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Effect of growth regulator and hollo priming on seed quality parameters in rice (*Oryza sativa* L.)

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Abstract
The experiment was conducted in Post Graduate Laboratory, Department of Seed Science and Technology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya-224229. U.P. during *Kharif* 2017 & 2018 in order to standardize the best method and or doses of priming in three cultivars viz., NDR-2064, Shusk Samrat and Shabha Sub-1 of rice. Dry (Moisture, 11-12%) and uniform seed of all three varieties were subjected to GA_3 @ 200 and IAA @ 50 ppm (hormonal priming), KNO_3 @ 200 ppm and KCL @ 200 ppm for 12 and 16 hrs. in Completely Randomized Design with three replications. Untreated seed of each variety was served as respective control. It was found that all the priming treatments enhanced significantly seed quality parameters *viz*., seed germination (%), speed of germination, root length (cm), shoot length (cm), seedling length (cm) and vigour index in comparison to their respective control. These seed quality parameters were significantly enhanced with hormonal priming (GA_3 @ 200 ppm) followed by halopriming (KNO_3 and KCL @ 200ppm) irrespective of the all three cultivars over 12 and or/16 hrs of priming. These seed priming treatments being cost effective and comparatively eco-friendly need to be exploited for befitting the rice cultivation.

Keywords: gibberellic acid, potassium nitrate, potassium chloride, seed enhancement, rice

Introduction

Rice (*Oryza sativa* L.) is one of the most important field crop after wheat in the world providing staple food to the basket of millions. It is an indispensable source of calories for almost half of the population within Asia. More than 90 per cent of the world, rice is produced and consumed in Asia, which is a native for 60 per cent of the earth's population. It is grown in all continents except Antarctica, occupying an area of 167.13 million ha, and producing 782.00 million ton paddy (FAO, 2017-18) [2]. Improved production and access to this vital food crop is very important as it feeds more than half the world's population while providing income for millions of rice producers, processors and traders. The protein content of milled rice is about 6-7 per cent however, compares favourably with other cereals in amino acid content. The biological value of protein is high, the fat content of rice is low (2.0-2.5%) and much of the fat is lost during milling. Rice grain contains as much B group vitamin as wheat. Milled rice losses valuable proteins, vitamins and minerals in the milling process during which embryo and aleuronic layer are removed and much of the loss of nutrients can avoided through parboiling process. The term "seed priming" was coined/reported by Heydecker (1974) [8] to describe a treatment to improve germination at low temperature. Heydecker and his co-workers have extensively used the "priming" to describe an osmotic seed treatment to enhance seed germination processes. Seed priming is defined as the technique associated with uptake of water by the seed to initiate the early event of germination but not sufficient to permit radical protrusion followed by drying (Basu, 1994) [5].

Various seed priming techniques such as hydropriming, halopriming, osmopriming, osmohardening, harmonolpriming and biopriming are employed to enhance the biological processes leading to increased growth and development, and finally yield (Nawaz *et al*., 2013; Yadav, 2018) [13, 21]. Seed primed has also been reported to improve germination and growth of rice seed. Hormonal and halo-priming refer to soacking the seed in plant growth hormones (auxins, gibberellins, kinetin, etc.) and inorganic salts (KNO_3, KCL, Na CL, etc) for specific period and retried back to original seed moisture. Priming of rice seed with gibberellic acid (GA_3) increased seedling growth (Watanabe *et al.*, 2007) [20]. Seed priming with GA_3 and KCL can prepare a suitable metabolic reaction in seed which can improve seed germination performance and seedling establishment (Khan *et al.*, 2009) [10].

Bajehbaj, (2010) [3] while evaluating the effects of KCL and KNO_3 on the germination traits and seedling growth, changes in activity of enzymes involved in hydrolysis of storage products, reported their important role in the initial growth and development of the embryo. Seed germination is promoted by halo-priming but also stimulate subsequent growth, thereby enhancing final crop yield (Sallam, 1999; Yadav *et al*., 2019) [15, 22]. The improvement in priming is governed by a number of factors such as plant species, priming media, its concentration and duration, temperature, storage conditions, etc. (Singh *et al*., 2015; Yadav *et al*., 2019) [16, 22]. Keeping the projected demand of rice and reproducibility of seed prime technique in view, the present investigation was undertaken to explore the possibility of further enhancement in seed vigour integrating after hormo- and halo-priming in genetically improved and widely adapted varieties of rice.

