Oryza Vol. 47. No.1, 2010 (48-52)

Response of hybrid rice to time of planting and plant density

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ABSTRACT

A field experiment was conducted to study the effect of planting time and planting density on the performance of rice hybrids PA 6201 and PHB 71 during dry season. Experimental results revealed that the crop recorded significantly maximum plant height (70.9 cm), effective tillers m^{-2}(8.13), leaf area Index (5.13), leaf area duration (252.9 days), dry matter production $hill^{-1}$(34.41 g $hill^{-1}$), root volume (26.1cc $hill^{-1}$), root weight (3.83 g $hill^{-1}$), crop growth rate (26.07 g m^{-2} day^{-1}), relative growth rate (64.79 mg $g^{-1}day^{-1}$), net assimilation rate (7.37 g m^{-2} leaf area day^{-1}), panicle length (26.1 cm), fertile spikelets $panicle^{-1}$(106.7), 1000 grain weight (23.07 g) and finally grain yield 5.87 tha^{-1} when planted on January, 01. The highest net monetary return (Rs. 14432/- $hectare^{-1}$) and B:C ratio (1.63) were obtained irrespective of varieties planted on January 01 at 15 x 15 cm plant spacing.

Key words: *hybrid rice, planting time, plant density, yield*

There is a sharp decline in the overall growth rate of food production from 4.23 % during 1967-1978 to 3.77 % during 1979-91 and 2.96 % during last five year (Paroda, 2006). To meet the demand of the burgeoning population it is of paramount importance that a second break through in food grain production and productivity advance is to be achieved in the country. Among the various options available, commercial exploitation of hybrids vigour in rice seems to be most feasible one. The overall yield advantage due to cultivation of hybrid rice over conventionally grown high yielding varieties has been found to be 15-20 per cent *i.e.*1.5 to 2.0 t ha^{-1} (Govindarasu *et al*., 1997). It covers more than 7,50,000 hectares in India largely in southern areas and to some extent in western and eastern parts of the country (Sundaram and Bentur, 2006). In Orissa about 7% of the total rice growing area is under dry season rice with higher productivity due to more solar radiation and favourable temperature throughout the crop growth period. Despite the higher cost of summer rice particularly due to increased requirement of irrigation, the return per hectare is perceived to be higher. With appropriate agronomic management there is a good scope to exploit the full potential of rice hybrids. Among various cultural practices planting date, variety and spacing are of utmost importance for yield maximization. Date of planting during the dry season is mostly governed by temperature since hybrids have relatively higher degree of thermo-sensitivity during flowering and grain filling stages than the high yielding varieties. In order to ensure normal flowering and fertilization and avoid damage due to low and high temperature, it is necessary to properly manage the date of nursery sowing and transplanting of hybrid rice. Hence, the experiment was planned and conducted at Central Research Station, Orissa University of Agriculture & Technology, Bhubaneswar during the dry season to evaluate the performance of rice hybrid vis-à-vis the ruling HYV with respect to time of planting and optimum spacing 2003-04 - 2004-05.

MATERIALS AND METHODS

A field experiment with 4 dates of planting (1 January, 16 January, 31 January and 16 February), 2 Hybrids (PA 6201, PHB 71) and one high yielding variety Lalat and 3 plant densities (20 cm x 15 cm, 15cm x15 cm and 20 cm x 10 cm) was carried out in spilt-split plot design replicated thrice during dry seasons of 2003-04 and 2004-05 with recommended agronomic practices in main plot and in subplot. The soil of the experimental

site was loamy sand, having pH 6.1, organic carbon 0.46 %, available N, P, and K of 126.2, 22.68 and 184.0 kg ha^{-1}, respectively. Observations on leaf area, dry matter accumulation, and root volume and root weight were subplot recorded by taking 5 contiguous clumps each time, from each plot for destructive sampling. Net Assimilation rate, relative growth rate and crop growth rate were computed on the basis observations taken for leaf area and dry matter accumulations. All the biometric data recorded were analyzed statistically as per the procedure prescribed for split-split-plot design (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

