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ssociations in physiological growth parameters of rice hybrids

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Abstract: A field experiment was conducted with 21 F_1 hybrids to examine the association of yield associated physiological and yield characters with grain yield in rice. Grain yield had significant correlation with productive tillers/plant, 100-grain weight, panicle length, post flowering CGR, LAI at heading and harvest index. Within the yield components, productive tillers exhibited high correlation with CGR and LAI at heading. Path analysis revealed that, in addition to CGR, days to 50% flowering had high direct positive effects on yield. Therefore, it was concluded that high yielding nature of hybrids was mainly due to high tillering habit coupled with high test weight of grains and these two attributes inturn were highly related to CGR and LAI.

Key words : Correlations, Physiological parameters, Rice.

ntroduction

In the history of research on tropical ce, the development of fertilizer responsive, igh yielding and semi-dwarf varieties of rice as an important landmark.

A large scale adoption of these new plant ypes [T(N)1, IR-8 and Jaya] with high input se almost doubled the yield of rice in mid-0's. After achieiving this quantum jump in rice yields, subsequent release of new varieties could not improve yield potential significantly. Under these circumstanes, use of hybrid vigour on commercial basis has become a tool for raising the present yield ceiling in rice. Proper utilization of hybrid vigour on effective basis needs identification of yield contributing traits with understanding of physiological basis of potential yield associated with hybrids. Therefore, the results of an investigation performed to study during *rabi*, 1999-2000 (Dec-May) at Agricultural Research Station, Warangal, the physiological and yield characteristics influencing the potential yield were reported in view of their high relevance to the hybrids being developed through CMS-System.

Materials and Methods

The experimental material of the present study contained 21 F_1 hybrids obtained from a 7x7 half parental diallel programme. The healthy 30 day old seedlings of each entry were transplanted in 2 rows of 3 metres length in a randomized block design with 3 replications, adopting a spacing of 20x15 cm with single seedling per hill. A fertilizer dose of 100 N, 60 P_2O_5, 40 K_2O kg/ha was followed along with recommended package. Observations were recorded on 10 plants in each replication and the estimation of dry matter was done on 5 plants at tillering, heading and maturity stages. The characters studied were leaf area index (LAI) at tillering and heading, net assimilation rate (NAR) from tillering to heading, crop growth rate (CGR) from tillering to heading (T-H) and heading to ripening (H-R), harvest index (HI), days to 50% flowering, productive tillers/plant, plant heig! ., panicle length, filled grains/panicle, 100-grain weight and grain yield/ plant.

Physiological growth parameters were computed as per the formulae given by Yoshida *et al.* (1976). Simple correlation coefficients were calculated as suggested by Panse and Sukhatme (1985) and path coefficient analysis was carried out according to Dewey and Lu (1959). The experiment was conducted under irrigated ecosystem maintaining water depth of 2 cm at tillering and 5 cm at reproductive and ripening stages.

Results and Discussion

The analysis of variance revealed highly significant differences among the entries for all the characters studied. Correlation studies showed that CGR, LAI at heading, productive tillers/plant, panicle length, 100-grain weight

Table 1. Estimates of simple correlation coefficients for physiological and yield characters

Character	Leaf area index at tillering	Crop growth rate (T-H)	Net assimilation rate (T-H)	Leaf area index at heading	Crop growth rate (H-R)	Days to 50% flowering	Productive tillers/ plant	Plant height	Panicle length	Filled grains/ panicle	100-grain weight	Harvest index	Grain yield per plant
Leaf area index at tillering	1.0000	0.0589	-0.5145*	0.2711	-0.080	0.4041	-0.2080	0.1570	0.3400	0.4703*	0.444	0.3440	0.2317
Crop growth rate (T-H)		1.0000	0.6097**	0.5811**	-0.1120	0.0343	0.5388**	-0.0036	0.0200	0.0625	0.0948	0.2237	0.2777
Net assimilation rate (T-H)			1.0000	-0.0942	-0.2249	-0.3884	0.3598	-0.3387	-0.500**	-0.2573	-0.2469	-0.1355	-0.1891
Leaf area index at heading				1.0000	0.0333	0.4626*	0.5251*	0.2114	0.5532**	0.1704	0.2806	0.1838	0.4337*
Crop growth rate (H-R)					1.0000	-0.1829	0.3002	0.7991*	0.2143	-0.1168	0.7898**	0.1716	0.7813**
Days to 50% flowering						1.0000	0.0723	0.0410	0.7531**	0.4925*	-0.1049	0.1948	0.2579
Productive tillers / plant							1.0000	0.3101	0.1186	-0.0464	0.3319	0.2920	0.5365**
Plant height								1.0000	0.4196*	0.2104	0.8305**	0.2853	0.8028**
Panicle length									1.0000	0.3029	0.3869	0.1855	0.5021**
Filled grains per panicle										1.0000	-0.1223	0.4982**	0.1779
100-grain weight											1.0000	0.2760	0.7171**
Harvest index												1.0000	0.4289*
Grain yield per plant													1.0000

* Significant at 5% level ** Significant at 1% level

and harvest index possessed positive significant correlation with grain yield/plant (Table 1). These results were in conformity with the findings of Siddiqi and Reddy (1984), Prasanth (1993), Ratnakumari (1998) and Sahoo and Guru (1998) for LAI at heading and CGR, Niranjana Murthy *et al.* (1991), Chau and Bhargava (1993), Nanja Reddy *et al.* (1996) and Chauhan *et al.* (1999) for harvest index, Meenakshi *et al.* (1999) for productive tillers/plant and Satpute (1996) and Dhananjaya *et al.* (1998) for 100 grain weight.

