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Physiological efficiency of rice hybrids under irrigated condition of Orissa

Annie Poonam*and P. Swain

Crop Production Division, Central Rice Research Institute, Cuttack – 753 006, Orissa, India

ABSTRACT

Eight rice hybrids (CRHR 1, CRHR 4, CRHR 5, PHB 71, DRRH 1,PA 6201, PA 6444 and KRH 2) both released and pre-release along with two local checks(Naveen and IR 64) were grown under field condition during wet seasons of 2002 and 2003 to analyze their physiological efficiency correlating its yield under irrigated transplanted condition of coastal Orissa. The results revealed that among the hybrids, CRHR 5, KRH 2, PA 6444 and PHB 71 were found to be most efficient with maximum leaf area index and total chlorophyll content at all the growth stages. However, CRHR 5 recorded highest grain yield (5.69 t ha^{-1}), grain number panicle^{-1} (122.3) and harvest index (0.43) with moderate sterility (28.8%) and panicle number (336 m^{-2}) at maturity.

Key words: *Hybrids, physiological efficiency, leaf chlorophyll content*

The introduction of hybrid rice programme in India has brought the necessity of testing their ability for higher production. Yuan Lougping *et al*. (1988) reported that hybrid rice could yield 20-30% more than conventional varieties with adequate management. Narendra and Nagaraju (1994) found seven hybrids to be superior to the check hybrid BPT 3291. The rice grain yield has been reported to be correlated with leaf area index (LAI), harvest index (Murty and Babu, 1992). The high grain yield, however, of any crop is a net result of photosynthesis productivity and its partition to the economic organs (sink) (Chandrashekar *et al.,* 2001). The high yield of hybrids was attributed to greater biomass production mainly due to higher crop growth before heading (Song *et al*., 1990). Keeping these in view, an experiment was carried out to investigate the relationship of physiological characters with yield and yield attributes of eight rice hybrids. (CRHR 1, CRHR 4, CRHR 5, PHB 71, DRRH 1, PA 6201, PA 6444 and KRH 2) both released and pre released along with three local checks (Naveen and IR 64) at Central Rice Research Institute during wet season of 2002 and 2003. The varieties were grown in randomized block design replicated three times under irrigated shallow lowland condition. Twenty five days old seedlings were transplanted at a spacing of 20 x 15 cm with one seedling hill^{-1}. Periodical data on physiological characters like dry weight, LAI and chlorophyll content were taken on ten randomly selected hills at different growth stages. Filled grains panicle^{-1}, harvest index and yield data recorded at harvest were subjected to statistical analysis following Gomez and Gomez (1984).

The analysis of variance indicated considerable variation among the hybrids for characters studied (Table 1). The dry matter production showed a progressive increase from 30 days after transplanting upto maturity (Shivani and Reddy, 1999) whereas, leaf area index (LAI) increased gradually from vegetative stage(30 DAT) till flowering and showed a declining trend towards maturity. In the initial stages the differences in dry matter production was not significant and was at par with the local checks, whereas in the later stages i.e., at flowering and mid flowering, all the hybrids produced greater dry matter and leaf area index compared to check varieties. Virmani *et al.*,(1982), Blanco *et al.*,(1990) and Song *et al.*,(1990) also reported greater dry matter production in rice hybrids than checks.

The LAI was significantly higher at flag leaf stage in CRHR 5and KRH 2 (5.97) followed by PA 6444 (5.94) and PHB 71 (5.85), whereas at mid flowering stage CRHR 5 (4.16) was at par with PHB 71(4.18) and significantly superior to rest of the hybrids and checks. However, among the hybrids least LAI was observed in CRHR 1 and DRRH 1 at all stages of