Experimental results revealed that crop planted on January 01 recorded significantly maximum panicle length (26.1 cm), panicle weight (2.48 g), fertile spikelets $panicle^{-1}$ (106.7) and 1000 grain weight (23.07g). Among the hybrids, PHB71 produced longest panicle (26.8 cm) with maximum panicle weight (2.12 g) and maximum number of fertile spikelets $panicle^{-1}$ (93.9). Maximum sterility percentage (36.8%) was recorded in the hybrid PA 6201 but test weight of Lalat (23.52 g) was maximum. Planting at 20 cm x 10 cm recorded maximum plant height (69.7 cm) and leaf area index (5.37). Effective $tillers^{-1}$, dry matter production, root volume and root weight were maximum with wider spacing of 20 cm x 15 cm. It was observed that the hybrids registered more sterility than the HYV 'Lalat' (24.1%). Closer spacing of 20 cm x 10 cm resulted in significantly more sterility (34.7 %) than wider spacing of 20 cm x 15 cm (28.6%). The magnitude of increase in sterility percentage due to delay in planting from 1st January was more in rice hybrids than Lalat (Table 1).

All the growth attributes were significantly influenced by the date of planting, variety and spacing. The crop planted on January, 01 recorded maximum height (70.9 cm), effective tillers $clump^{-1}$ (8.13), leaf area index (5.13) and dry matter accumulation $clump^{-1}$ (34.41g). Crop growth rate (26.07 g m^{-2} day^{-1}), relative growth rate (64.79 mg g^{-1} day^{-1}), net assimilation rate (7.73 g m^{-2} leaf area day^{-1}), root volume (26.3 cc $hill^{-1}$ at 60 DAT) and root dry weight (3.56 g $hill^{-1}$) were also maximum in January 01 planted crop (Table 2.). Hybrid rice PHB 71 produced significantly maximum number of effective tillers $clump^{-1}$ (8.39) followed by PA 6201 (7.38).Wider spacing of 20 cm x 15 cm produced significantly more reproductive tillers $clump^{-1}$ than closer

Table 1. Effect of date of planting and plant density on yield attributes of rice hybrids

Date of Planting	Plant height (cm)	Panicle Length (cm)	Panicle weight (g)	Fertile spikelets $panicle^{-1}$	Sterility percentage	1000-grain weight (g)
1-Jan	70.9	26.1	2.48	106.7	19.5	23.07
16-Jan	69.5	25.8	2.34	99.3	23.1	22.69
31-Jan	68.0	24.6	1.81	79.8	35.2	21.86
16-Feb	67.0	23.9	1.34	60.4	47.4	21.28
SE(m)	1.25	0.19	0.04	1.81	0.63	0.15
CD(P=0.05)	NS	0.58	0.12	5.57	1.95	0.45
Variety						
PA 6201	66.7	25.5	2.02	86.1	36.8	22.95
PHB 71	71.6	26.8	2.12	93.9	33.1	21.2
Lalat	68.3	23.1	1.84	79.6	24.1	23.52
SE(m)	0.22	0.09	0.03	1.82	0.51	0.10
CD(0.05)	0.65	0.25	0.08	5.26	1.47	0.27
Spacing (cm)						
20 x 15	68.0	25.0	2.10	91.3	28.6	22.56
15 x 15	68.8	25.6	1.99	87.2	30.7	22.28
20 x 10	69.7	24.7	1.87	81.1	34.7	21.83
SE(m)	0.24	0.09	0.02	1.17	0.59	0.08
CD(P=0.05)	0.67	0.26	0.06	3.30	1.66	0.22

Table 2. Effect of date of planting and plant density on growth parameters and yield and economics of rice hybrids

