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Physiological parameters and grain yield as influenced by time of transplanting and rice (*Oryza sativa*) hybrids

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ABSTRACT

A field experiment comprising 4 dates of transplanting (15, 25 June and 5, 25 July) in conjunction with 4 genotypes (3 hybrids : 'ORI 161' 'PMS2A/IR31802, 'PMS10A/PR106' and 1 inbred variety 'HKR 126') was conducted during rainy season of 1993 and 1994. Crop-growth rate (CGR) prior to panicle-initiation (PI) stage was higher in July transplanting, whereas it increased significantly in 25 June planting during post-PI stage through flowering period. Leaf-area duration (LAD) during pre-PI stage was the longest in the most delayed planting, but 25 June planting excelled over other dates during flowering period of crop growth. Leaf-area ratio (LAR) was the highest in June-planted crop at all the time intervals. Panicles/m^2, grain and straw yields were higher in 25 June-planted crop, followed by 5 July. Spikelet sterility was maximum in 25 July and minimum in 25 June-transplanted crop. Hybrid 'ORI 161' ('PHB 71') exhibited superiority to other genotypes in CGR, LAD, grain yield and straw yield. Spikelet sterility (%) was lowest in 'ORI 161', followed by 'HKR 126'.

Key words **:** Physiological parameters, Yield, Rice, Transplanting

Heterosis in rice brings about 14–28% increase in grain yield (Siddiq, 1993) and its commercial exploitation is the only alternative to combat the arising situation of food insecurity. An effective agronomic management is, therefore, necessary to exploit the yield potential of hybrid rice. Temporal variability at a particular location may influence growth and development of the plant. Thus, the knowledge of rate and pattern of growth parameters with respect to grain yield may offer a pertinent ground for the inductive assessment of hybrids. To collect the information in this context, the present study was undertaken.

MATERIALS AND METHODS

A field study was undertaken during wet seasons of 1993 and 1994 at Rice Research Station, Kaul (Kaithal). The experiment comprised 4 dates of transplanting (15, 25 June and 5 and 25 July) in main plots and 4 genotypes (3 hybrids: 'ORI 161' 'PHB 71') 'PMS2A/IR31802' and 'PMS10A/PR106' and 1 inbred variety 'HKR 126') in sub-plots. The soil of the experimental site was clay-loam, with pH 8.1, EC 0.26 dS/m, O.C. 0.31%; and 99.6, 26.0 and 389.7 kg/ha available N,P and K respectively.

Two seedlings/hill were planted at a spacing of 20 cm × 15 cm in split-plot design with 4 replications. Staggered sowing of nursery was done to get 30-day-old seedlings at the time of transplanting except in 25 July transplanting in 1993, where 40-day-old seedlings were used. The field was fertilized with 150 kg N, 60 kg P_2O_5 and 25 kg $ZnSO_4$/ha. Nitrogen was applied in 3 equal splits at 4, 21 and 42 days after transplanting (DAT).

The observations on leaf-area index (LAI) and dry–matter accumulation were recorded at an interval of 20 days. The crop-growth rate (CGR) and leaf-area duration (LAD) were worked out using the formula given by Watson (1952) and Power *et al.* (1967) respectively. The LAR was calculated by the formula described by Ahlawat and Sharma (1993). The time intervals for which the growth rates have been computed are symbolised by : T_1, 20 days duration before panicle-initiation (PI) stage; T_2, 20 days duration after PI stage; and T_3, 20 days duration during flowering stage.

RESULTS AND DISCUSSION

Crop-growth rate (CGR)

The crop transplanted on 25 June recorded the highest CGR during post-PI stages (T_2 and T_3), which was significantly superior to that obtained in other dates of planting except 15 June in T_2 (20 days after PI stage) in 1993 (Table 1). Prior to PI stage (T_1) 5 July in 1993 and 25 July in 1994 were significantly better for CGR over other dates. The (CGR) either remained consistent or increased with the advanced growth of the crop in first 3 dates, whereas it decreased from T_1 onwards in 25 July planting. These results are in partial confirmation with those of Kim (1985).

Hybrid 'ORI 161' ('PHB 71') was either significantly superior or at par with other genotypes at all the time intervals. During flowering stage (T_3), inbred cultivar 'HKR 126' was significantly better than other hybrids except 'PHB 71'.

Leaf-area duration (LAD)

The LAD was significantly longer in most delayed planting (25 July) than other dates before PI stage (Table 1). After that 25 June transplanting recorded the longest LAD except in T_2 during 1994. The results of 5 July transplanting were significantly superior to the earliest planting (15 June) at all the time intervals except at T_3 in 1994, where the differences were non-significant. The LAD was the longest in hybrid 'PHB 71' followed by 'PMS2A/IR31802' at all the time intervals. There was a tremendous increase in LAD from T_1 to T_2 but thereafter it decreased through flowering period (T_3).

