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Crop establishment, fertility and weed management practices in scented hybrid rice

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ABSTRACT

An experiment was conducted during two consecutive rainy seasons at Rajendra Agricultural University, Pusa to study the effect of establishment method, fertility levels and weed management practices on scented hybrid rice. Two crop establishment methods (standard method of transplanting and SRI method of transplanting), three fertilizer levels (80:40:20, 100:60:40, 120:80:60 N, P_2O_5, K_2O kg/ ha) and three weed management practices (weedy check, one hand weeding (HW) at 35 days after transplanting (DAT) and pre-emergence application of pendimethaline at 1 kg/ha were tested in a randomized block design. SRI method of transplanting recorded higher grain yield than the standard method of transplanting. The yield increased with the increase in fertility levels and was maximum with 120:80:60 kg/ha N, P_2O_5 and K_2O/ha. One hand weeding registered higher grain and straw yields. Weed control efficiency was better with one hand weeding at 35 DAT in comparison to pre–emergence application of pendimethalin at 1 kg/ha.

Key words: Establishment method, Fertility level, Hybrid rice, Weed management

Rice is a staple food of our country and critically important for food security. The demand is expected to grow between 2.0 to 2.5% per annum until 2020, requiring continued efforts to increase productivity while ensuring sustainability. The system of rice intensification (SRI) developed in Madagascar over 3 decades ago is a holistic agro-ecological crop management technique seeking alternative to the conventional high-input oriented agriculture, through effective integration of crop-soil-water continuum. Literature. on SRI is full of controversies regarding its high yield enhancement (Sinclair 2004), additional labour requirement (Moser and Barrette 2003) *etc*. However, at the same time SRI has also received support for yield enhancement (Vijaykumar *et al*. 2006, Kabir and Uphoff 2007), input productivity water saving (Satyanarayana *et al*. 2007). Effect of nutrient management and weed management in SRI is an important and under-addressed issue. Hence, for a system as productive as the SRI system, it is imperative to find out nutritional need of the crop for which wide range of fertilizer doses need to be tested. Addition of fertilizer favours the growth of weeds more than that of crop. The problem of weeds is expected to be more acute under SRI system as compared to conventional transplanting. Hence, fertilizer application without adopting suitable weed control measures becomes a wasteful practice. The objective of this experiment was to evaluate the performance of SRI and standard practices of rice cultivation under optimum combinations of establishment methods, fertility levels and weed management practices.

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MATERIALS AND METHODS

An experiment was conducted during rainy (*Kharif*) season of 2005 and 2006 at Crop Research Center, Rajendra Agricultural University, Pusa. The soil was sandy loam in texture, low in available N, P, K and soil pH (8.2) was higher than neutral range. The experiment was laid out in a randomized block (factorial) design comprising two establishment methods, *viz*. standard practice of transplanting with 20 x 15 cm spacing and system of rice intensification method of transplanting with 25 x 25 cm spacing; three levels of N, P_2O_5 and K_2O, *viz*. 80:40:20, 100:60:40 and 120:80:60 kg/ha were applied. Three weed management practices, *viz*. weedy check, hand weeding at 35 DAT and application of pendimethalin at 1kg /ha as pre-emergence. The combinations of all the treatments were replicated thrice. In standard practice of transplanting, 25 days old seedling (1 or 2 seedling/hill) and in SRI method of transplanting, 14 days old seedling (1 seedling/hill) were planted. *Pusa RH-10* of 125 days maturity was the test variety.

SRI transplanted plots were kept moist throughout the vegetative phase with proper irrigation and drainage facilities. However, in standard practice of transplanting 5±2 cm depth of water was maintained during vegetative phase. In both the methods, 2-3 cm of standing water during reproductive phase was maintained. As per the treatment, the entire quantity of phosphorus as di-amonium phosphate (DAP) and potassium as muriate of potash and half dose of nitrogen as urea was applied as basal, the rest nitrogen was applied in equal splits through urea. The observations on weed density and weed dry weight were recorded. The data were analyzed according to randomized block (factorial) design by standard ANOVA at $P<0.05$ level of significance.