Table 1.Physiological characters of rice hybrids at different growth stages

Varieties	Leaf area index				Total leaf chlorophyll content				Dry matter accumulation(g m^{-2})					HI
	30 DAP	45 DAP	Flag	15 DAF	30 DAP	45 DAP	Flag	15 DAF	30 DAP	45 DAP	Flag	15 DAF	HVT	
CRHR 1	0.93	2.43	4.65	3.77	2.33	2.31	3.01	2.02	109.8	275.1	476.0	666.6	1169.7	0.38
CRHR 4	0.99	3.28	5.49	3.68	2.34	3.15	3.08	2.52	109.5	312.4	526.2	711.5	1122.1	0.40
CRHR 5	1.25	3.87	5.97	4.16	2.35	3.15	3.78	3.36	112.0	323.5	548.4	767.9	1277.2	0.43
DRRH 1	0.88	2.94	4.59	3.35	2.60	2.79	3.33	2.61	100.9	288.0	486.2	681.7	1123.9	0.39
PHB 71	1.02	3.95	5.85	4.18	2.47	3.03	3.47	2.86	107.5	315.1	518.6	770.6	1188.3	0.42
PA6201	0.94	3.68	5.25	3.48	2.43	3.27	3.50	2.64	100.0	302.2	503.5	750.6	1167.4	0.39
PA 6444	1.06	3.85	5.94	3.77	2.41	3.13	3.62	3.03	109.8	316.0	536.8	755.5	1247.0	0.42
KRH 2	1.05	3.92	5.97	3.96	2.62	2.97	3.59	3.28	122.2	337.3	579.1	787.0	1223.9	0.42
Naveen	0.81	2.79	4.56	3.27	2.84	2.73	2.63	2.23	119.1	226.3	455.2	645.1	1128.4	0.36
IR 64	0.69	2.84	3.91	2.88	2.63	2.86	2.57	2.17	109.9	186.2	418.5	639.4	1097.6	0.32
CD (P=0.05)	0.07	0.19	0.25	0.32	NS	0.35	0.68	0.63	NS	25.2	65.1	31.6	75.2	0.02

DAP – Days after planting; DAF – Days after flowering.

growth. The decrease of leaf area towards maturity may be due to lesser green leaf area as a result of senescence in early formed leaves. However, LAI was comparatively and significantly higher in hybrids than checks. The total leaf chlorophyll content showed gradual increase from maximum vegetative (45 DAP) to flag stage and then declined towards mid flowering stage. Total leaf chlorophyll content at flag stage was more in the hybrids and the highest being recorded in CRHR 5 (3.78 mg g^{-1}fresh weight) followed by PA 6444 (3.62 mg g^{-1}fresh weight) and KRH 2 (3.59 mg g^{-1}fresh weight). At mid flowering stage CRHR 5 followed by PA 6444 and KRH 2 retained highest chlorophyll content indicating the delayed senescence in the cultivar. On the other hand, on the initial date *i.e.*, 30 DAT the hybrids were at par with the checks in their dry matter production. Whereas at the later stages, 45DAT, flag leaf stage, 15 DAF and harvesting stage, the hybrids produced significantly greater dry matter as compared to the check varieties. Significantly higher dry matter production was recorded by KRH 2 at maximum vegetative stage (337.3 g m^{-2}), flag leaf stage (579.1 g m^{-2}) and mid flowering stage (787.0 g m^{-2}), whereas, at harvesting stages CRHR 5 recorded highest biomass of 1277.2 g m^{-2}. Higher dry matter production in CRHR 5 might be attributed to higher LAI at flowering and post flowering stage. These hybrids also recorded considerably higher values of harvest index.

Maximum grain yield of 5.69 t ha^{-1} was obtained in the hybrid CRHR 5 followed by KRH 2 (5.55 t ha^{-1}) The yield differences among the hybrids and checks were due to significant differences in their yield components (Table 2). Highest grain yield in CRHR 5 might be due to high sink capacity in terms of panicle number m^{-2} (336), more number of grains $panicle^{-1}$ (122.3), low spikelet sterility (28.8 %) and higher 1000 grain weight (24.10 g) which was then followed by KRH 2 and PA 6444 with similar yield attributing trend. The translocation of total dry matter to the sink is the major factor that governs the economic yield of the variety. Song *et al.* (1990) also observed similar results of greater carbohydrate translocation from vegetative plant parts to the spikelet resulting in higher grain yield in rice hybrids. High chlorophyll retention during post-flowering period causing delayed senescence in CRHR 5 can be considered as a useful trait which has favoured for higher yield. However, among the hybrids CRHR 1, CRHR 4 and DRRH 1 recorded comparativelypoor yield and yield attributes almost at par with the checks indicating their unsuitability for the region during wet season.

Table 2. Grain yield and yield attributes of rice hybrids

Treatments	Grain yield (t ha^{-1})	Grain Number $panicle^{-2}$	Sterility (%)	PanicleNumber m^{-2}	1000 grain weight (g)
CRHR 1	4.47	102.6	33.8	254	22.41
CRHR 4	4.76	107.7	35.1	280	21.28
CRHR 5	5.69	122.3	28.8	336	24.10
DRRH 1	4.52	93.9	42.7	289	23.23
PHB 71	5.16	119.2	28.5	262	22.93
PA 6201	4.62	109.0	31.0	316	21.58
PA 6444	5.10	121.4	27.7	349	23.17
KRH 2	5.55	121.3	27.4	327	23.51
Naveen	4.22	87.9	28.02	258	24.52
IR 64	4.32	61.8	33.83	304	20.52
CD (P=0.05)	0.82	2.03	11.76	58.76	0.38

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