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PLANT PHYSIOLOGY

Effect of Hydro and Hormonal Priming on Seedling Vigour during Initial Vegetative Growth of Rice (*Oryza sativa* L.)

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Abstract

In the present piece of work, rice seeds were primed with distilled water and different concentrations of kinetin (0 to 30 ppm) T_2 to T_{11}, whereas; seeds without any treatment referred as control (non-primed) (T_1). Various physio-morphological (shoot and root lengths, root number, fresh and dry weights) and biochemical (proline content, total chlorophyll content and superoxide dismutase activity (SOD at 20 days after sowing)) parameters were studied in the seedlings, obtained from 10, 15 and 20 DAS old primed and non-primed plants. Among treatments, 2.5 ppm treatment (T_3) was found to perform best and the T_1 was the poorest.

Highlight

- Rice seeds ,primed with kinetin conc.2.5 ppm , represented best performance among all treatments in improving seedling growth.

Keywords: Seed priming, Kinetin, Rice, Seedling growth

Rice (*Oryza sativa* L.), is the most important staple food crop for more than 2/3rd of Indian population. Therefore, to achieve food security and to alleviate poverty of our country, the higher production with lowering production cost of rice is preferable. To meet out these two challenges some seed enhancement technology is introduced by our seed scientist, one of them are seed priming.

Seed priming (pre sowing imbibition treatment) is widely used to enhance seed performance with respect to rate and uniformity of germination (Bradford 1986). The beneficial effects of seed priming are, it promotes germination, seedling growth, protease activity in endosperm of cereals, solubulization and mobilization of nitrogen from endosperm/ cotyledons to growing embryo, rate of water uptake by germinating seeds/ growing seedlings etc. which eventually improves the nitrate reductase activity, chlorophyll content, amino acid content and finally yield in crops like maize, wheat, rice, mustard, okra etc. (Bose *et al*., 1982, Mandal and Basu 1984, Paul *et al*., 1993, Ahamad and Ibrar 1996, Bose and Mishra 1999, Bose and Mishra 2001, Kumari *et al*., 2002, Bose and Pandey 2003, Sharma and Bose 2006 and Mondal *et al*., 2011) while treated with various chemicals. Now a day various types of growth promoting and retarding hormones are

also used widely for seed priming in various crop plants. Hence, the present piece of work was taken to screen out the most appropriate concentration of kinetin for priming purposes of rice var. MTU 7029, and to study its effect on initial vegetative growth phases.

Materials and Methods

In the present investigation, before sowing the healthy and bold rice (*Oryza sativa* L. var. MTU 7029) seeds were surface sterilized by keeping them in 0.1% $HgCl_2$ (Mercuric chloride) solution for 2 minutes and then thoroughly washed with distilled water for 5-6 times. For priming, the sterilized seeds were soaked either in distilled water or in different concentrations of kinetin (ranging from 0 to 30 ppm) for 20h (total 11 treatments T_1-T_{11}). After that the seeds were taken out and gently washed with distilled water once and then dried back to its initial weight at the room temperature by placing them forced air under room temperature (32 ± 2°C).

Dried seeds were then packed in paper bags separately for each treatment and were used as per requirement but within one month of priming. The seeds without any treatment referred as control (non-primed) and both the primed and non-primed seeds were sown in small pots (3.5 × 5 inch) in kharif season 2011 in a complete randomized design (CRD) with three replications according to recommended practices.

The physio-morphological (shoot and root lengths, root number, fresh and dry weights) and biochemical (proline content, total chlorophyll content and superoxide dismutase activity (SOD at 20 days after sowing)) observations were measured at 10, 15 and 20 days after sowing (DAS).

