Indian Journal of Agronomy 47 (1) : 50–56 (March 2002)

Comparative performance of *indica* and *japonica* rice (*Oryza sativa*) varieties under late-planted rainfed lowland condition

S.S. SINGH[1], SONI SRIVASTAVA AND A.K. SINGH[2]

Rajendra Agricultural University, Pusa, Bihar 848 125

Received: May 2001

ABSTRACT

An experiment was conducted during the rainy (*kharif*) season of 1996 and 1997 at Pusa, Bihar, in silty loam soil under rainfed lowland conditions to compare the performance of *japonica* type and 4 photosensitive varieties (PSV) of *indica* rice (*Oryza sativa*) planted under late planted conditions on 21, 31 August and 10 September with a seedling age of 65, 75 and 85 days. The HYV 'Kanak' and 'Mahsuri' were not found suitable for late planting due to their staggered flowering and maturity, high incidence of insect pests and diseases, poor yield and profit. In September planting both HYV did not perform well. Weakly PSV, medium-bold-seeded 'Rajshree' was found suitable up to 31 August planting. Coarse-grained PSV 'Vaidehi' was found suitable only up to 21 August planting, with a profit of Rs 7,708/ha. Scented PSV were found suitable in all 3 dates due to less incidence of pests, optimum yield attributes and better market price of grains although their profit in 10 September planting was very marginal (Rs 2,467/ha). Highest profit of Rs 9,328/ha was found in 'Kamini' planted on 21 August. Highest uptake of nutrients (N, P_2O_5 K_2O) was in PSV 'Rajshree' with 54.3, 32.05 and 61.03 kg/ha while lowest of 44.11, 27.45 and 58.02 in HYV 'Kanak' under this condition.

Key words : Rainfed lowland, Late planting, HYV, Photosensitive rice

In eastern India, rice is grown predominantly under rainfed lowland (RLL) ecology during the rainy (*kharif*) season. This rice is transplanted from the first week of July with younger seedlings till end of August due to early submergence by flash flood or other input scarcity. Crop yield and its tolerance to stress vary according to its genetic make up, seedling age or planting period, and other prevailing management or environment. High-yielding varieties (HYV) *japanica* type suitable for RLL do not perform well under late planting due to poor tillering and problem in flowering

Present address : [1]ICAR Research Complex for Eastern Region, P.O. Phulwari Sharif, Patna, Bihar; 801 505; [2]Project Directorate for cropping systems Research, Modipuram, Meerut, Uttar Pradesh 250 110.

owing to low temperature. Photo-sensitive varieties (PSV) *indica* type rice always flower by October last and have ability to cope up the adverse effect of such conditions (Singh *et al.*, 1995). The PSV having scented character may be alternative to coarse PSV due to their higher market rate. In normal conditions, nutrient uptake in HYV is higher than PSV but under this adverse condition the pattern may differ which decides crop performance. It is necessary to determine the maximum allowing delayed period for HYV and PSV (improved, coarse and scented), their extent of planting period and nutrient uptake pattern under adverse late-planted conditions. The present experiment was an attempt in this direction.

MATERIALS AND METHODS

An experiment was conducted at Experimental Farm, Pusa, Bihar, during the rainy (*kharif*) season of 1996 and 1997 with objective to evaluate the comparative performance of *indica* and cross *japonica* type of rice varieties in extreme late-planted RLL conditions. The PSV indica varieties were : 'Kamini' and 'Sugandha' having scented character, coarse-seeded variety 'Vaidehi' and medium bold grain 'Rajshree'. The HYV *japonica* cross varieties were 'Kanak' and 'Mahsuri'. The soil was silt loam, with 8.6 pH and 0.46% of organic carbon, The available N, P_2O_5 and K_2O were 210.0 (low), 18.88 (medium) and 86.0 (low) kg/ha, respectively. The experiment was carried out in randomized block design with 3 replications consisting of 18 treatments having with combination of aforesaid varieties and 3 late-planting dates of 21 August, 31 August and 10 September during both the seasons. The nursery was sown by 17 June and therefore, seedling age were 65, 75 and 85 days on respective 3 dates. The crop was planted at 15 cm × 15 cm spacing (44 hills/m^2) under 40, 20 and 10 kg/ha N, P_2O_5 and K_2O schedule for PSV and 60, 30 and 15 kg/ha for HYV. One spraying each of Democron 100 EC and Endophil M-45 was done as plant protection. The total precipitation received during specified crop season was 349.3 mm in 1996 and 261.2 mm in 1997 with corresponding total pan evaporation of 222.7 and 284.6 mm, respectively. The mean minimum temperature at flowering stage (25 October to 2 November) was 20.8°C. The infestation of stem borer (*Triporyza incertulas*), case worm (*Nymphula depunctalis*) insects and brown spot (*Helminthosporium oryzae*) and sheath rot (*Scarodiadium oryzae*) diseases were scored as per the IRRI scoring manual. Total N in grain and straw was estimated by Kjeldhal's method (Jackson, 1973). The content of P was estimated by colorimetric method (Jackson, 1973). The content of K was estimated with help of flame photometer (Jackson, 1973).

