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Short Communication

Photosynthetic pigments in rice (*Oryza sativa* L.) genotypes under low temperature stress

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Rice (*Oryza sativa* L.) has been enlisted as cold sensitive crop, because it is susceptible to low temperature at its different growth stages starting from seed germination till grain filling. In India, low temperature injury during winters adversely affects the yield potential of the crop. Chlorophyll deficiency has been observed as a common phenomenon in tropical rice cultivars at low temperature [1], which may be expressed as wilting, chlorosis, necrosis and even death of the leaf tissues at seedling stage. In fact, chlorophyll and other photosynthetic pigments are greatly influenced by climatic factors like light and temperature [2]. But different rice cultivars vary for cold sensitivity of photosynthetic pigments and it has been used as a measure of cold tolerance by several workers [3, 4].

Seedlings of 26 rice genotypes with variable reaction to low temperature stress were raised in experimental nursery during winter season of 1997-98 to study photosynthetic pigments in relation to cold tolerance. Rating of genotypes for cold tolerance was done on 1-9 scale (1- excellent : 9-poor) suggested by IRRI [4] after one week of exposure to the low environmental temperature (daily mean temp. < $18^{o}C$, minimum upto $4^{o}C$) temperature. Survived seedlings were transplanted in field in R. B. D. to observe grain yield per plant. Photosynthetic pigments were estimated as per method suggested by Krishnan *et al.* [5]. The mean data of five random plants from each plot were subjected to ANOVA for the design and genetic parameters were estimated as per standard procedures. Correlation coefficients were worked out from variance and covariance components.

Analysis of Variance revealed significant differences among genotypes for all the characters under study. A wide range and higher GCA as well as PCV were observed for all of them. A comparatively larger difference between GCV and PCV observed for grain yield per plant indicated greater influence of environent on the expression of this trait than on others. The estimate of broad sense heritability was moderate for survival percentage (SP) and grain yield per plant (< 80%). Rest of the characters exhibited considerably higher values of heritability as well as higher genetic advance (GA). SP showed higher GA unlike grain yield, which exhibited lower GA. High heritability in combination with higher GA for chlorophyll content, chlorophyll stability index (CSI), chl a: chl b, carotenoids and cold tolerance (CT) score indicates that substantial improvement for these traits could be achieved through direct selection. Such characters are considered to be governed by additive gene action or by fewer numbers of genes.

Correlation studies (Table 2) revealed that except chl a : chl b ratio all the characters had significant and negative correlation with CT score. It indicates that higher content of chlorophyll and carotenoids, greater value of CSI, lower chl a: chl b ratio and higher SP were associated with higher degree of cold tolerance. Association between cold tolerance and chlorophyll content have been reported earlier also [4, 7]. Grain yield showed significant association with only total chlorophyll content, CSI and CT score.

Van Hasselt [8] has described that at lower temperatures, light energy absorbed by photosynthetic pigments can not be used for photosynthesis in temperature sensitive crops and got dissipated in photooxidation reaction leading to loss of pigments. But, in resistant plants presence of higher levels of antioxidants retards this process of photooxidation. Besides this, increased level of carotenoids is also helpful in reducing loss of chlorophyll a and b by encouraging preferential self-oxidation. One other reason behind development of chlorosis in rice seedlings at

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Table 1. Estimates of genetic parameters for differet cold tolerance characters in rice

Characters	Mean	Range	GCV (%)	PCV (%)	Heritability % (bs)	Genetic Advance (% of mean)
Total chlorophyll (mg/g)	0.38 ± 0.02	0.24-0.55	21.84	23.21	89.74	41.77
Chlorophyll stability index	86.29 ± 0.08	69.04-102.42	12.32	13.56	88.00	26.34
Chl a: chl b	0.72 ± 0.02	0.45-0.87	19.63	20.49	90.00	37.66
Carotenoids (mg/g)	0.79 ± 0.03	0.63-0.91	9.96	11.50	75.00	17.99
Survival percentage	50.00 ± 2.42	15.00-90.00	32.20	33.50	92.20	63.70
CT Score	6.50 ± 0.66	3.50-8.00	17.70	19.52	82.00	33.03
Yield/plant (g)	7.46 ± 0.56	4.60-9.50	8.25	12.46	66.00	13.56

Table 2. Genotypic correlation coefficients under low temperature stress in rice seedlings

	CT Score	Yield/Plant (g)
Total chlorophyll (mg/g)	–0.73**	0.50**
Chlorophyll stability index	–0.76**	0.61**
Chl a : chl b	0.53**	0.32
Carotenoids (mg/g)	–0.48*	0.38
Survival percentage	–0.71**	0.37
CT score	1.00	–0.43*

* - Significant at 0.05
** - significant at 0.01

lower temperatures (< $15^{o}C$) is decline in rate of chlorophyll synthesis [9]. Tolerant genotypes continue to synthesize even at low temperature, whereas susceptible ones fail to do so [4]. All these processes result in higher chlorophyll contents and higher CSI in the leaves of tolerant genotypes in comparison of sensitive ones.

Although significant, but lower magnitude of correlation between cold tolerance and grain yield suggests that cold tolerance at seedling stage might not be always associated with higher grain yield. Reasons for this might be post flowering factors, poor genetic potential or poor adaptability of the genotype, etc.

Therefore, selection for total chlorophyll content and CSI might be proved very effective in screening rice genotypes for cold tolerance at seedling stage as well as higher grain yield.

References

1. **Chuong P. V. and Omura O.** 1982. Studies on the chlorosis expressed under low temperature condition in rice (*Oryza sativa* L.). Bulletin of Inst. f Tropical Agr. Kyushu Univ., p 5.
2. **Jun C. J. and Sooichi M.** 1990. The propanil hydrolysing enzyme and acylamidase in the wild races of genus *Oryza*. Pestic. Biochem. Physiol., **38**: 26-33.
3. **Suge H, Sato T and Kumagi T**. 1991. UVB injury in rice plants: A genetic study. Jap. J. Genet., **66**: 347-361.
4. **Sthapit B. R.** 1992. Genetic variation of chlorophyll synthesis of etiolated nepaleese sedlings at low temperature - a new approach for cold tolerance screening. IRRN., **17**: 14-15.
5. IRRI. 1996. Standard evaluation system for rice. Intl Rice Res. Inst. Philippines. 1-49.
6. **Krishnan P., Ravi I and Nayak S. K.** 1996. Method for determining leaf chlorophyll content of rice a reappraisal. Indian J. of Exp. Biol., **34**: 1030-1033.
7. **Baruah K. K. and Medhi A.** 1993. Growth and metabolic response of rice (*Oryza sativa* L.) to low temperature stress. Indian J. of Plant Physiol., **34**: 53-55.
8. **Van Hasselt P. R.** 1972. Photo oxidation of leaf pigments in *Cucumis* discs during chilling. Acta Botanica Neerlandica, **21**: 539-548.
9. **Kaimori N. and Takahashi N.** 1981. Genecological studies on chlorosis of rice plans at low temperature. Bulletin of Inst. of Agric. Res. Tohuku Univ., **3**.