The length of the shoot was taken by using centimetre- scale by placing it on the surface of the soil of the pot and upto the top of the plant leaf. To get the length and number of roots upto 20 days, the seedlings were first watered vigorously and then uprooted very gently to avoid any type of injury to root system of the seedlings. These were kept in a beaker of 1 L capacity filled with distilled water. The soil present on root surface was washed thoroughly for its proper cleaning by using small brush. The centimetre scale was placed at the base of shoot to the tip of the longest root to measure the root length. The number of roots of plants was also counted by placing the root part on a glass plate and by using a needle.

The dry weight of seedlings was obtained by keeping the sample for an hour in an oven pre-set at 100 - 110°C. Thereafter it was placed in another oven, which was set at 60 to 70°C till to get the constant weight (5 seedlings were taken into consideration for each treatment and per replication).

Proline and total chlorophyll content of leaves and SOD activity were measured by using the method of Bates *et al.* (1973), Witham *et al.* (1971) and Dhindsa (1981) respectively. However, the treatment details were as follows: (i) Non primed seeds (control) (T_1), (ii) Seeds primed with distilled water (T_2), (iii) Seeds primed with 2.5 ppm kinetin (T_3), (iv) 5 ppm kinetin (T_4), (v) 7.5 ppm kinetin (T_5), (vi) 10 ppm kinetin (T_6), (vii) 12.5 ppm kinetin (T_7), (viii) 15 ppm kinetin (T_8), (ix) 20 ppm kinetin (T_9), (x) 25 ppm kinetin (T_{10}), (xi) 30 ppm kinetin (T_{11}).

Results and Discussion

Efficient seed germination and early seedling establishment are important and foremost requirement for commercial agriculture. Rapid and uniform seedling emergence leads to successful establishment, as it produces a deep root system before the upper layers of soil dry out, harden, or reach supra-optimal temperatures (Harris 1996).

In the present piece of work, among the hydro and kinetin primed seeds, treatment T_3 (18.51, 21.05 and 24.61 cm) noted to have highest shoot length in all the three days of study, and shown statistically significant results at 1 and 5% level of significance followed by the other treatments in case of shoot length. While studying the root length of the primed and non-primed seedling, the treatment T_3 showed highest value and statistically significant results at 10 days. However, at 15 DAS T_3 (14.02 cm), T_4 (13.92 cm) and T_7 (13.05 cm) attained higher value and at 20 DAS T_3 (15.98 cm) has shown statistically significant results from the other treatments in case of root length.

Whereas, T_4 (3.8) showed more number of roots at 10 DAS, T_6 (4.8) at 15 DAS and T_3 (5) at 20 DAS. In case of fresh weight of seedlings at 10, 15 and 20 DAS, the highest scorer was T_3 (0.61, 0.62 and 0.64g) respectively. When the measurement of dry weight of seedlings were recorded the highest performer