RESULTS AND DISCUSSION

Growth, flowering and maturity

Maximum plant height was in 'Sugandha', while minimum in 'Kanak'. There was a decline in final height. Highest decline (47.5%) against normal height was in 'Kanak', followed by 'Vaidehi' and 'Mahsuri' and lowest (18.5%) in 'Sugandha'. In PSV growth was recorded till early October, irrespective of their

seedlings age and hence less reduction was recorded in these varieties compared with HYV. Maximum height was in 21 August planting and significant reduction was recorded at each successive date of planting. Souza (1986) and Canet *et al.* (1986) reported that length of vegetative growth stage of rice was progressively reduced due to delayed planting with variable effect in various varieties.

Tiller numbers of all 6 varieties were comparable but effect was pronounced due to delayed planting. On an average, 244 tillers/m^2 could be achieved in all varieties. Maximum tillers/m^2 were recorded at 21 August planting, while minimum in 10 September (Table 1).

The HYV flowered earlier (22–28 October), while PSV flowered slightly late (26 October–2 November) except 'Rajshree'. Staggered flowering and maturity was recorded in 'Kanak' and 'Mahsuri', which was less in 21 August planting and highest in 10 September. The

Table 1. Growth, flowering, disease incidence and maturity of rice varieties as influence of extreme late planting under rainfed lowland conditions (mean data of 1996 and 1997)

Treatment	Plant height (cm)	Tillers/ m^2 at 30 DAS	Mean flowering date/ pattern	Insect pest incidence at flowering stage (infested tiller per cent)		Disease incidence at milking stage		Mean maturity date/ pattern
				Stem-borer	Case-worm	Brown spot (infested leaf part %)	Sheath rot (infested sheath %)	
Variety								
'Kanak (HYV)	69.3	252.8	27 Oct.**	9.5	36.9	36.4	32.3	28 Nov.**
'Mashuri' (HYV)	104.2	244.7	29 Oct.**	9.8	29.8	20.6	14.3	28 Nov.**
'Rajshree' (Improved PSV)	94.6	249.6	26 Oct.	8.4	25.6	9.2	6.4	25 Nov.
'Kamini' (Scented PSV)	112.4	236.0	30 Oct.	15.3	16.7	21.6	1.8	2 Dec.
'Sugandha' (Scented PSV)	122.2	251.4	28 Oct.	28.4	15.2	36.1	1.2	1 Dec.
'Vaidehi (Coarse PSV)	11.8	240.7	29 Oct.	14.3	21.4	21.1	3.0	29 Nov.
CD (P=0.05	2.9	NS	-	7.2	7.4	11.8	12.7	
Date of planting (age of seedling)								
21 August (65 days)	117.1	267.6	Mahsuri **	5.7	8.4	12.2	2.3	'Mahsuri'*
31 August (75 days)	103.9	240.4	Kanak ** Mahsuri**	11.4	20.3	23.5	6.4	'Kanak'** 'Mahsuri' **
10 September (85 days)	86.2	224.4	Kanak ** Mahsuri**	11.4	20.3	23.5	6.4	'Kanak' ** 'Mahsuri' **
CD (P=0.05)	2.0	10.6	-	11.8	18.4	10.7	11.6	-

HYV, High-yielding variety (*japonica* crossed); PSV, photosensitive varieties (*indica* type); *staggered flowering and maturity; **highly staggered flowering and maturity

PSV always flower by October last and are tolerant to low temperature of about 20°C. Weak PSV like 'Rajshree' flower slightly early if nursery is raised early. The HYVs 'Kanak' and 'Mahsuri' are thermosensitive and cool night temperature causes staggered flowering. The reason might have been responsible in uniform flowering of PSVs and staggering in HYV. Rao *et al.* (1983) reported cold injury in HYV resulting in irregular flowering and low yield due to late planting. Maturity pattern was found linked with flowering.

Incidence of insect pests and diseases

At flowering stage incidence of case worm (CW) and stem-borer (SB) was found in all 6 varieties at all 3 planting dates which was in increasing order with delayed planting. Incidence of CW was higher than SB under all treatments. The SB infestation was higher in PSV, while CW in HYV (Table 1). Due to the genetical susceptibility incidence of SB was highest in 'Sugandha'. Singh (1987) and Vaigenti and Saxena (1988) reported higher incidence of brown plant-hopper and stem-borer under delayed planting.