Date of Planting	Effective tillers clum^{-1}	LAI at flag leaf stage (60 DAT)	DMP at harvest (g clum^{-1})	Root dry weight at 60 DAT (g clump^{-1})	Grain yield (t ha^{-1})	Harvest index(%)	Net Return	B:C ratio
1-Jan	8.13	5.13	34.41	3.83	5.87	50.9	14432	1.63
16-Jan	7.84	5.02	32.51	3.71	5.44	50.5	11763	1.51
31-Jan	7.25	4.72	29.01	3.45	4.13	45.4	4327	1.19
16-Feb	6.37	4.53	22.91	3.02	2.68	38.6	-4308	0.81
SE(m)	0.04	0.07	0.49	0.03	0.08	0.15		
CD(P=0.05)	0.12	0.20	1.50	0.11	0.24	0.45		
Variety								
PA 6201	7.38	4.98	30.90	3.56	4.55	45.8	6492	1.28
PHB 71	8.39	5.51	33.11	3.67	4.90	46.8	8647	1.37
Lalat	6.42	4.06	25.12	3.28	4.15	46.4	4521	1.20
SE(m)	0.08	0.03	0.26	0.07	0.05	0.21		
CD(P=0.05)	0.23	0.08	0.75	0.21	0.14	0.60		
20 x 15	7.84	4.10	33.85	4.04	4.20	46.8	5058	1.23
15 x 15	7.58	5.08	28.77	3.31	4.83	47.9	8145	1.35
20 x 10	6.78	5.37	26.50	3.16	4.57	44.3	6457	1.27
SE(m)	0.02	0.03	0.15	0.03	0.06	0.18		
CD(P=0.05)	0.06	0.07	0.42	0.08	1.60	0.50		

spacing of 15 cm x 15 cm and 20 cm x 10 cm. Comparatively higher percentage of tillers became effective with wider spacing (66.1 %) PHB 71 registered significantly maximum growth in height followed by Lalat. It also produced significantly maximum number of fertile spikelets panicle^{-1} when the crop was planted on January 01 at an spacing of 20 cm x 15 cm. Maximum CGR of 22.35 g m^{-2} day^{-1} was recorded during 45-60 DAT (Fig.1). Thereafter, there was decline in the CGR to the minimum of 1.71 g m^{-2} day-1 during 90 DAT – harvest. Maximum relative growth rate (RGR) and net assimilation rate (NAR) of 62.42 mg g^{-1} day^{-1} (Fig 2.) and 6.98 g m^{-2} leaf area day^{-1} (Fig 3.), respectively were recorded during the period 15 to 30 DAT. Rate of RGR and NAR declined with time and the corresponding minimum value of 1.33 mg g^{-1} day^{-1} and 0.83 g m^{-2} leaf area day^{-1}were recorded during 90 DAT –harvest. CGR, RGR and NAR were reduced with the delay in planting from 1st January. RGR and NAR of HYV were higher than rice hybrids PHB 71 and 'PA 6201'. Chandrashekhar *et al* (2001) also reported higher RGR and NAR with HYV 'NLR33358' than that of rice hybrids 'MGR 1', 'APRH 2', 'KRH 1', TNRH 16' and 'DRRH 1', but the CGR of rice hybrids was much higher during early stages of growth because of better foliage and high dry matter accumulation than check 'Lalat'. Chandrashekhar *et al* (2001) and Mohapatra (2003) reported similar results in hybrids and HYVs (Table 2).

It was found that the grain yield of was significantly higher and decreased progressively with successive delay in planting compared with January 01 planted crop, irrespective of hybrid and variety. There was 7.3 %, 29.5 % and 54.4 % reduction in grain yield due to 15, 30 and 45 days delay in planting from January 01, respectively. Among the genotypes/hybrids PHB 71 recorded significantly maximum grain yield of 4.90 t ha^{-1} followed by hybrid 'PA 6201' (4.55 t ha^{-1}) and HYV Lalat (4.15 t ha^{-1}). The magnitude of reduction in grain yield, however, was higher in hybrids than in the inbred check Lalat. The 15 cm x 15 cm spacing registered significantly maximum grain yield of 4.83 t ha^{-1} (Table 2). Higher yield of early planted crop might be the effect of favourable temperature at vegetative and ripening stages which helped in better photosynthesis and translocation of photosynthates to the sink, thereby resulting in better grain filling. The reduction in yield of the late planted crop might be due to higher temperature at ripening stage. Several reports on high yielding

