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Short Note

Effect on growth, yield attributes and productivity of scented and non-scented rice (*Oryza sativa* L.) in system of rice intensification in Himachal Pradesh

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Abstract

HPR 2143 & HPR 1068 (non-scented) and Kasturi (scented rice) cultivars were evaluated under System of Rice Intensification (SRI) and Integrated Crop Management (ICM) in comparison to Conventional transplanting (CT) method, all under 50 & 100% fertility levels at 20 cm x 15 cm geometry. The number of seedlings used hill^{-1} was one for SRI (10 day old), two for ICM (15 day old) and three for CT (22 day old). Plant height, dry matter accumulation and crop growth rate, panicle length, panicle weight, number of total and filled spikelets panicle^{-1} & 1000 grain weight, yield and returns were more in ICM & SRI and at 100% fertility level. The tiller formation, flowering and maturity were earlier in SRI and ICM. ICM (6253 kg ha^{-1}) and SRI (5917 kg ha^{-1}) produced significantly more yield mainly due to heavier panicle (as well more tillers in ICM) as compared to CT (5152 kg ha^{-1}) by 21.4 and 14.8 % respectively. Averaged over the methods, HPR 2143 (6631 kg ha^{-1}) gave significantly more paddy yield followed by HPR 1068 (6282 kg ha^{-1}) and Kasturi (4409 kg ha^{-1}). All the three varieties were found suitable for new methods yet Kasturi (scented) with recommended fertility level was more suitable under ICM on account of higher profit.

Key words: System of rice intensification, growth, yield attributes, nutrition, productivity.

Keeping aside the controversies and inadequate scientific insight, rice productivity is claimed to be increased considerably by adopting new methods of establishment *viz.* System of Rice Intensification (SRI; Uphoff, 2003) and Integrated Crop Management (improved SRI; ICM; Balasubramanian, 2005; Balasubramanian, 2007) translating the fact that younger seedlings transplanted in carbon and oxygen rich rhizosphere can produce more. Experimentation, so far in India, has revealed that the newer methods are relatively more advantageous in south India (particularly Andhra Pradesh and TN) compared to north India (Viraktamath, 2006). Mankotia *et al.* (2006) found that in mid hills of Himachal Pradesh, when rice was transplanted on a common date (i.e. nurseries sown at different dates) under SRI, ICM and CT (conventional transplanting); despite more tillers hill^{-1} in SRI and ICM, total tillers in CT (as well as effective tillers), on per unit area basis, were not compensated and hence, the yield was more under CT. Therefore, it was thought to evaluate rice productivity under these methods with nurseries grown on the same date but transplanted at different dates and with normal crop geometry, as in hills the low temperature during the reproductive phase may have adverse effect on the rice productivity (Katoch *et al.*, 2004). Since differential behaviour of the genotypes is reported

under these methods and as soil fertility may be a limiting factor in tillering. Therefore, the varietal and fertility aspects were also included for evaluations.

The field experiment was carried out during *kharif* 2006 at Rice and Wheat Research Centre, Malan (76'2° E 32'1° N & 950 m above msl), CSK HPKV, Palampur. Agroclimatically, the zone represents the mid hill sub-humid zone. The mean weekly maximum (27°C-35°C) and minimum temperatures (15.6°C-22.3°C) were quite favorable for the growth and development of the crop. The soil was silty clay loam in texture, acidic (pH 5.7) in reaction and medium in available nutrients (325 kg N, 21.5 kg P_2O_5 and 232 kg K_2O ha^{-1}) and organic carbon (0.58 %). The experiment was laid out in split plot design with three replications. There were 18 treatments which comprised of combinations of 3 varieties (HPR 2143, HPR 1068 and Kasturi), and two fertility levels 50 and 100 per cent of recommended NPK (90kgN, 40kgP_2O_5 & 40kgK_2O ha^{-1}) in main plots and three methods of establishment (SRI, ICM and CT) in sub-plots. For SRI nursery, raised nursery beds were prepared with soil and FYM in 2:1 ratio and seeds were spread uniformly on the bed (12 June), covered with paddy straw for 3 days and water was sprinkled frequently. In SRI, 10 day old (on 22 June) single seedlings were removed from the nursery bed along with soil & intact seed and carefully transplanted in the field by using 1seedling $hill^{-1}$. ICM nursery was raised by using modified mat nursery (MMN) technique. For nursery sowing, the soil mix was prepared by mixing 75 % soil, 20% farmyard manure and 5% rice hull ash + IFFCO (12%N, 32% P_2O_5 & 16% K_2O). The nursery area was leveled and divided into 1.2 m wide and 0.05 m high beds of convenient length. A black polythene sheet was spread over the beds. A wooden frame of 0.5 m length, 1.0 m width and 0.04 m depth having four equal segments was placed over the plastic sheet. The frame was then filled with soil mix almost upto top. Pre-germinated seeds were sown on 14 June, covered with a thin layer of soil mix and firmed gently with hand. The seed bed was soaked with water and the wooden frame was removed carefully for further nursery sowing. The beds were kept moist by sprinkling water with cans as per requirement. In ICM, 15 day old (on 27 June) 2 seedling $hill^{-1}$ was transplanted. In CT 22 day old 3 seedling $hill^{-1}$ were transplanted. The crop geometry was 20 cm x 15 cm in all the three methods. The seed rate in SRI, ICM and CT was 10, 20 and 30 kg ha^{-1}, respectively. The farmyard manure was applied at the time of puddling @ 5 t ha^{-1} on dry weight basis. Half N (Urea 46%) and full P (SSP 16%) and K (MOP 60%) were applied at the time of last puddling. The remaining nitrogen was top dressed in two equal splits at the time of tillering and panicle initiation stages. In SRI and ICM weeds were controlled with manual push and pull row weeder, incorporating weeds into the soil and helping in aeration of the soil. Butachlor @ 1.5 kg ha^{-1} was applied in CT plots. Spot weeding was also done to free the crop from weeds under all the methods. Standing water upto panicle initiation stage was avoided in SRI and ICM plots, thereafter 2-3 cm water was allowed at intervals. The measurement of water saving component was ignored as the region receives high amount of rainfall; 187.5 cm rainfall occurred