Brown-spot incidence was the highest in HYV 'Kanak', followed by PSV 'Sugandha' and lowest in 'Rajshree'. Similarly, highest incidence of sheath rot was in 'Kanak' (32.3%), followed by 'Mahsuri'

Table 2. Yield attributes, yield and profit of rice varieties as affected by date of extreme late planting under rainfed lowland system (Pooled data of 1996 and 1997)

Treatment	Panicles/ m^2	Grains/ panicle	1,000-grain weight (g)	Grain: fertility (%)	Grain: straw ratio	Grain yield (tonnes/ ha)	Net profit (Rs/ha)	Nutrient uptake (kg/ha)		
								N	P_2O_5	K_2O
Rice variety										
'Kanak (HYV)	269	94.2	21.57	74.5	0.58	2.16	2,342*	42.55	28.46	56.21
'Mashuri' (HYV)	242	78.4	16.59	68.4	0.43	1.97	4,020*	44.39	26.49	56.88
'Rajshree' (Improved PSV)	264	93.9	19.89	75.6	0.48	2.29	5,656	54.30	32.05	61.03
'Kamini' (Scented PSV)	280	104.6	17.10	84.4	0.55	2.13	5,912	44.11	27.45	58.02
'Sugandha' (Scented PSV)	306	114.2	16.02	86.3	0.55	2.13	5,921	40.19	25.09	56.50
'Vaidehi (coarse PSV)	354	108.7	27.67	81.2	0.59	2.41	3,661**	46.14	31.55	58.9
CD (P=0.05	14	2.8	1.21	2.6	0.05	0.24	820	3.89	3.04	3.44
Date of planting (age of seedling)										
21 August (65 days)	301	124.6	21.78	84.1	0.59	2.79	7,875	51.11	32.06	61.17
31 August (75 days)	278	97.4	19.93	79.8	0.54	2.24	4,927	46.51	28.16	37.48
10 September (85 days)	228	80.6	17.84	71.6	0.45	1.46	852	38.23	25.32	55.11
CD (P=0.05)	10	2.0	0.86	1.9	0.03	0.17	1,160	2.75	2.15	2.43

*No profit (loss) and; ** nominal profit at 10 September planting

(14.3%) and lowest in 'Sugandha' (1.2%). On an average, incidence of both diseases was 2 times more at each successive delayed date of planting. In general, PSVs were found more tolerant to diseases than HYVs under this condition. Singh *et al.* (1986) also reported that varieties showing resistance to sheath rot with 25 days rice planted seedlings were highly affected by this disease when planted with 50 days old seedlings.

Yield and yield attributes

Maximum panicles were under 'Sugandha' and significantly higher to rest 5 varieties. Minimum panicles were recorded in 'Mahsuri'. Lowest panicle number was recorded in 10 September planting which may be due to least available vegetative and reproductive period of rice crop. The interaction effect was found significant. Highest panicle number was found in 'Kamini' under 21 August planting, while lowest (204.0/m^2) in 'Mahsuri' on 10 September planting.

Grain number under 'Kamini', 'Sugandha' and 'Vaidehi' was significantly higher than under 'Kanak' and 'Mahsuri'. Highest grains/panicle were under 21 August planting which is significantly reduced at each later planting to the extent of 36% less under 10 September planting. Interaction effect was significant; 'Vaidehi' planted at 21 August produced maximum grains.

Highest value for 1,000-grain weight was recorded in 'Vaidehi', a bold-seeded variety, followed by 'Kanak', which is also bold seeded. Lowest weight was under fine scented variety 'Sugandha'. Due to their genetic characters, this variation could be observed but significant reduction was observed at each successive stage of delayed planting from 21 August to 10 September.

In general, grain fertility (%) was significantly higher in PSV over HYV. Maximum and minimum values of GFP were recorded in 'Sugandha' and 'Mahsuri' respectively. The trend was due to tolerant capacity of variety against low temperature at flowering stage. The grain fertility was significantly reduced from 84.1% in 21 August planting to 71.6% in 10 September planting. Interaction effect was significant. Maximum grain fertility of 88.7% GEP was in 'Sugandha' planted on 21 August and lowest of 54.1% in 'Mahsuri' planted on 10 September. Ashraf *et al.* (1989) and Kurmi *et al.* (1993) reported that number of panicles/m^2, grains/panicle and 1,000-grain weight are major yield characters. Though they are genetically governed, their expressions are mainly associated with environment.

Grain : straw ratio under 'Kanak' was at par to 'Kamini', 'Sugandha' and 'Vaidehi'. The ratio under PSV was significantly higher than HYV 'Mahsuri'. Genetically HYV have high ratio than PSV planted under normal conditions. Trend recorded in the experiment proved that due to adverse condition high ratio of HYV was declined and share of grain in biomass was decreased. Here PSV could maintain their optimum ratio and become at par with HYV. The ratio was decreased significantly from 0.59 in 21 August planting to 0.45 in 10 September planting. The interaction effect was non-significant.

