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**Research Communication**

# Relative efficiency of methods of crop establishment in rice (*Oryza sativa*)

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## ABSTRACT

Agronomic potential, feasibility and profitability of three methods of stand establishment *viz.,* conventional transplanting (CT), system of rice intensification (SRI) and double transplanting (DT) with three rice (*Oryza sativa* L.) cultivars *viz.,* 'Pusa Basmati 1401', 'Pusa 44' and 'PRH 10' were evaluated in a field experiment conducted during wet season of 2010 at the research farm of Indian Agricultural Research Institute, New Delhi. Grain and straw yield and net return were significantly higher in SRI over CT and DT. Among the rice cultivars, rice hybrid 'PRH 10' gave the highest grain and straw yield but 'Pusa Basmati 1401' gave the highest net return.

***Key words:*** Conventional transplanting, Double transplanting, Rice varieties, System of rice intensification

System of rice intensification (SRI) has attracted attentions because of its apparent success in increasing rice yields with less water use (Uphoff *et al.* 2011). SRI management involves many departures from the methods conventionally recommended for rice cultivation. SRI proposes the use of single young seedlings, drastically reduced plant densities, keeping fields unflooded, use of a mechanical weeder which also aerates the soil, and enhanced soil organic matter. These practices have the aim of providing optimal growth conditions for the plant, to get better yield and resource productivity (Stoop *et al.* 2002). SRI practices are reported to increase the yields of irrigated rice by 25–50% or even more (Thakur *et al*. 2010) while reducing water requirements (Satyanarayana *et al.* 2007). Double transplanting (DT) involves transplanting rice seedlings from primary nursery to secondary nursery and finally into main field (Rautray, 2006). This practice is used by farmers as a contingent strategy in some parts of eastern India and Bangladesh, which are prone to flooding especially during *Aman* season rice. No information on these methods of rice establishment are available in rice-wheat cropping system belt of north India and therefore the present study was undertaken.

The experiment was conducted during wet (*kharif*) season of 2010 at the research farm of Indian Agricultural Research Institute, New Delhi. The year 2010 received more than normal rainfall (929.8 mm) during June to November. Months of July, August and September had 9, 11 and 15 numbers of rainy days, respectively. The soil of experimental field had 139.9 kg/ha alkaline permanganate oxidizable N, 15.64 kg/ha available P, 283.2 kg 1 N ammonium acetate exchangeable K, 0.56% organic carbon and 7.8 pH (1: 2.5 soil and water ratio). The experiment was laid out in factorial randomized block design with nine treatments combinations comprising of 3 methods of crop establishment *viz.,* conventional transplanting (CT); system of rice intensification (SRI) and double transplanting (DT) and 3 rice cultivars *viz.,* 'Pusa Basmati 1401'; ('PB 1401') 'Pusa 44' and 'PRH 10' and treatments were replicated four times.

After puddling twenty-one days old seedlings of rice varieties were transplanted under conventional transplanting at 20 cm × 10 cm spacing keeping 2 seedlings/hill. For DT, uprooted seedlings were transplanted on puddle field in closer spacing (7.5 cm × 7.5 cm) and when the total age of these seedlings became 41 days, they were uprooted and transplanted on the main field. For SRI, 12 days old seedlings were transplanted in main field. In conventional and double transplanting method 3-5 cm water was maintained from transplanting to grain filling stage of crop and later only moist soil conditions were maintained. However in SRI, alternate wetting and drying conditions were maintained in early crop growth period and 2 cm water was maintained between panicle initiation stage and grain filling stage. All the plots received 120 kg N, 60 kg $P_2O_5$ and

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40 kg $K_2O$/ha as urea, single super phosphate and muriate of potash.

Plant height at harvest was significantly higher in SRI as compared to conventional transplanting (CT) and DT (Table 1)**.** This can be attributed to more space, sunlight and nutrients available in SRI due to the wider spacing (Thakur *et al.* 2010). Rice hybrid 'PRH 10' recorded significantly higher plant height than 'PB 1401' and 'Pusa 44'. This was because the later two varieties are semi-dwarf and lodging resistant. Madhuri *et al.* (2001) reported more tillering capacity in rice hybrids than inbred varieties. Highest root volume in top 15 cm soil depth was recorded in SRI followed by CT and DT. Higher root growth and activity under SRI relates to increased root oxidation activity and root-sourced cytokinins (Zhang *et al.* 2009).

Significantly higher fertile tillers/$m^2$ were noticed in SRI as compared to DT and CT (Table 1). This might be due to lesser tiller mortality in SRI due to water management through alternate drying and wetting than conventional flooding method followed in CT and DT.'PRH 10' produced significantly higher fertile tillers than 'Pusa 44' and 'Pusa Basmati 1401'. The heaviest panicles were recorded in SRI, significantly more than CT and DT, which were *at par*. Hossain *et al*. (2003) reported similar results. 'PRH 10' produced heaviest panicles, significantly higher than 'Pusa 44' which in turn produced significantly heavier panicle than 'PB 1401'. Significantly more filled grains/ panicle were recorded in SRI than in DT and CT. Mulu (2004) reported more filled spikelets/ panicle with 8 day old seedlings compared to 15, 20 and 25 day old seedlings. 'Pusa 44' recorded the significantly higher filled grains $panicle^{-1}$ than 'PRH 10' and 'PB 1401'. The 1000-grain weight of 'PRH 10' and 'Pusa 44' was statistically *at par* and significantly higher than 'PB 1401'.

