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Short Communication

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Distribution Pattern of Free Proline in Rice (*Oryza sativa* L.) Grown under Low Light Irradiance

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With 1 table

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Abstract

The variation in free proline levels of two rice (*Oryza sativa* L.) cultivars grown under normal and low light intensities was studied. The aim of the present investigation was to find the distribution pattern of free proline in the whole plant. Free proline levels were determined in Flag leaves, culm and pollen grains, milky, dough and mature grains of Swarnaprabha (SP) and Ratna cultivars. The Flag leaf of Ratna had higher proline levels compared with (SP) under both light levels. Among the parts studied, pollen grains had the maximum free proline content in both the cultivars. Low light irradiance did not alter free proline levels of pollen grains in both the cultivars, indicating that proline could be important for the pollination process. Milky, dough and mature grains had lower proline levels under low light. The varietal, treatment and their interaction was not significant for mature grains of both low light tolerant 'SP' and standard Ratna Cultivars. It was indicated that low light stress is unique with regard to free proline.

Key words: Free proline, rice, *Oryza sativa* L., Flag leaf, pollen grains, milky grains, mature grains, low light stress

Introduction

Proline is important in relation to tolerance and susceptibility of plants to stresses due to abiotic (IBRARRA-CABALLERO et al. 1988) and biotic, such as disease infection (MOHANTY and SRIDHAR 1982). Such studies have often been centered around the accumulation of proline in vegetative parts and very little information is available about proline levels under low light. The objective of the present investigation is to examine the distribution pattern of proline levels in rice plants grown under low and normal light regimes.

Materials and Methods

Twenty-five-day-old rice (*Oryza sativa* L.) seedlings of Ratna and Swarnaprabha (SP) cultivars were transplanted into pots containing 6 kg puddled soil. Three plants per pot were maintained with normal cultural practices (100:50:50, N:P:K). The reduced light intensity (50 % of normal) was imposed 40 days after transplanting until harvest by covering plants with a shade frame fitted with wooden batons. Measurement of light, air temperature and relative humidity were made in the vicinity of the crop using a portable phosynthesis system (Licor-6000, Lambda instruments, Lincoln, Nebraska, USA). All the measurements were taken between 10.00 and 12.00 at weekly intervals with a minimum of two consecutive observations a week at each sampling of reproductive phase (KASTURIBAI et al., 1988). The Licor Instrument has a quantum sensor, a thermocouple and a humidity sensor which automatically records photosyntheti-

Table 1. Distribution pattern of free proline (μ mol g^{-1} fr wt) levels in vegetative and reproductive tissues of rice cultivars.

	Flag leaf	Culm	Pollen grains ×10^3	Milky grains	Dough grains	Mature grains
Normal light						
Ratna	291	182	19.9	132	78	97
Swarnaprabha	239	104	10.4	194	63	101
Low light (50 % normal)						
Ratna	252	171	19.9	129	41	96
Swarnaprabha	109	87	11.6	183	26	93
C.D. at 5 %						
Variety (V)	4.59	1.20	1.36	5.20	3.78	NS
Treatment (T)	NS	1.20	NS	5.20	3.78	NS
V × T	6.49	NS	NS	NS	5.30	NS

Agrometeorological conditions during the experimental period were as follows: Air temp. 32 ± 2 °C, VPD 15.73 mb, radiation 263 w m^{-2} and 130 w m^{-2} for normal and low light intensity respectively. Four estimations per plant and four replications each with df = 15.

cally active radiation (μE), temperature (°C) and humidity (%), respectively. The radiation and humidity were later converted to Wm^{-2} and VPD. The measurements were made just above canopy level of the crop under open and also within the shade frame fitted with wooden batons as described earlier (VOLETI et al. 1991). The proline levels in flag leaf, culm, pollen grains, milky, dough and mature grains were analysed according to BATES et al. (1973). From each part a sample of 250 mg fresh tissue (excluding husk in case of grains) was used except for pollen grains (25 mg). Four replications per pot per treatment were analysed and the results were statistically analysed.

Results and Discussion

The flag leaf and culm of the susceptible cultivar, Ratna, under normal as well as under low light irradiance was found to be higher in proline than the tolerant SP cultivar. The differing levels of proline content in both cultivars is a varietal variation. Earlier we have shown such varietal differences of these cultivars for photosynthesis, nitrogen and protein levels under similar growth conditions (VOLETI et al. 1991), while SINGH et al. (1973) reported on proline levels in Barley.

Of all the parts analysed, pollen grains had the maximum free proline levels in both the cultivars (Table 1). In general, here also the susceptible Ratna had a higher proline level than SP. The role of proline as an important osmoregulatory agent during water stress is well established but was questioned by STEWART and HANSON (1980). The controversy was perhaps due to the restricted studies carried out in isolation, especially in vegetative tissues during water and other related stresses. However, scattered reports on proline levels in pollen grains varied between 1.65 % in grasses to 2.2 % in apple on dry weight basis (STANLEY and LINSKENS 1974). Thus, the present results were in accordance with the literature. The high levels of proline in pollen grains may be of vital significance. Since pollen grains are disposed by wind, they should be viable till they find a receptive stigma. Until the process of fertilization, the presence of high proline might act as an enzyme protector (HANSON and HITZ 1982). This view is further supported by high levels of proline even under low light irradiance. Earlier, KOBAYASHI (1976) had shown the role of proline in the pollination process in rice. The reasons for high levels of proline under low light may be due to an increase in ABA as an after effect, which has still to be studied. The proline levels measured from milk, dough and mature grains was lower under low light than normal light. Although the plants are grown under low light stress, proline could not be accumulated since the plants were not under water stress. Thus, another interesting point comes out from the present study that low light did not alter the water relations of the tissues, while the other stresses have a direct effect on water relations of the tissues. Thus, it can be concluded that low light, in spite of being abiotic, is unique with regard to proline accumulation, a panacea of abiotic and biotic stresses.

Zusammenfassung

Verteilungsmuster freier Proline bei Reis (*Oryza sativa* L.) unter dem Einfluß geringer Lichtmengen

Die Variation freier Prolinkonzentrationen wurde bei zwei Reis (*Oryza sativa* L.)-Kultivaren unter normaler und geringer Lichtintensität untersucht. Das Ziel der vorliegenden Untersuchung war es, das Verteilungsmuster freier Proline in der Gesamtpflanze zu bestimmen. Freie Prolinkonzentrationen wurden in den Fahnenblättern, im Halm und in den vollen Körnern, bei Körnern im Milchstadium, in der Teigreife und an reifen Körnern der Sorten Swarnaprabha (SP) und Ratna untersucht. Das Fahnenblatt von Ratna hatte unter beiden Lichtbedingungen höhere Prolinkonzentrationen als Swarnaprabha. Die Pollenkörner hatten einen Maximalwert an freiem Prolingehalt in beiden Kultivaren. Geringe Belichtung änderte die freien Prolinkonzentrationen der Pollenkörner in beiden Kultivaren nicht, was ein Hinweis auf die Bedeutung von Prolin für die Bestäubung sein könnte. Körner im Milch- und Teigstadium sowie reife Körner hatten geringere Prolinkonzentrationen unter geringem Licht. Sorte, Behandlung und deren Interaktion war auch für reife Körner weder bei der gegen geringes Licht toleranten Sorte Swarnaprabha noch bei der Standardsorte Ratna signifikant. Dies weist darauf hin, daß Streß als Folge geringer Belichtung einmalig im Hinblick auf freie Prolineist.

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