Materials and Methods

The experiment was conducted in Post Graduate Laboratory of Seed Science and Technology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya-224229. U.P. during *Kharif* 2017 and 2018 in three cvs. namely, NDR-2064, Shusk Samrat and Shabha Sub-1 of rice. .. For the preparation of 1 ppm solution, one milligram of each solute was dissolved in one litre water. Accordingly, the stock solution of each hormone/ inorganic salt was prepared in beaker separately. Dry (Moisture, 11-12%) and uniform seed of all three cultivars were subjected to GA_3 @ 200 and IAA @ 50 ppm (hormonal priming), KNO_3 @ 200 ppm and KCL @ 200 ppm (halo priming) for 12 and 16 hrs. Untreated seed of each cultivar was served as respective control. After periodical soaking the seed in solution, the seed were drained out from the beaker and dried in shadow to bring about at original moisture. Thereafter, 50 seed were randomly taken and put on between towel papers following completely randomized design (CRD) with three replications in BOD incubator at 22+-2 ^{o}C. The observations for germination (%), speed of germination, seed moisture content (%), root length (cm), shoot length (cm), seedling length (cm) and vigour index were recorded following ISTA (1999) [9] and Baki and Anderson (1973) [6], respectively.

Results and Discussion

Seed germination

Seed germination is the basis for playing its successful role in the agriculture. Germination of seed is commonly embodied three distinct phases as Phase I: seed hydration process through passive imbibition of tissues with water movement first occurring in the Apo plastic spaces, Phase II: activation phase associated with the re-establishment of metabolic activities and repairing processes at the cellular level and Phase III: initiation of growing processes associated to cell elongation and leading to radicle protrusion. Phase I and III involve an increase in the water while hydration remains stable during Phase II. It is commonly dried again considered that before the end of Phase II, germination remains reversible process means the seed may be dried again and remain alive during storage and able to subsequently re-initiate germination under favourable conditions (Lutts *et al*., 2016) [12]. Effect of seed priming treatments under study were found to be the most effective for significant increasing the seed germination (%) in all three cultivars *viz.,* NDR-2064, Shusk Samrat and Shabha Sub-1 during both the duration period (Fig.1). The most effective treatment was found to be IAA @ 50 ppm for 12 hrs (96%) followed by GA_3 @ 200 ppm and KNO_3 @ 200 ppm as compared to control (87%) in NDR 2064. In the case of Shusk Samrat, the maximum seed germination was observed with GA_3 @ 200ppm (16hrs) closely followed by GA_3 @200ppm and KNO_3@200ppm (12hrs). Besides, the maximum seed germination (96%) was recorded with priming of KNO_3 @200ppm followed by GA3 @200ppm during 16 hrs. of priming in Shabha Sub-1. It is reported that the earlier and better-synchronized germination is associated with increased metabolic activities in the soaked seeds (Basra *et al*., 2003; Yadav, 2018) [4, 21]. Tanaka *et al.* (1970) [19] and Steinbach *et al.* (1997) [17] emphasized that the presence of GA3 at adequate endogenous levels in cereal seeds seemed to be an essential requirement for germination, and that the GA_3 hormone is continuously required throughout the germination process.

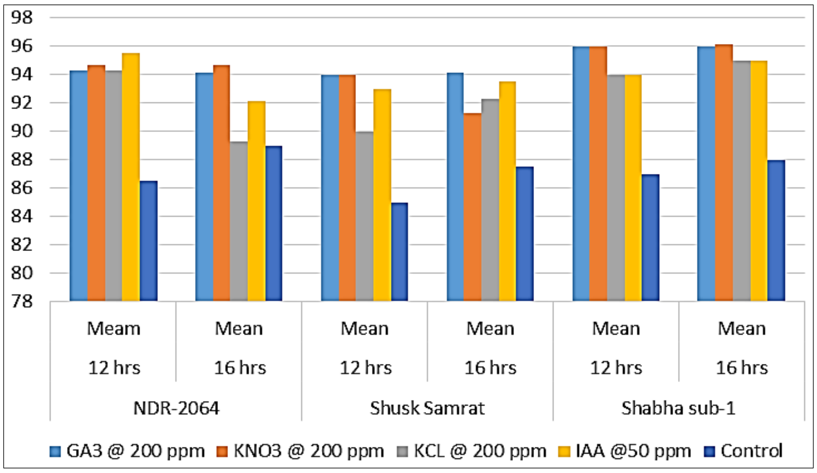

Fig 1: Effect of priming treatments on average seed germination (%) in three rice cultivars during 12 and 16 hrs. of priming.