Significantly higher grain yield was recorded in SRI (5.03 t/ha) as compared to CT (4.53 t/ha) and DT (Table 2). Nissanka and Bandara (2004) reported 7.6 t/ha grain yields in SRI and it was 9% greater than the conventional transplanting. Higher grain yield production in the SRI might be attributed to the vigorous and healthy growth, development of more productive tillers and leaves, ensuring greater resource utilization in the SRI compared to conventional transplanting. Rice hybrid 'PRH 10' produced significantly (9.7%) higher grain yield (5.00 t/ha) as compared to 'Pusa 44' (coarse grain type, HYV) and 'Pusa Basmati 1401'. Rice straw yield was significantly higher under SRI (9.04 t/ha) than CT and DT. Haque (2002) found higher biological yield in SRI compared to the conventional planting. 'PRH 10' produced significantly higher straw yield than 'PB 1401' and 'Pusa 44'.

The highest net returns was obtained from SRI followed by DT and CT (Table 2). Among rice varieties, 'PB 1401' gave highest net return followed by 'PRH 10'. SRI has distinct advantage of having higher yield, less input-cost and this led to higher income over CT and DT. Overall, combined effect of reduction in cost and higher yield in SRI resulted in increased net return to the extent of 16% as compared to CT. The reduction in seed rate and irrigation requirement in SRI reduced the cost of cultivation. In DT in spite of increase in labour cost, reduced number of irrigations in main field was responsible for lower cost of cultivation than CT. Cultivation of *Basmati* rice variety 'PB 1401' gave the highest net return mainly due to its better grain quality and higher market price. An evaluation of SRI done in four districts of Tamil Nadu, India by the National Centre for Agricultural Economics found that SRI methods comparatively reduced labour input by 17% and labour costs by 28% (Barah, 2009). An IWMI evaluation of rainfed SRI production in West Bengal State cal-

**Table 1.** Effect of methods of crop establishment on plant growth parameters and yield attributes at harvest in rice

| Treatment | Plant height (cm) | Root volume (cc /0.3 $m^2$) | Fertile tillers/$m^2$ | Panicle weight (g) | Filled grain/panicle | 1,000-grain weight (g) |
|---|---|---|---|---|---|---|
| *Planting Method* | | | | | | |
| CT | 95.3 | 212.1 | 381.1 | 3.72 | 111.6 | 23.5 |
| SRI | 100.3 | 225.8 | 425.1 | 4.48 | 134.7 | 23.6 |
| DT | 97.5 | 214.1 | 383.3 | 3.76 | 121.0 | 22.8 |
| SEm± | 1.3 | 3.7 | 8.4 | 0.13 | 2.9 | 0.29 |
| CD (P=0.05) | 3.7 | 10.7 | 24.6 | 0.39 | 8.5 | NS |
| *Variety* | | | | | | |
| 'PRH 10' | 107.6 | 221.4 | 413.8 | 4.78 | 121.6 | 24.5 |
| 'PB 1401' | 93.0 | 214.7 | 374.6 | 3.12 | 99.0 | 20.9 |
| 'Pusa 44' | 92.5 | 215.9 | 400.9 | 4.06 | 146.6 | 24.5 |
| SEm± | 1.3 | 3.7 | 8.4 | 0.13 | 2.9 | 0.3 |
| CD (P=0.05) | 3.7 | NS | 24.6 | 0.39 | 8.5 | 0.8 |

**Table 2.** Effect of methods of crop establishment and varieties on yield and economics of rice cultivation

| Treatment | Grain yield (t/ha) | Straw yield (t/ha) | Cost of cultivation (×10³ ₹/ha) | Gross return (×10³ ₹/ha) | Net return (×10³ ₹ /ha) | Benefit : cost ratio |
|---|---|---|---|---|---|---|
| *Planting method* | | | | | | |
| Conventional | 4.53 | 8.55 | 30.3 | 113.5 | 83.2 | 2.78 |
| SRI | 5.03 | 9.04 | 25.7 | 125.8 | 100.1 | 3.89 |
| DT | 4.48 | 8.46 | 28.6 | 111.3 | 84.4 | 2.95 |
| SEm± | 0.04 | 0.14 | | 2.92 | 0.01 | |
| CD (P=0.05) | 0.12 | 0.41 | | 12.1 | 12.1 | |
| *Variety* | | | | | | |
| 'PRH 10' | 5.00 | 10.00 | 29.3 | 110.2 | 80.9 | 2.76 |
| 'PB 1401' | 4.44 | 8.25 | 28.3 | 139.7 | 111.4 | 3.93 |
| 'Pusa 44' | 4.58 | 7.81 | 27.8 | 100.1 | 73.3 | 2.63 |
| SEm± | 0.04 | 0.14 | | 12.1 | 12.1 | |
| CD (P=0.05) | 0.12 | 0.41 | | 35.3 | 35.3 | |

culated an 8% reduction in labour requirements (Sinha and Talati, 2007). Variety and crop establishment interaction was not significant for all the characters studied.

Based on one year study, it is concluded that system of rice intensification is better than conventional and double transplanting method and hybrid 'PRH-10' superior to 'Pusa 44' and 'PB-1401'.

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