during the cropping season (June to October, 2006) in 68 rainy days. The crop growth rate was computed using:

$$CGR = W_2 - W_1 / T_2 - T_1$$

where W_2 and W_1 are dry matter at T_2 and T_1 days, respectively.

Effect of methods of establishment: Plant growth, yield attributes and yield varied significantly by methods of establishment (Table1). Plants in SRI and ICM were significantly taller by 8.7 & 7.3 cm, respectively, compared to CT. The number of tillers m^{-2} in SRI and ICM, started increasing early. At 33 days (nursery + main field duration), the tillers in ICM and SRI were 23.6 and 12.8 % more as compared to CT. Days taken to maturity of the crop were less in ICM and SRI by 4-5 days. Early tiller formation and better crop growth rate under new methods resulted into taller plants at different stages. The young transplanted seedlings recoup earlier and attain different growth stages earlier (Cheralu *et al.*, 2006; Hua *et al.*, 2006). The ICM method of establishment registered higher number of total and effective tillers m^{-2}. This could be due to the robust seedlings produced in MMN receiving rice husk ash, FYM and fertilizers at the time of nursery sowing. Moreover, alternate wetting and drying of field improves the oxygen concentration in the rhizosphere. Rice plants when grown under saturated condition develop more hairy, fine and branched secondary adventitious roots near the root-soil interface in order to absorb the dissolved oxygen in the oxidized layer (Obermueller and Mikkelsen, 1974) and the elongation of the root system is repressed. Kar *et al.* (1974) showed that 78% of the roots die back at the flowering stage when the rice is grown under flooded conditions as compared to that under aerated conditions. Aerobic soil conditions have more beneficial effects on biological populations and processes in soil (Randriamiharisoa *et al,* 2006). In SRI, Triveni *et al.* (2006) noticed very high populations of bacteria, fungi, actinomycetes and azotobacter except PSB. Biological nitrogen fixation is also facilitated under aerobic conditions (Boddey *et al.*, 2006). Thus, many favourable effects in rhizosphere can be expected to interpret into better crop growth and development in new methods of establishment. Number of grains $panicle^{-1}$ and spikelet fertility were also found higher in SRI followed by ICM and CT. Significantly more effective tillers m^{-2} (244) and 1000 grain weight (27.5 g) in ICM contributed to significantly higher grain yield in ICM (6253 kg ha^{-1}). Similarly, more number of grains $panicle^{-1}$ (109) contributed to higher grain yield in SRI (5917 kg ha^{-1}). Thus, ICM and SRI recorded 21.4 and 14.8 % higher grain yield over CT, respectively. Net returns in ICM (Rs 49,161 ha^{-1}) and SRI (Rs 45,899 ha^{-1}) were also more. The NPK uptake by the crop followed the trend of grain and straw; ICM resulted in significantly higher uptake of nutrients followed by SRI and CT.