RESULTS AND DISCUSSION

Growth and yield attributes

Rice establishment methods, fertility levels and weed management practices had significant effect on most of the growth and yield attributes. The SRI method of crop establishment had taller plants as compared to standard method, but the difference was non-significant. Number of tillers/hill, length of panicles (cm), no. of fertile grain/panicle and 1000-grain weight registered significantly higher values in case of SRI method than standard method of crop establishment. Panicles/m^2 at harvest did not vary due to variation in crop establishment methods. Under wider spacing in case of SRI, the growth potential of the crop is fully expressed. Transplanting young seedling below the age of 15 days *i.e.* prior to start of fourth phyllocron of growth, preserves plant potential for tillering and root growth which is otherwise reduced under conventional method of transplanting. Though the tiller number under individual hill was higher under wider spacing, the total tiller production per unit area was higher under closer spacing (Table 1). Increased tiller production per unit area with decrease plant spacing has also been reported by Siddiqui *et al.* (1999). Numerically more panicles/m^2 was recorded for standard method of crop establishment than the SRI system due to higher plant density. The plants getting wider spacing as in case of SRI method of transplanting had lower below and above ground competition so essential for better grain filling, higher test weight and number of fertile grains/panicle and also for preventing mortality of late formed tillers resulting in higher productive tillers and increased weight of panicles.

The growth and yield attributes except 1000-grain weight, increased significantly with increase in fertility levels; and were more in plots receiving 120:80:60 kg/ha $N:P_2O_5:K_2O$. The increase in levels of fertilizer improved all growth and yield attributing parameters due to the adequate nutrient availability since early growth stages ensured proper nutrition for enhanced photosynthetic efficiency and accumulation of photosynthates from source to sink with increased level of fertilizer. Chopra and Chopra (2000) also reported no variation in test weight due to N-levels, indicating negligible influence of N on grain filling in medium duration rice.

Weed population, weed dry weight and weed growth rate were found minimum with one hand weeding at 35 DAT which were significantly lower than that of application of pendimethilin as a pre-

Table 1. Growth, yield attributes and yields of rice as affected by establishment method, fertility level and weed management practices

Treatment	Plant height (cm)		Length of panicle (cm)		No. of fertile grain/ panicle		Panicles/m^2 at harvest		1000-grain weight (g)		Grain yield (t/ha)		Straw yield (t/ha)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Establishment method														
Standard method (20 x 15 cm)	82.1	82.5	24.2	24.5	97	102	228	299	21.3	21.8	4.89	5.10	6.04	6.28
SRI method (25 x 25 cm)	84.6	85.2	26.2	26.7	103	111	279	291	21.9	22.4	5.19	5.59	6.16	6.54
LSD (P=0.05)	NS	NS	1.09	0.92	3.66	3.94	N5	N5	0.36	0.40	0.27	0.23	NS	0.25
Fertility level														
80:40:20 N,P_2O_5, K_2O	78.0	78.1	22.6	23.2	89	94	248	262	21.4	21.8	4.45	4.71	5.61	5.90
100:60:40 N,P_2O_5, K_2O	84.9	85.7	25.8	26.4	103	100	289	304	21.6	22.2	5.13	5.49	6.29	6.53
120:80:60 N,P_2O_5, K_2O	87.2	87.8	27.1	27.3	110	116	313	320	21.8	22.4	5.48	5.80	6.39	6.79
LSD (P=0.05)	5.3	4.31	1.33	1.13	4.48	4.83	15.5	17.6	NS	NS	0.33	0.29	0.25	0.31
Weed management														
Weedy check	76.6	79.7	23.4	24.2	83	88	236	250	21.2	21.7	4.14	4.41	5.24	5.51
HW at 35 DAT	88.3	87.4	26.2	27.1	112	118	313	329	21.9	22.5	5.59	5.93	6.64	6.96
Pre-emergence pendimethalin	85.2	84.4	26.0	25.5	107	113	301	308	21.7	22.2	5.33	5.68	6.41	6.78
LSD (P=0.05)	5.30	4.31	1.33	1.13	4.48	4.83	15.5	17.6	0.44	0.49	0.33	0.29	0.25	0.31

emergence and weedy check. In case of weed control efficiency, percentage was also higher with hand weeding. However, the application of pendimethelin was also effective to minimize weed population, weed dry weight and weed growth rate than the check but it was significantly lower than that of hand weeding (Table 2).

The grain yield increased linearly with corresponding increase in fertility levels and higher yield was observed in plot treated with 120:80:60 kg/ ha N: P_2O_5: K_2O. The nutrient uptake by plants increase with increase in fertilizer dose (Table 3) which significantly increased the growth and yields attributes and ultimately led to greater assimilation of photosynthates.