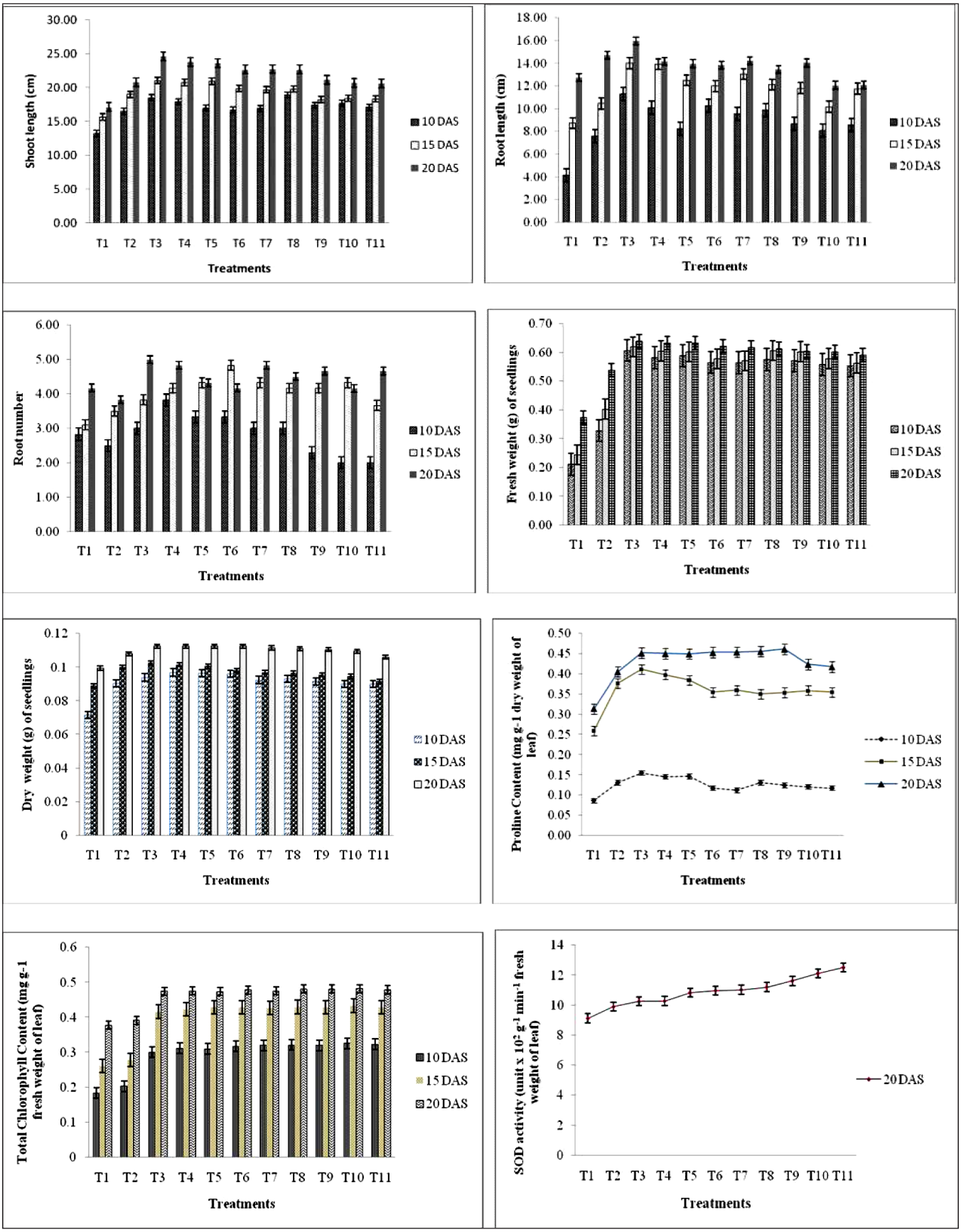

Fig. 1: Effect of hydro and hormonal seed priming on shoot and root lengths, root number, fresh and dry weights, proline content, total chlorophyll content and super oxide dismutase activity of rice var. MTU 7029

was T_4, T_5 and T_6 (0.1g), T_2 to T_8 (0.1g) and T_2-T_{11} (0.11g) respectively at all the studied 3 DAS (Fig. 1).

In the present investigation, all primed sets enhanced the shoot and root lengths, fresh and dry weights of the growing seedlings in respect to control. This may be happen due to the action/ interactions of particular essential element(s) within the cell system, and that has been added with the action of particular PGR like kinetin, specifically required for the accumulation of source properly, for enhancing the performance of sink in particular part (Banerji and Laloraya, 1965 and Sugiura, 1963) of organ of the plant/ crop. Root number and root length both are very important criteria for a growing crop. It gives the proper anchorage to the plant as well as supply the water and minerals also. Bose and her group have been established that the initiation of rooting points is depended on the interplay of the level of various plant growth regulators like auxin and cytokinin (Bose and Srivastava 1979).