Response of varieties: Kasturi, a tall plant type produced significantly taller plants (120.5 cm) as compared to HPR 2143 (118.5 cm) and HPR 1068 (111.8 cm) (Table 2).The latter two recorded more crop growth rate as compared to Kasturi. Panicle length in Kasturi was significantly more as compared to HPR 2143 and HPR 1068. The

Table 1. Growth & development, yield & yield attributes, productivity & returns, nutrient uptake and soil nutrient status at harvest of crop in ICM, SRI and CT

Parameter		ICM	SRI	CT	CD (P=0.05)
Plant height (cm)		118.9	120.3	111.6	2.1
No. of tillers m^{-2} at					
	33 DAS	241	220	195	6.6
	Maximum tillering	304	291	301	7.6
Crop growth rate between ($g\ m^{-2}\ day^{-1}$)					
	Sowing to PI	8.11	7.67	5.56	0.39
	PI to flowering	30.24	29.52	29.22	0.22
	Flowering to harvest	5.84	5.63	5.13	NS
Days taken to					
	50% flowering	84	85	88	0.7
	Maturity	122	123	127	0.7
Yield attributes					
	Effective tiller m^{-2}	244	224	231	3.2
	Panicle length (cm)	26.7	27.2	25.2	0.3
	Grain $panicle^{-1}$	100	109	92	2.7
	Spikelet fertility (%)	80.0	82.9	74.4	1.3
	1000 grain weight(g)	27.5	26.6	27.0	0.3
	Panicle weight (g)	2.98	3.16	2.65	0.17
Yield ($kg\ ha^{-1}$)	Grain	6253	5917	5152	108
	Straw	7700	7375	6483	306
Net returns($Rs\ ha^{-1}$)		49161	45899	36519	1182
Nutrient uptake ($kg\ ha^{-1}$)					
	N	98.1	93.1	78.4	4.5
	P	18.4	17.6	15.3	0.4
	K	91.2	85.4	73.9	2.6

SRI : System of Rice Intensification; ICM: Integrated Crop Management; CT : Conventional transplanting; PI :Panicle initiation stage; DAS : Days after sowing

grains $panicle^{-1}$ were more in HPR 2143. The thousand grain weight was significantly more in HPR 1068 (29.5 g) as compared to HPR 2143 and Kasturi. HPR 2143 and HPR 1068 took 12 days less to mature compared to scented variety. Plant height, vigour and duration are all controlled genetically and hence differentials in varietal responses. Yield is governed by different yield attributes. The number of effective tillers m^{-2} were more in HPR 2143 (242) with an average of 108 filled grains per panicle. Though the test weight was less (8%) than HPR 1068, but it produced 3.49 q ha^{-1} (5.56%) more grain yield as compared to HPR 1068. The number of effective tillers per unit area and number of grains $panicle^{-1}$ were relatively less in HPR 1068, but mainly due to higher seed weight it produced 6282 kg $ha^{-1}$of grain yield. The yield of Kasturi was 4409 kg ha^{-1}, as its effective tillers m^{-2} (218), grains $panicle^{-1}$ (91) and 1000 grain weight (24.5 g) were less than HPR 2143 and HPR 1068. HPR 1068 produced significantly higher straw yield followed by

HPR 2143 and Kasturi. Net returns from Kasturi were more as its price was higher than other two varieties which were otherwise more productive. The uptake of nutrients mainly followed the trend of grain and straw yield.

Effect of fertility levels: Since the experimental field was medium in available N, P and K, a significant increase in paddy yield was recorded as the fertility level increased from 50 to 100 per cent (Table 2). This was due to the more plant height, higher crop growth rate and due to the higher values of yield attributes (effective tillers m^{-2}, panicle length, grains $panicle^{-1}$ and panicle weight). Crop receiving higher fertility level accumulated more of nutrients. Returns were more at higher fertility level.

Thus, it is concluded that the farmers in mid hill conditions of Himachal Pradesh, can make the cultivation of transplanted rice more productive and remunerative by transplanting 15 days old two seedlings $hill^{-1}$ of cultivars HPR 1068, HPR 2143 or Kasturi. Kasturi due to its higher market price further increases the net returns.