Highest yield was under 21 August planting, which was declined significantly in 31 August and 10 September plantings. Crop yield was associated with number of days availed by crop in main field, utilized rainfall, tillering, incidence of pest, flowering pattern and other yield attributes. Maximum yield was recorded in coarse PSV 'Vaidehi' which was at par to next higher yielder 'Rajshree'. 'Kanak' could yield at par to 'Rajshree'. Lowest yield was in HYV Mahsuri due to poor growth and development, staggered flowering and high pest incidence (Table 2). The HYV could not exceed over PSV who maintained constantly good performance with aforementioned factors. The interaction effect was non-significant.

Economics

The maximum net profit was under 21 August planting and significantly higher than that under rest dates. Decline in 37.4% net profit was recorded under 31 August planting over first date. Crop planted by 10 September could give a profit of only Rs 852/ha. Among varieties maximum profit was in PSV 'Sugandha' at par to 'Kamini' and lowest in HYV Kanak (Rs 2,342/ha). This was associated with grain and straw yields as well as market price of particular variety. Scented rice fetched higher rate over coarse varieties in each dates. On 21 August planting 'Kamini' fetched highest profit which was at par to 'Rajshree' and lowest profit was under 'Kanak'. In 10 September planting both 'Kanak' and 'Mahsuri' were at loss, while 'Rajshree' and Vaidehi' were at very negligible profit. At this date only 'Sugandha' and 'Kamini' could give a marginal profit of Rs 2,603 and Rs 2,371/ha respectively.

Total NPK uptake

Total uptake of N, P_2O_5 and K_2O was significantly declined by delaying of planting. Highest values for aforesaid nutrients were under 21 August planting with 51.11, 32.06 and 61.17 kg/ha respectively. Difference was significant at all stages under all 3 nutrients except in K_2O where 31 August and 10 September were at par. Reduction in N, P and K uptake was by 25.3, 21.1 and 10.0% from 21 August to 10 September respectively (Table 2).

Highest total uptake of N was in 'Rajshree', being significantly superior to rest varieties. Lowest N uptake was by 'Sugandha'. 'Rajshree' was rated for highest total P uptake but at par with 'Vaidehi'. Lowest total uptake was in 'Mahsuri'. All varieties were able to show at par ability for K uptake except 'Rajshree' whose total K uptake was significantly higher than of 'Kanak', 'Mahsuri' and 'Sugandha'. The interaction effect was non-significant in all cases. The trend in total uptake was associated with uptake in grain and straw. These findings are in close conformity in those of DRR (1996).

The experiment showed that under adverse extreme late planted conditions (20 August to 10 September) PSV *indica* types are able to perform better than HYV *japanica* type rices in term of yield, profit and nutrient uptake and therefore PSV *indica* type are better choice.

REFERENCES

Ashraf, M., Mohamad, S., Munsif, M. and Yusuf, M. 1989. Relationship of transplanting time and grain yield of Basmati 385. *International Rice Research Newsletter* 14 (1) : 8

Canet, R., Colon, C., Delis, A. and Baulenko, N. 1986. Effect of sowing dates on grain yield—a group of rice (*Oryza sativa*) cultivars with different growth cycle. *Rice Abstracts* 9(2) : 62.

DRR. 1996. *Annual Report of AICRIP*, Directorate of Rice Research, Hyderabad, Andhra Pradesh.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India, Pvt. Ltd, New Delhi

Kurmi, K., Baruah, R.K.S.M. and Das, G.R. 1993. Effect of seeding age on grain yield and yield components of *ahu* rice. *Oryza* 30 (2) : 136–138.

Rao, M.V. and Reddy, B.B. 1983. Suitable rice varieties for late (post-flood) planting in lowland areas. *Oryza* 20(4) : 260–262.

Singh, B.N., Sahu, S.P., Prasad, Y. and Singh, R.S. 1986. Seedling age in relation to sheath rot occurence. *International Rice Research Newsletter* 11(4) : 26.

Singh, R.S. 1987. 'Investigation on sheath rot of rice.' Ph.D. Thesis, Rajendra Agricultural University, Pusa, Bihar.

Singh, S.P., Pillai, K.G., Pati, D. and Rani, N. Sobha. 1995. Influence of time of planting and grain yield and quality of dwarf scented rice varieties. *Oryza* 30(4) : 285–288.

Souza, P.R. De. 1986. Sowing dates and rates of nitrogen in irrigated rice cultivars. *Rice Abstracts* 9(3) : 111.

Vaigenti, V.D. and Saxena, R.C. 1988. Effect of plant age on rice susceptibility to yellow stem borer (*Scirpophaga incertulas* Walkar). *International Rice Research Newsletter* 13 (3) : 37.