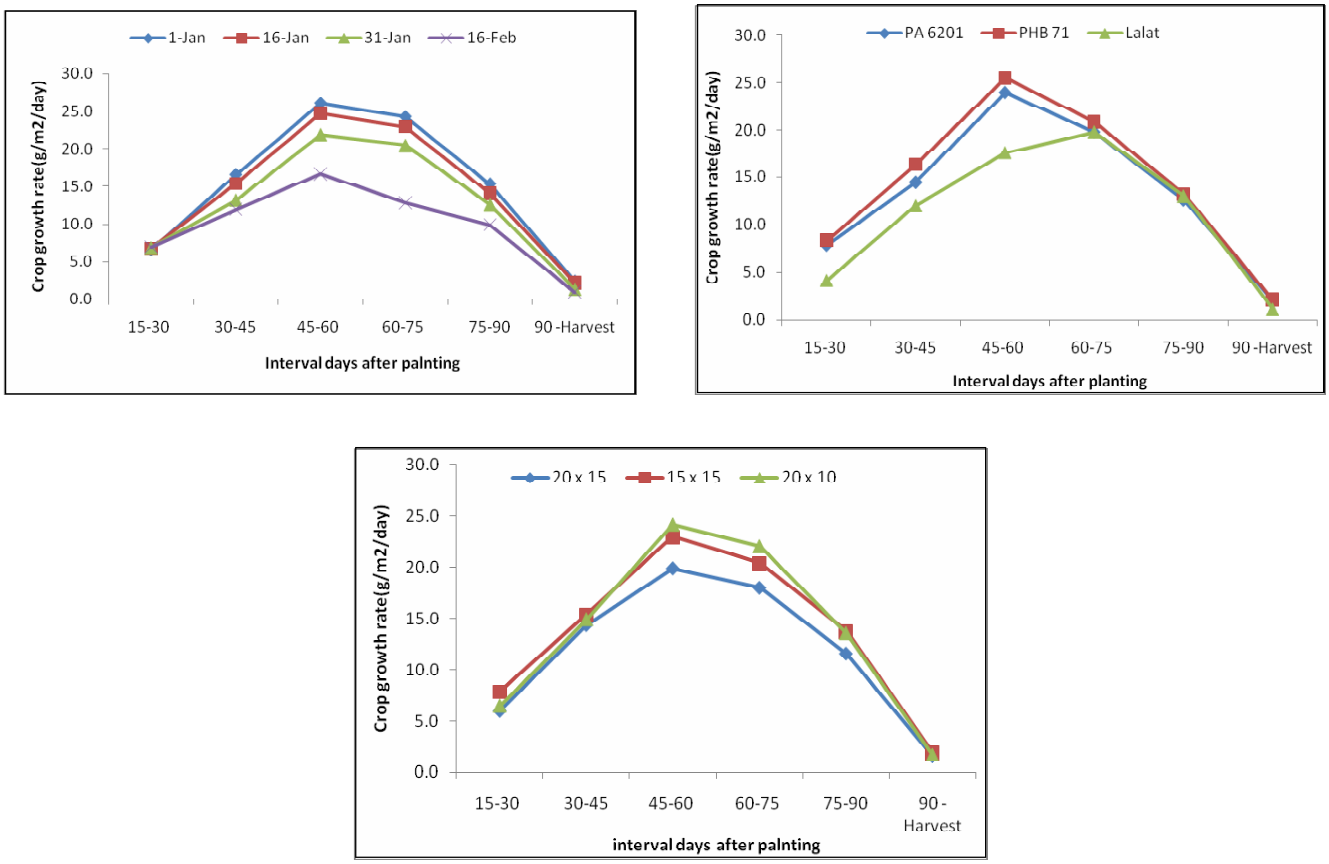

Fig 1. Effect of planting date and density on crop growth rate (g m^{-2} day^{-1}) of rice hybrids.