Table 2. Performance of the crop as influenced by variety and fertility level

Parameter	HPR 2143	HPR 1068	Kasturi	CD (P=0.05)	F_1	F_2	CD (P=0.05)
Plant height (cm)	118.5	111.8	120.5	2.6	114.9	119.0	2.1
CGR (sowing to PI)	7.43	7.30	6.61	0.62	6.82	7.41	0.51
CGR (PI to flowering)	31.57	31.62	25.80	0.25	29.63	29.69	NS
CGR (flowering to harvest)	5.96	5.95	4.68	0.93	5.12	5.94	0.76
Effective tiller m^{-2}	242	238	218	4.5	231	235	3.7
Panicle length (cm)	25.7	24.4	29.1	0.4	26.1	26.7	0.4
Grains (No.$panicle^{-1}$)	108	102	91	4.4	98	102	3.6
1000 grain weight (g)	27.1	29.5	24.5	0.4	26.9	27.2	NS
Panicle weight (g)	3.22	3.20	2.36	0.23	2.81	3.05	0.19
N uptake (kg ha^{-1})	104.9	100.1	64.5	3.4	86.8	92.9	2.8
P uptake (kg ha^{-1})	18.1	17.3	15.9	0.8	16.2	18.0	0.7
K uptake (kg ha^{-1})	92.6	89.9	68.1	2.2	80.3	86.8	1.8
Grain (kg ha^{-1})	6631	6282	4409	152	5701	5846	125
Straw (kg ha^{-1})	7267	7300	6990	177	6938	7433	145
Net returns (Rs. ha^{-1})	42644	40254	48681	1219	43357	44362	995

CGR: Crop growth rate; PI : Panicle initiation; F_1 (45 N:20 P_2O_5:20 K_2O + 5 t FYM ha^{-1}); F_2 (90 N:40 P_2O_5:40 K_2O + 5 t FYM ha^{-1})

References

Balasubramanian V, Rajendran R, Ravi V, Chellaiah N, Castro E, Chandrasekaran B, Jayaraj T and Ramanathan S 2005. Integrated crop management for enhancing yield, factor productivity and profitability in Asian rice farms. Int. Rice Comm. Newsl. **54**: 63-72.

Blasubramanian V, Sie M, Hijmans RJ and Otsuka K 2007. Increasing rice production in Sub-

Saharan Africa: challenges and opportunities 2007. Adv. Agron. **94**: 55-133.

Boddey RM, Bruno JRA, Veronica MR and Segundo U 2006. Biological nitrogen fixation in agroecosystems and in plant roots. **In**: Biological Approaches to Sustainable Soil System, eds. Uphoff N, Ball A, Fernandes ECM, Herren H, Husson O, Laing M, Palm CA, Pretty J, Sanchez PA, Sanginga N, and Thies J. CRC Press, Boca Raton: 177-89.

Cheralu C, Rao Jalapathi L, Sreedhar M 2006. An experience with "SRI" in Warangal district of Andhra Pradesh. Balasubramanian Dobermann A 2004. A critical assessment of the system of rice intensification (SRI). Agric. Systems **79**: 261-81.

Hua L, Chunzan W, Ailiu C, Yuyun D and Chuanshuang L 2006. Yield increasing mechanism of system of rice intensification (SRI) and its key techniques. Hybrid Rice **21**: 42-43.

Kar S, Varde SB, Subramanyam TK and Ghildyal BP 1974. Nature and growth pattern of rice root system under submerged and unsaturated conditions. II Riso **23**:173-79.

Katoch PC, Kaushik RP Sharma SL and Sharma BD 2004. Genetic Improvement of Rice Varieties of Himachal Pradesh. **In:** "Genetic Improvement of Rice Varieties of India", eds Sharma D, Prasada Rao U, Today & Tomorrow's Printers and Publishers: 551-79.

Mankotia BS, Shekhar J and Negi SC 2006. Performance of rice in SRI (system of rice intensification), ICM (integrated crop management) and conventional transplanting methods with common date of transplanting in the mid hills of Himachal Pradesh. Haryana J. Agron. **22**: 68-70.

Obermueller AJ and Mikkelsen DS 1974. Effects of water management and soil aggregation on the growth and nutrient uptake of rice. Agron. J. **66**: 627-32.

Randriamiharisoa R, Barison J and Uphoff N 2006. Soil biological contributions to the System of Rice Intnsification. **In**: Biological Approaches to Sustainable Soil System, eds Uphoff N, Ball A, Fernandes ECM, Herren H, Husson O, Laing M, Palm CA, Pretty J, Sanchez PA, Sanginga N, and Thies J. CRC Press, Boca Raton: 409-24.

Triveni, Raghu Rami, Reddy P, Veranna G and Rao Jalapathi 2006. Influence of SRI method of cultivation on microbial population in wet lands. In Proc. National symposium on system of rice intensification (SRI) – Present Status and Future Prospects, Hyderabad, November 17-18.

Uphoff N 2003. Higher yields with fewer external inputs :The system of rice intensification and potential contributions to agricultural sustainability. Int. J. Agric. Sustainability **1**: 38-50.

Viraktamath BC 2006. Evaluation of System of Rice Intensification (SRI) under All India Coordinated Rice Improvement project. **In**: Proc. Nat. Symp. System of Rice Intensification (SRI) – Present Status and Future Prospects, Hyderabad, November 17-18: 11-13.