Interestingly, the productive tillers/ plant exhibited high correlation with physiological parameters CGR (T-H) and LAI at heading indicating the major importance of this trait. The association between HI and productive tillers was also positive but not significant (Meenakshi *et al.* 1999). According to Lin *et al.* (1996), the higher tiller number and number of grains per panicle were attributable to higher leaf areas, higher photosynthetic rates in individual leaves particularly in later growth stages, wich resulted in higher yield formation. In the present study also, the association of NAR, which is a direct measure of photosynthetic efficiency and CGR (T-H) with productive tillers/plant was positive indicating that higher tiller number was associated with high CGR and NAR.

Plant height expressed positive correlation with grain yield and increased days to 50% flowering also resulted in increased LAI and filled grains/panicle. Hence, optimum height coupled with ideal duration is necessary to balance the other attributes.

Correlation coefficients reveal only the relationship existing between two characters, whereas, path coefficient analysis give complete idea about the direct and indirect effect of a character on grain yield. Among the physiological traits (Table 2) the CGR (Pre and Post flowering) had high direct positive effect on yield as reported earlier by Prasanti (1993) and Rathnakumari (1998). Whereas, harvest index had low

Table 2. Estimates of direct and indirect effects of physiological and yield characters

Character	Leaf area index at tillering	Crop growth rate (T-H)	Net assimilation rate (T-H)	Leaf area index at heading	Crop growth rate (H-R)	Days to 50% flowering	Productive tillers/ plant	Plant height	Panicle length	Filled grains/ panicle	100-grain weight	Harvest index
Leaf area index at tillering	0.1395	0.0082	-0.0718	0.0378	-0.0113	0.0564	-0.0290	0.0219	0.0474	0.0656	0.0062	0.0480
Crop growth rate (T-H)	0.0176	0.2984	0.1819	0.1734	-0.0334	0.0102	0.1608	-0.0011	0.0060	0.0187	0.0283	0.0668
Net assimilation rate (T-H)	0.0013	-0.0015	-0.0025	0.0002	0.0006	0.0010	-0.0009	0.0008	0.0012	0.0006	0.0006	0.0003
Leaf area index at heading	-0.0057	-0.0121	0.0020	-0.0209	-0.0007	-0.0097	-0.0110	-0.0044	-0.0116	-0.0036	-0.0059	-0.0038
Crop growth rate (H-R)	-0.0578	-0.0801	-0.1607	0.0238	0.7144	-0.1307	0.2145	0.5709	0.1531	-0.0835	0.5642	0.1226
Days to 50% flowering	0.1313	0.0111	-0.1263	0.1503	-0.0595	0.3250	0.0235	0.0133	0.2448	0.1601	-0.0341	0.0633
Productive tillers / plant	-0.0204	0.0530	0.0354	0.0516	0.0295	0.0071	0.0983	0.0305	0.0117	-0.0046	0.0326	0.0287
Plant height	0.0516	-0.0012	-0.1112	0.0694	0.2624	0.0135	0.1019	0.3284	0.1378	0.0691	0.2727	0.0937
Panicle length	0.0027	0.0002	-0.0039	0.0043	0.0017	0.0059	0.0009	0.0033	0.0079	0.0024	0.0030	0.0015
Filled grains per panicle	-0.0650	-0.0086	0.0356	-0.0236	0.0161	-0.0681	0.0064	-0.0291	-0.0419	-0.1382	0.0169	-0.0689
100-grain weight	-0.0091	-0.0194	0.0504	-0.0573	-0.1613	0.0214	-0.0678	-0.1696	-0.0790	0.0250	-0.2042	-0.0564
Harvest index	0.0458	0.0298	-0.0181	0.0245	0.0229	0.0259	0.0389	0.0380	0.0247	0.0663	0.0368	0.1332
Grain yield per plant	0.2318	0.2777	-0.1892	0.4337	0.7813	0.2580	0.5365	0.8029	0.5021	0.1780	0.7172	0.4290

Residual effect = 0.2123

direct effects. Productive tillers/plant and 100 grain weight though had significant correlations with grain yield, their direct contribution was not observed. However, these traits played an indirect role through CGR to a larger extent.

From the foregoing discussion, it can be concluded that CGR is the most important yield deciding parameter, because, it had highly significant positive correlation with yield besides high direct positive effects. Higher CGR was associated with high number of productive tillers/ plant. Increased CGR after heading resulted in increased test weight, thus resulting in higher values of harvest indices. The yield components days to 50% flowering and plant height mostly exhibited positive association and positive direct and indirect effects with other yield attributes. Hence, in the process of development of high yield potential hybrid varieties, the criteria has to be aimed at higher productive tillers/ plant, 100 grain weight in combination with optimum plant height and duration.

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