Speed of germination

Performance of seed priming treatments under study were found to be most effective for significant increasing the speed of germination in all three cultivars *viz*., NDR-2064, Shusk Samrat and Shabha Sub-1 during both the duration period. The most efficient seed priming treatment was found to be GA_3 @ 200 ppm for 16 hrs. in NDR- 2064 and for 12 hrs. in rest both Shusk Samrat and Shabha Sub -1 varieties (Fig.2). Enhanced responses of GA_3 to germination, emergence and speed of germination have also been reported by Acharya *et al.* (1990) [1]. KNO_3 is a promising compound. The nitrate (NO_3) could be absorbed, being used in the metabolism of the embryo through the enzyme nitrate reductase (NR). Besides, the priming could also activate the response of the antioxidant system, becoming the primed seed prepared more possible stresses. Lara *et al*. (2014) [11] showed that KNO_3 priming increased NR activity as well as in the antioxidant enzymes. The germination time and germination rate had a better performance .it was also observed the activity of enzyme nitrate reductase in the production of nitrite/ nitric oxide, which acted removing dormancy and promoting faster germination. Singh *et al*., (2015) [16] reported that osmo-priming with KNO_3 were superior for seed germination, emergence, plant height and dry matter accumulation in comparison to control in cowpea. KCL seed priming showed higher germination, germination index, coefficient of variation, shoot and root length as compared to control (Lutts *et al*.,) [12].

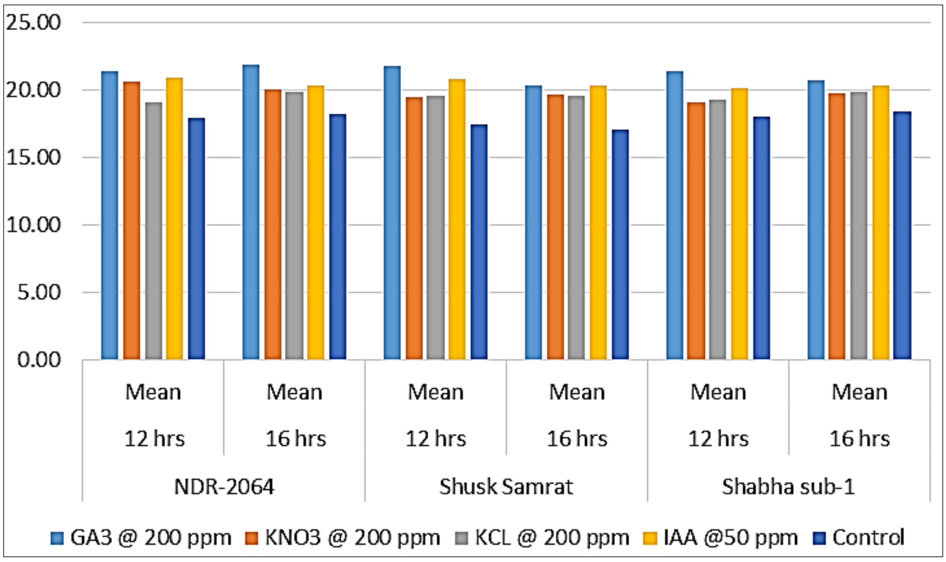

Fig 2: Effect of priming treatments on average speed of germination in three rice cultivars during 12 and 16 hrs. of priming.

Seed moisture content (%)

Effect of seed priming treatment under study were found to be varied depending upon the genetic architecture of the seed. Initially the seed moisture content was increased during imbibition but after drying back, the moisture was remain at par to original moisture content (Fig.3). That's why, the primed seed could be stored for a while if unfavourable condition prevails during sowing time.