Leaf-area ratio (LAR)

The LAR was highest before PI stage (T_1) which decreased through T_2 and remained at minimum level during heading stage (T_3) irrespective of time of transplanting and genotypes (Table 2). In 1994, LAR was significantly higher in 15 June planting than other dates except in T_3

Table 1. Effect of time of transplanting and rice hybrids on crop-growth rate and leaf-area duration

Treatment	Crop-growth rate ($g/m^2/day$)						Leaf-area duration (days)					
	T_1		T_2		T_3		T_1		T_2		T_3	
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
Time of transplanting												
15 June	15.0	10.0	19.0	24.0	19.5	23.5	48.3	52.5	112.5	120.1	94.8	126.3
25 June	12.5	15.5	20.5	30.5	23.0	26.5	71.7	63.3	143.4	147.1	142.2	163.0
5 July	18.0	19.5	14.5	21.0	18.5	20.0	72.3	83.1	128.4	149.6	112.5	140.1
25 July	12.5	25.5	5.0	12.5	3.5	12.0	119.4	100.7	88.6	149.4	46.0	103.8
CD (P = 0.05)	1.8	3.2	2.8	2.6	1.9	1.8	7.9	8.5	10.4	21.7	13.5	20.6
Rice hybrid												
'PHB 71'	15.5	19.0	17.0	24.0	19.0	21.5	85.8	81.6	126.4	154.7	105.4	143.6
'PMS2A/IR31802'	15.5	17.0	17.0	23.0	14.5	19.5	82.8	83.2	125.8	150.0	104.5	136.2
'PMS10A/PR106'	13.5	18.0	12.5	19.5	14.0	19.5	71.1	69.8	107.5	131.8	89.8	125.0
'HKR 126'	13.5	16.5	12.5	21.0	17.0	21.5	72.0	65.0	113.2	129.0	95.8	126.2
CD(P = 0.05)	1.5	NS	3.0	2.2	1.5	1.7	7.3	7.8	9.2	18.6	13.0	15.8

T_1, 20 days duration before PI stage; T_2, 20 days duration after PI stage; T_3, 20 days duration during flowering stage

Table 2. Effect of time of transplanting and hybrids on leaf-area ratio and yield of unhusked rice

Treatment	Leaf area ratio (cm^2/g)						Panicles/ m^2		Spikelet sterility (%)		Grain yield (q/ha)		Straw yield (q/ha)	
	T_1		T_2		T_3									
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
Time of transplanting														
15 June	135	225	105	138	46	68	303	232	26.2	27.6	72.0	67.8	68.5	68.1
25 June	141	188	129	118	70	66	347	263	20.4	23.4	78.9	75.4	70.6	71.1
5 July	119	170	100	115	55	66	326	204	22.1	25.4	76.3	72.1	69.5	69.1
25 July	103	167	58	105	24	53	291	204	28.8	37.9	55.3	42.4	53.4	49.4
CD (P = 0.05)	18	21	13	11	5	6	24	10	2.1	1.8	4.0	2.7	1.9	2.2
Rice hybrid														
'PHB 71'	119	185	94	120	47	63	327	242	19.2	24.4	77.8	73.5	69.3	68.0
'PMS2A/IR31802'	136	212	99	126	49	68	336	253	25.3	29.7	72.6	65.7	66.1	63.9
'PMS10A/PR106'	122	162	95	112	49	62	294	226	30.1	33.9	63.2	57.7	62.9	63.8
'HKR 126'	122	199	103	117	51	62	310	227	23.5	27.6	69.0	60.8	63.6	62.2
CD (P = 0.05)	NS	17	NS	NS	NS	NS	20	14	2.0	2.0	1.9	2.0	2.7	2.8

T_1, 20 days duration before PI stage; T_2, 20 days duration after PI stage, T_3, 20 days duration during flowering stage where it was at par with 25 June and 5 July planting. In 1993, 25 June planting excelled over other dates in LAR. The LAR due to genotypes did not differ significantly except during pre-PI stage in 1994.

Yield and yield attributes

Grain yield was significantly higher in 25 June transplanted crop (75.4 q/ha) in 1993, but at par with 5 July planting in 1994. Panicles/m^2, grain and straw yields were the highest in 25 June planting. Spikelet sterility increased when the crop was planted on the earliest date (15 June) or July planting and reached the highest level in 25 July planting. Hybrid 'PHB[1]' gave 7.2, 23.1 and 12.8; and 11.9, 27.4 and 20.9% higher grain yield than hybrids 'PMS2A/IR31802', 'PMS10A/PR106' and inbred cultivar 'HKR 126' in 1993 and 1994 respectively. Straw yield was the highest and spikelet sterility was the lowest in 'PHB 21', followed by variety 'HKR 126'. The superiority of hybrid 'PHB 71'in grain yield over other genotypes was reported by Singh and Panwar (1994). The increase in grain yield with 25 June planting and hybrid 'PHB 71' might be due to higher CGR and LAR, longer LAD particularly after PI stage and lowest spikelet sterility.

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