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Effect of Low Light on Physiological Characters and Consequent Seed Germination of Rice Cultivars

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Two distinguished rice cultivars Ratna and Swarnaprabha, were evaluated for some of their physiological traits under normal and low (50% of normal) light intensities during dry season. The cultivar Ratna, inspite of having higher chlorophyll content, leaf nitrogen, soluble protein and photosynthetic rates under both light regimes yielded lower than Swarnaprabha. The test weight was also lower than Swarnaprabha under both light intensities. The seeds harvested from both regimes of light revealed a tendency for temporary dormancy. Maternal carry over did not occur in these cultivars.

Key words : Low light, chlorophylls, photosynthesis, seed germination

INTRODUCTION

Rice, a tropical species is very sensitive to light especially during anthesis time. Under eastern region conditions, during wet season, continuous cloudy days for four to five days, result in lower productivity of rice. Therefore, it is necessary to screen and identify low light tolerant cultivars. Attempts were being made from time to time and identification of a rice cultivar had been reported recently (6.7). It is essential to understand the traits associated with tolerance so that it would help in breeding programme. In this paper an attempt is made to understand various physiological processes associated with tolerance of Swarnaprabha (SP) in comparison to Ratna, a standard cultivar. In addition, seeds harvested from these cultivars under both light intensities were tested for maternal carry over influence till germination.

MATERIALS AND METHODS

Twentyfive day old seedlings of rice (*Oryza sativa* L.) Ratna and Swarnaprabha (SP) cultivars were transplanted into pots containing six kg puddled soil. Three hills per pot were maintained with normal cultural practices (fertilizer dose 100:50:50 N: P: K/hill) in the net house. The reduced light intensity (50% of normal) was imposed from 40 days after transplanting to harvest by covering with shade frames fitted with wooden batons. Four replications were maintained throughout the experimental period.

The agrometeorological parameters and photosynthetic rates (Pn) were measured with LI-COR-6000. Portable Photosynthesis System (Nebraska, USA). Chlorophyll, soluble proteins and leaf nitrogen of the flag leaves were estimated according to Arnon (1). Lowry *et al.* (5) and Yoshida and Coronel (10) respectively. Yield per hill and test weights were recorded after the harvest.

In continuation, the seed harvested from both the light regimes stored at room temperature for 10 days were germinated in pertri-dishes (100 seeds each) containing moist filter paper (Whatman no. 1). The percent germination was followed from day 2nd to 8th. The results are statistically analysed.

RESULTS AND DISCUSSION

Under normal light intensity, the cultivar Ratna had significantly higher photosynthetic rates, soluble protein (1.4 fold), total chlorophyll and leaf nitrogen; in comparison to Swarnaprabha (SP). It was evident from Table 1 that these advantages were not reflected on yield of Ranta. The yield of SP was more than Ratna by 42%. Similarly, the test weight of SP was higher by 11%. Earlier Dey *et al.* (3) showed that the yield of Ratna was lower than SP during wet season. The reasons attributed for lower

Table 1. Physiological characters of the rice cultivars grown under normal and reduced light intensity

	Pn umolm $^{-2}$ Sec $^{-1}$	Chloro Phyll a/b	Total chlorophyll mg dm $^{-2}$	Total leaf N mg dm $^{-2}$	Soluble protein mg dm $^{-2}$	Yield hill $^{-1}$ gm	Test weight gm (1000 seeds)
Light							
Ratna	25.34	3.70	3.95	13.1	39.4	2.85	21.1
SP	22.03	3.38	3.61	11.8	33.5	4.62	23.7
S.Ed for V&T+	0.16	0.03	0.03	0.28	0.77	0.06	0.10
C.D.	0.49	0.10	0.10	0.90	2.33	0.30	0.30
Reduced Light							
Ratna	17.23	3.57	4.58	10.6	31.3	0.75	19.9
SP	16.66	3.15	4.45	9.7	30.7	1.68	23.0
S.Ed for V&T+	0.23	0.10	0.05	NS	1.08	0.06	NS
C.D.	0.71	NS	0.13		3.30	0.10	–