Amongst weed management practices, one hand weeding at 35 DAT was found significantly superior, which registered more growth and yield attributes, followed by application of pendimethalin at 1.0 kg/ha during both the years. The pre-emergence application of pendimethalin did not control all the weeds and might have caused phototoxity to emerging seedling, also with the lapse of time, the effectiveness of herbicides mostly decrease and the weeds tends to regenerate which later on hindered the efficiency of production factor resulting in lower values of growth and yield attributes than hand weeding. Whereas, hand weeding resulted in diminished crop weed competition at most critical period of weed interference and thus the weed free environment prevailing during rice growth and development ensured vigorous plants resulting in higher yields. Due to stiff competition from weeds the growth and yield attributes were recorded the least in the weedy check plots.

Table 2. Weed parameters as affected by different treatments

Treatment	Weed population/m^2at 60 DAT		Weed dry wt. (g/m^2) at 60 DAT		Weed growth rate at 30-60 DAT (g/day)		W.C.E (%) at 60 DAT	
	2005	2006	2005	2006	2005	2006	2005	2006
Establishment method								
M_1-Standard method (20x15cm)	110.3	105. 4	36.7	35.4	0.81	0.84	48.87	42.95
M_2-SRI method (25x25cm)	112.8	107.4	37.3	36.3	0.80	0.80	48.19	43.26
LSD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Fertility level								
F_1-80:40:20 N,P_2O_5,K_2O	109.7	104.3	36.3	35.4	0.79	0.78	48.47	42.78
F_2-100:60:40 N,P_2O_5,K_2O	111.4	106.7	37.2	35.8	0.81	0.86	49.15	43.22
F_3-120:80:60 N,P_2O_5,K_2O	113.6	108.1	37.5	36.3	0.81	0.80	47.97	43.32
LSD(P=0.05)	NS	NS	NS	NS	NS	0.05	NS	NS
Weed management								
W_0- Weedy check	207.3	197.6	71.9	69.6	1.85	1.81	-	-
W_1-HWat 35 DAT	37.4	35.8	9.10	8.83	- 0.24	- 0.14	87.34	73.89
W_2- Pre-emergence pendimethalin	90.1	85.7	30.0	29.1	0.81	0.78	58.25	55.43
LSD(P=0.05)	6.16	5.44	2.22	1.85	0.05	0.05	3.66	2.96

Table 3. Nutrient uptake by weeds as affected by different treatments

Treatment	Nutrient uptake by weeds (kg/ha)					
	N		P		K	
	2005	2006	2005	2006	2005	2006
Establishment method						
M_1-Standard method (20 x 15 cm)	12.9	13.4	2.91	2.98	18.3	17.4
M_2-SRI method (25 x 25 cm)	12.7	13.1	2.84	2.90	17.6	17.1
LSD (P=0.05)	NS	0.22	0.06	0.05	0.38	0.29
Fertility level						
F_1-80:40:20 N, P_2O_5, K_2O	13.1	13.4	2.88	2.96	17.9	17.3
F_2-100:60:40 N, P_2O_5, K_2O	13.3	13.3	2.99	3.00	18.3	17.3
F_3-120:80:60 N, P_2O5, K_2O	12.2	12.9	2.74	2.86	17.7	16.9
LSD (P=0.05)	0.31	0.27	0.07	0.06	N5	0.35
Weed management						
W_0-Weedy check	20.2	23.3	4.84	5.23	31.6	30.2
W_1-HW at 35 DAT	5.94	5.98	1.47	1.32	8.19	7.79
W2- Pre-emergence pendimethalin	12.4	10.3	2.30	2.26	14.2	13.6
LSD (P=0.05)	0.31	0.07	0.07	0.06	0.46	0.35

Yield

Crop establishment methods, fertility levels and weed management practices significantly influenced the grain yield during both the years. The crop raised by SRI method produced significantly higher grain yield (5.59 t/ha) than the plots planted under standard method of establishment (4.85 t/ha) and (5.10 t/ha) in 2005 and 2006, respectively. The favourable effect on growth and yield attributes resulted in higher grain yield under SRI method of crop establishment. Sparse planting in SRI avoids the inhibition of root growth that results from crowding and by exposing plants to more light and air, SRI create border effect for the whole field (Satyanarayan *et al.* 2007*)*.

Amongst weed management practices, one hand weeding at 35 DAT registered the highest mean yield followed by pre-emergence application of pendimethalin both of which were significantly superior to weedy check. These results are in conformity with the findings of Agrawal and Sharma (1997) and Sarath and Thilak (2004).

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