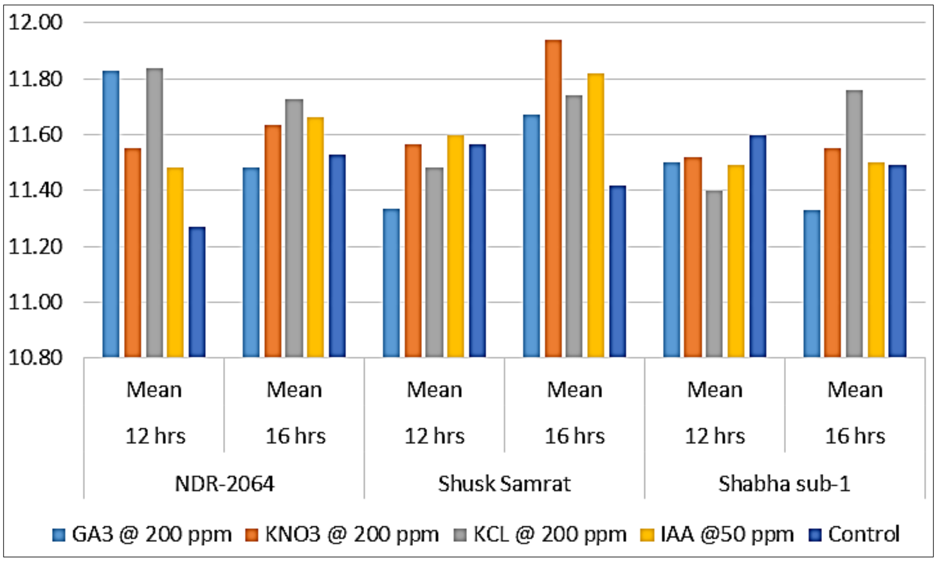

Fig 3: Status of seed moisture content (%) of primed seed after drying in three cultivars of rice.

Root length (cm)

Effect of seed priming treatments were found to be most effective for significant increasing the root length (cm) in all three cultivars *viz.;* NDR-2064, Shusk Samrat and Shabha Sub-1 during both the duration period under study. The most efficient seed priming treatment was the GA_3 @ 200 ppm for 16 hrs. in NDR-2064 and Shabha Sub-1, 12 hrs. in Shusk Samrat (Fig.4).

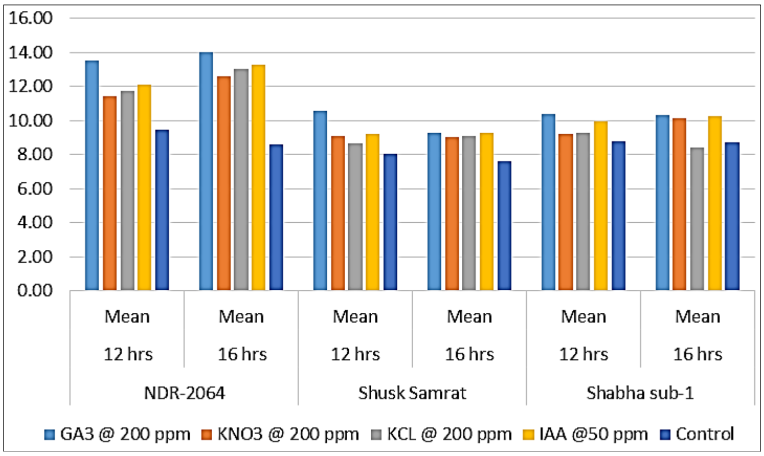

Fig 4: Effect of priming treatments on average root length (cm) in three rice cultivars during 12 and 16 hrs. of priming.

Shoot length (cm)

The effect of seed priming treatments on shoot length in all three cultivars *viz.*, NDR-2064, Shusk Samrat and Shabha Sub-1 during both the duration is presented in Fig.5). The most efficient seed priming treatment was again the GA_3 @ 200 ppm for 12 hrs invariably in all three cultivars under study. The shoot length was significantly higher in all the primed treatments over respective control. Yari *et al.* (2010) [23] reported that seed primed with KCL 2% showed good potential to enhance germination, emergence, growth and grain yield in wheat.

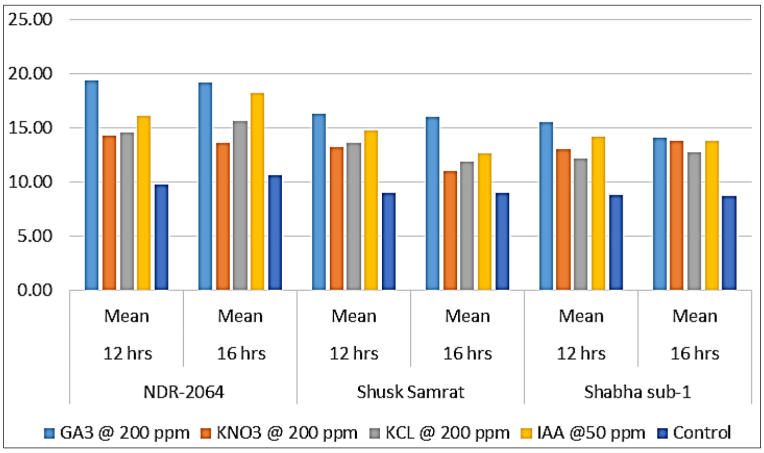

Fig 5: Effect of priming treatments on average shoot length (cm) in three rice cultivars during 12 and 16 hrs. of priming.

