wheat. The ideal seed bed prepared under manual line sowing and conventional sowing might have been responsible for better growth, yield attributes under such methods. Singh *et al.* (2005) also reported similar results. Interaction between the crop-establishment methods of rice and wheat were not significant for growth, yield attributes and yield of wheat.

Considering the rice-wheat system as a whole, line transplanted rice followed by manual line sowing of wheat resulted in highest net returns (₹ 30, 577 ha^{-1}) and benefit : cost ratio (1.75) (Table 3). Line transplanted rice followed by wheat sown with zero-till drill accrued almost similar net returns (₹ 29, 800) and second highest benefit : cost ratio (1.68). Thus, zero-till drill should be given preference to conventional tillage for wheat sowing. However, the best method of wheat establishment after line transplanted rice was found to be manual line sown wheat.

Thus, on the basis of three years study, it is concluded that random transplanting followed by conventionally sown wheat can be profitably replaced with line transplanted rice with subsequent wheat established either by manual line sowing or sowing with zero-till drill.

REFERENCES

Chatrath Ravish and Singh SK 2010. Productivity improvement in the rice-wheat cropping system. Indian Farming 60 (5):12-15

Jaiswal VP and Singh GR 2001. Effect of planting methods, source and level of nitrogen on the growth and yield of rice (*Oryza sativa*) and on succeeding wheat (*Triticum aestivum*). Indian J Agron 46 (1): 5-11

Prasad SM, Mishra SS and Singh SJ 2001. Effect of establishment methods, fertility levels and weed management practices on rice (*Oryza sativa*). Indian J Agron 46 (2): 216-221

Sharma SN, Bohra JS, Singh PK and Srivastava RK 2002. Effect of tillage and mechanization on production potential of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy 47: 305-310

Sharma SN 2005. Integrated nutrient management in rice-wheat cropping system. Fert News 50 (2): 53-71

Singh KK, Jat AS and Sharma SK 2005. Improving productivity and profitability of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system through tillage and planting management Indian J agric Sci 75 (7) : 396-399

Timsina J and Conner DJ 2001. Productivity and management of rice-wheat cropping system : issue and challenges. Field Crops Research 69 (1-3) : 93-132