The air temp. 32 ± 2°C, VPD mb, radiation 263 and 130 Wm^{-2}, respectively for normal and low light intensity. For all the parameters 5 readings per plant and four replications each with df = 15.

yield were to prevailing low light intensity during wet season. If, this would be the reason during dry season under normal conditions, the yields of Ratna were expected to be equal to or more than the yield of SP as the light intensity was not a limiting factor. The consistant higher productivity of SP was further supported by lowering the light intensity (50% normal). Under low light conditions, temporal and spatial adjustments would occur in plants as an adaptive phenomenon. In the present investigation, since the plants were fully matured (40-day-old) only spatial adjustments were possible. Under low light, reduction in Pn, leaf nitrogen and soluble proteins occurred in rice also as reported for several other crops (2). However, the relative adaptiveness of a cultivar could be seen in terms of either reduction or increase in some of these parameters (8). Once again, it was seen that SP could adopt by enhancing its total chlorophyll content by 23% in comparison to normal light as against 16% by Ratna. Similarly, the reduction in Pn, leaf nitrogen, and soluble proteins was at lower magnitude for SP in comparison to Ratna. Under low light the yield and test weight of Ratna were lower by 55% and 13%, than SP. The reduction in yield of Ratna due to low light intensity was 74%, while for SP, it was 64%. Similarly, the reduction in test weight due to low light was 5.5 and 3% for Ratna and SP respectively. The lower yield of Ratna inspite of having high Pn, leaf nitrogen, soluble protein is possibly due to impairment in translocation of assimilates or respiratory losses.

The seeds produced under normal light intensity had higher percent of germination than the seeds produced under low light intensity. This type of behaviour could be due to either accumulation of inhibitors or delay in embryo maturation. The role of inhibitors is ruled out since the germination per cent improved with time (fig. 1). Further, the seeds stored for another week, tested for germination resulted in 80-95% germination (data not shown). Thus, the inhibition of germination was only a temporary phenomenon. However, in Rumex species (4, 9) reported that the seedlings were weak. This shows that maternal carry over either does not exist or even if exists, it is only a temporary one in rice.

Thus, it can be concluded that Ratna inspite of having better physiological attributes, lacked translocation efficiency, leading to lower yield than SP. Low light probably results in prolongation of embryo maturation.

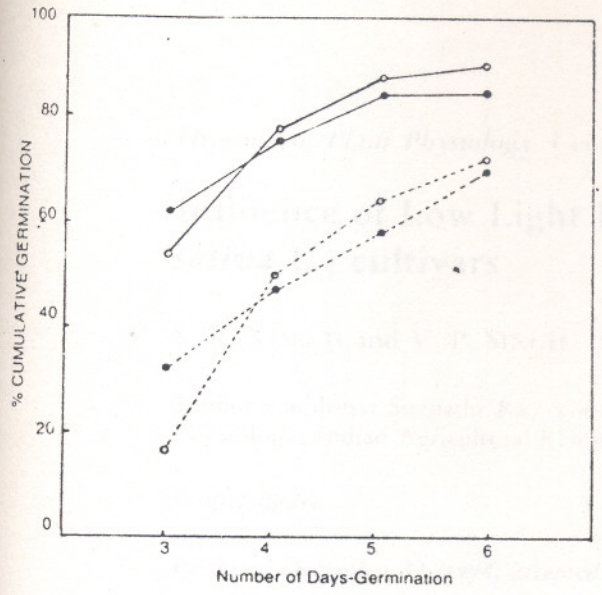

Fig. 1. Percentage cumulative germination of Rice (●-●) Ratna, SP (○-○) seeds produced from normal light (—) and low light (- - -) respectively. Per replication 100 seeds and four replications each.

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