In the present case also kinetin upto certain extent improve the number of roots in the rice variety MTU-7029. This may conclude that kinetin treatment in form of seed priming may produce vigorous seedling due to the formation of more number of root and long length of the same in which latter will help to search the water from the soil in a growing crop and improved the seedling vigour. However, Srivastava, (2002) showed a closed correlation between an improved seedling growth characteristics and greater production of roots is essential to an increased level of cell division after the germinative phase of plant growth.

However, at 10 DAS T_3, T_4 and T_5 (0.15), at 15 DAS T_3 and T_4 (0.41 and 0.40) and at 20 DAS T_3, T_4, T_5, T_6, T_7, T_8 and T_9; showed statistically at par result and presented higher contents of proline on all the respective days. Among all the primed seeds, T_{10} (0.325, 0.433 and 0.482) was recorded greater amount of total chlorophyll content (mg g^{-1} fresh weight of leaf) in all the study periods. Whereas, when we consider superoxide dismutase activity of rice seedling at 20 DAS the treatment T_{11} showed the highest enzyme activity in var. MTU 7029 (Fig. 1).

From the present experiment it can be observed that plants raised from kinetin primed seeds showed a significant increase in proline content in comparison to the hydro primed and control (non primed seeds) seeds. The increment in the proline may improve the stress ameliorating capacity in the growing crops being an important molecule for osmo-regulation in plants in adverse condition during growth. This has been supported by a number of scientists time to time working on different plant systems under various stresses like salinity, water deficit, drought, heat etc. (Srinivas and Balasubramanian 1995, Leigh *et al.*, 1981, Ketchum *et al.*, 1991, Pahlich *et al.*, 1983, Yuan-Chun Chang and Tse- Min Lee 1999, Bajii *et al.*, 2000 and Tatar and Gerrek 2008). Therefore, in the present study it has been shown very clearly that the kinetin has more ability to improve the proline content in leaves at each and every study period.

The total chlorophyll content was more while seeds were primed with kinetin and distilled water as compared to control. In this case kinetin was responsible for the synthesis of chlorophyll. Cytokinin represents a class of phytohormone that play an important role at all phases of plant development from seed germination to senescence (Mok and Mok 1994, Niazi *et al.*, 2005 and Riefler *et al.*, 2006). Cytokinins act at the cellular level by inducing expression of some genes, promotion of mitosis and chloroplast development (Osborne 1962 and Yaronskay *et al.*, 2007). Enhancement of chlorophyll synthesis by kinetin has also been demonstrated by Banerji and Laloraya (1965) and Sugiura (1963). Stetler and Laetsch (1965) have reported kinetin-induced chloroplast maturation and chlorophyll production in callus tissue of tobacco which is well correlated with the present piece of work.

Superoxide dismutase (SOD) is a key enzyme in cell which plays a vital role in cell against oxidative damage and severe environmental conditions. In the present case, the activity of SOD enzyme was more in primed seeds than the control one. For this parameter the rice seeds primed with higher concentration of PGR showed higher values. These findings are in line with previous reports in which seed priming also increased the activity of SOD in rice seedlings (Yuan-Yuan *et al.*, 2010). Abiotic as well as biotic stresses have the capacity to degenerate and modulate the metabolic activities in living system(Alscher *et al.*, 2002 and Bheemareddy and Lakshman 2011) as a result reactive oxygen species (ROS) are formed and SOD is an enzyme which constitutes the first line of defence against

reactive oxygen species (ROS). These ROS are produced in both non stressed and stressed cells but later produces more which can be mitigated by SOD enzyme. However, the increased value of SOD always reflects the defence capacity of plants toward various stresses.

Conclusion

The present study concludes that 2.5 ppm kinetin treatment (T_3) is the best performer among all studied treatments for achieving the adequate vegetative growth. As it is a known truth that seed priming is an environment friendly technology and improves the potentiality of the seeds as well as seedlings/ plantlets to resist various biotic and abiotic stresses and to increase the yield potentials of the crops, can be a worthy recommendation for the commercialization of using of primed seeds to the farmers of our nations.

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