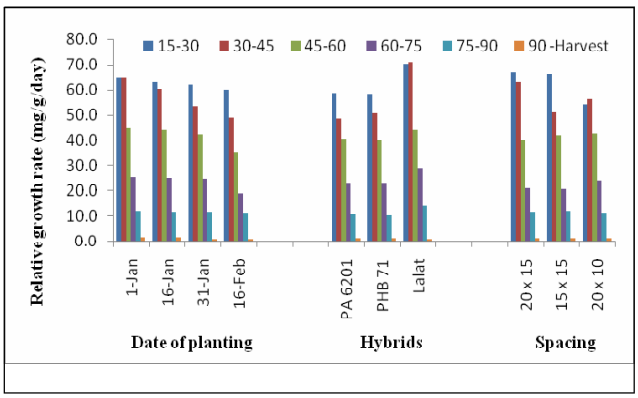

Fig 2. Effect of planting dates and density on relative growth rate (mg g^{-1} day^{-1}) of rice hybrids

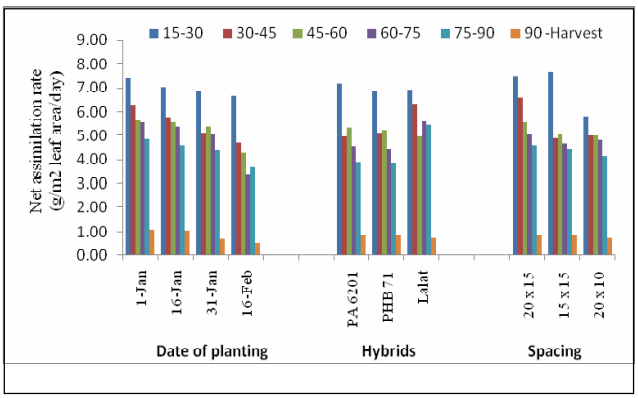

Fig 3. Effect of planting dates and density on net assimilation rate (g m^{-2} day^{-1}) of rice hybrids.

varieties (Deb Choudhary and Guha, 2000) indicated that early planting in middle January is the best and delay in planting by 15 and 30 days from mid-January reduces the yield by 21 and 34 %, respectively. Similarly, harvest index was also significantly influenced by dates of planting. It was significantly more on the first date of planting which might be due to higher rate of translocation of photosynthates to grains under favourable temperature at grain filling stage and it showed that crop planted early in the season was more efficient in partitioning the assimilates for economic yield in the reproductive phase. In case of late planting in February, high temperature in the vegetative as well as the reproductive phase caused early senescence of the leaves, reduced the ripening period and was responsible for higher spikelet sterility and reduced

harvest index. The cost of cultivation was comparatively more under early planting than under the late planting, more under high yielding rice and more under closer spacing than under wider spacing largely because of difference in seed and labour cost. Rice hybrids recorded higher monetary return and B: C ratio than high yielding varieties. Maximum net return per hectare (Rs.14432/-) and B: C ratio (1.63) was obtained irrespective of varieties and spacing planted on January 01.

REFERENCES

Cochran WG and Cox GM 1957. Experimental design (2nd Edition) Johan Wiley and sons, Incs.,New York, pp. 611

Chandrashekhar J, Ramarao G, Reddy BR and Reddy KB 2001. Physiological analysis of growth and productivity of hybrid rice. Indian Journal of Plant Physiology. 6: 142-146

Deb Choudhary PK and Guha B 2000. Performance of rice varieties under different timeof planting in boro season. Annals of Biology 16 (1):41-44

Govindarasu R, Ramamoorthi N, Manian K and Subramanian M 1997. Hybrid rice for second green revolution. Kisan World 15-17

Mohapatra AK 2003. Studies on direct and residual effect of secondary and micro nutrient on rice(Hybrid) – rice cropping sequence. Ph.D. Thesis submitted to OUAT, Bhubaneswar.(Unpublished).

Paroda RS 2006. Strategy for increasing productivity, growth rate in agriculture. Farmer's Forum. 6(8): 2-6.

Ramiah K 1937. Rice in Madras- a popular hand book. Suptd. Govt.Press, Madras.

Sundaram RM and Bentur JS 2006. Rice genetics. Current Science. 90 (7): 901-903