SHORT COMMUNICATION

NUTRITIONAL CHANGES LEADING TO MALE STERILITY IN A THERMOSENSITIVE MALE STERILE RICE LINE USED FOR TWO LINE BREEDING

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Investigations aimed to characterize the thermosensitive nature indicated reduction in nitrogen, potassium, calcium, copper and boron contents in sterile TS 29 leaves. The reduction in leaf nitrogen and potassium content under critical sterility temperature (CST) was 17 per cent and 32 per cent respectively from that of fertile plants. The reductions in the contents of calcium, boron and copper are 24, 34 and 23 per cent respectively, as a result of CST treatment. The reduction in the nutrients might be attributed to the susceptibility of TS 29 to elevated temperature, which in turn might have affected the synthesis of proteins and various metabolic enzymes, leading to male sterility.

Key words: **Male sterility, nutrients, rice, thermosensitive**

Hybrid rice technology is the most promising approach to break yield barriers in rice. The cytoplasmic male sterility (CMS) system also known as three line system is presently the most widely used technology. Although it is effective, yet it is cumbersome, because CMS lines require specific maintainer and restorer lines and possess wild abortive cytoplasm vulnerable to biological stresses. Yuan (1987) put forward a new strategy of hybrid rice breeding, which did not involve a maintainer line, hence it was called two-line method. Zhou *et al.* (1998) reported a novel source of genic male sterility in rice that was found to revert to fertility under certain temperatures. It was called temperature sensitive genic male sterility. (TGMS). Currently research is mainly focused only on the breeding aspects of TGMS lines and, to date there has been a total lack of information on the nutritional changes leading to sterility mechanisms in these lines.

Crop plants, subjected to nutrient deficiency, exhibit reduction in anther size and lead to pollen abortion. Wu and Li (1993) reported that the contents of soluble calcium in the leaves and young panicles of Nongken 58 S were significantly correlated with fertility transformation. The current study was undertaken to explore the possible relationship between nutrients (N, K, Ca, Cu and B) and, the sterility mechanisms in a stable TGMS line TS29.

Thermosensitive (TS) 29 line along with a known thermoinsensitive variety CO 46 formed the basic material for the experiment. Plants were grown in the glasshouse in plastic pots. Plants were transferred to the growth chamber when they were in stage III of panicle development (panicle about 1mm long and covered with white hairs). Plants were kept inside phytotron up to stage VII of panicle development (filling phase of pollen and floret and panicle reach full length and colour turns green). The nutrient analysis was done immediately after stage VII. Temperature treatments, given in the phytotron to imitate the diurnal variation of summer season for induction of male sterility are given below:

Time (hrs)	Temp (°C)	RH (%)	Light intensity ($\mu mol\ m^{-2}\ s^{-1}$)
08.00 – 10.00	34°C	80	600
10.00 – 12.00	35°C	70	800
12.00 – 16.00	36°C	60	800
16.00 – 08.00	35°C	60	600

Treatments: T_1 – TS 29 – Glasshouse (Fertile pollen)
T_2 – TS 29 – Phytotron (Sterile pollen)
T_3 – CO 46 – Glasshouse
T_4 – CO 46 - Phytotron

Replication: five; Design: CRD

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Sowing date was adjusted, so that, the TS 29 line and CO 46 came to panicle initiation stage during the 1st week of December.

The third leaf from apex at Stage VII of panicle development was taken for analysis of various nutrients. Total nitrogen content was estimated by microkjeldhal method (Humphries 1956) and the content was expressed as percentage. The potassium content was determined using flame photometer and expressed as percentage on dry weight basis (Jackson 1962). Calcium content of leaves and young panicles was analyzed by the method proposed by Piper (1966) and expressed in µg g^{-1} dry weight. Copper content was estimated by atomic absorption spectrophotometer (Lindsay and Norvell 1978) and was expressed in µg g^{-1} dry weight. The content of boron in leaves and young panicles was estimated as proposed by Banuleas *et al.* (1992) and expressed in µg g^{-1} dry weight.

The reduction in leaf nitrogen content in CST treated male sterile TS 29 was 17 per cent, whereas, the reduction was only 2.3 per cent in CO 46 after CST treatment (Table 1). It appeared that the reduced nitrogen content in sterile TS 29 deprived the line from getting optimum supply of amino acids affecting the synthesis of proteins and various metabolic enzymes. Peng and Wang (1991) also attributed reduced leaf nitrogen content for sterility in rice. They opined that the cause for sterility could be due to reduced synthesis and blocking of transport of amino acids or proteins to the developing anthers. In contrast, Elsy (1997) failed to notice any difference in nitrogen content between sterile and fertile plants.

In sterile TS 29, the reduction in leaf potassium content was nearly 32% from that of fertile plants. Optimum potassium level in any plant is considered as a tool to resist environmental stresses and hence the steep reduction in potassium level might be attributed to the susceptibility of TS 29 to elevated temperature producing sterile pollens. When exposed to high temperature, certain bean cultivars were found to have reduced potassium level in leaves (Moreno-Limon *et al.* 2000). Reduction in both nitrogen and potassium contents were also noticed under sterile condition in rice by Rerkasem and Jamjod (1997). The boron content was also found to decrease drastically in sterile TS 29 as compared to the fertile one. The reduction was about 34 per cent, whereas about 24 and 23 per cent reductions were observed in calcium and copper contents respectively as a result of CST treatment to TS 29. In CO 46, the reductions were only marginal after CST treatment and hence, produced fertile pollens. Nutrient deficiencies causing male sterility in rice have been reported by Rerkasem and Jamjod (1997). Jian *et al.* (1998) emphasized the importance of calcium in leaves and young panicles for pollen fertility, as calcium might influence cell functions through spatial and temporal changes induced by stimuli. Azouaou and Souvre (1993) found relationship between copper deficiency and male sterility. Boron deficiency induced male sterility has been reported by Garg *et al.* (1979) in rice.

Table 1. Nutrient status of leaves of TS 29 and CO 46 at stage VII of panicle development

Treatments	Nitrogen (%)	Potassium (%)	Calcium (mg g^{-1} dw)	Copper (mg g^{-1} dw)	Boron (µg g^{-1}) (mg g^{-1} dw)
TS 29 - Glasshouse (Fertile pollen)	2.99 (100.0)	1.52 (100.0)	203.00 (100.0)	106.00 (100.0)	39.00 (100.0)
TS 29 - Phytotron (Sterile pollen)	2.49 (83.0)	1.03 (76.4)	155.00 (76.4)	82.00 (77.4)	22.00 (56.4)
CO 46 - Glasshouse	3.01 (100.0)	1.49 (100.0)	208.00 (100.0)	120.00 (100.0)	37.00 (100.0)
CO 46 - Phytotron	2.94 (97.7)	1.40 (94.0)	205.00 (98.9)	110.00 (91.7)	35.00 (94.6)
Mean	2.86	1.36	192.75	104.50	33.25
CD (P=0.05)	0.147	0.058	2.050	1.778	2.376

Values in parentheses are per cent change in phytotron plants as compared to glasshouse plants

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