Seedling length (cm)

Effect of seed priming treatments under study were found to be most effective for significant increasing the seedling length (cm) in all three cultivars *viz.*, NDR-2064, Shusk Samrat and Shabha Sub-1 during both the duration. The most efficient seed priming treatment was the GA_3 @ 200 ppm for 16 hrs (33.30 cm) in NDR-2064 and 12 hrs. in Shusk Smrat and Shabha Sub -1. Hormonal priming with different hormones *viz.*, GA_3, Kinetin, IAA, etc. has been reported to promote the growth and development of the crops. Thus, the KNO_3 priming decreased mean germination time and increased seedling size as compared to non-primed seed.

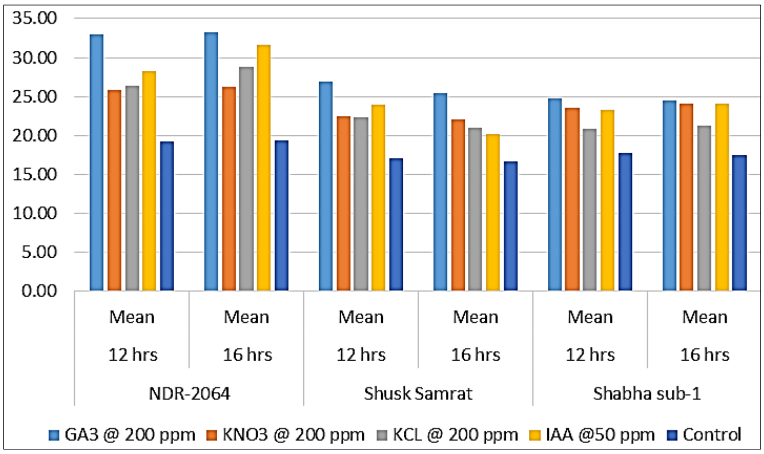

Fig 6: Effect of priming treatments on average seedling length (cm) in three rice cultivars during 12 and 16 hrs. of priming.

Vigour index

Vigour index is a compered value of germination (%) and seedling length (cm). Since these both parameters have already responded significantly to seed priming treatments. Accordingly, effect of seed priming treatments under study were found to be most effective for significant increasing the seedling vigour index in all three varieties *viz.*, NDR-2064, Shusk Samrat, Shabha Sub-1 during both the duration. The most efficient seed priming treatment was the GA_3 @ 200 ppm for 16 hrs (3136.22) in NDR- 2064 and 12 hrs. in Shusk Samrat and Shabha Sub-1.

Raun *et al.* (2002) [14] reported that priming of rice seed with KCL improved its germination index. Greater efficiency of seed priming with KCL is possibly related to the osmotic advantage that K+ has in improving cell water saturation and that act as co-factor in activities of numerous enzymes. The gibberellic acid in involved both in overcoming dormancy and in controlling the hydrolysis of reserves. The presence of adequate levels of this acid in the seeds stimulates the synthesis, activation and secretion of hydrolytic enzymes, mainly a-amylase, releasing reducing sugars and amino acids which are essential for embryo growth. (Chrispeels and Varner, 1967; Tanaka *et al.*, 1970) [7, 19].

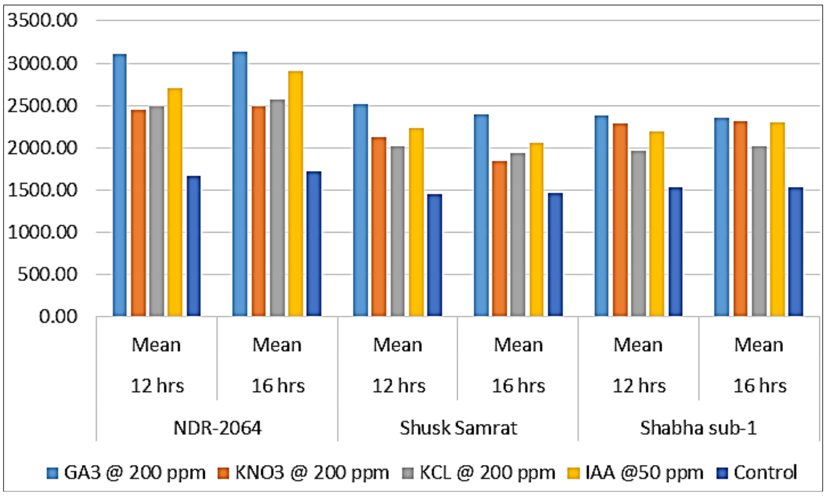

Fig 7: Effect of priming treatments on average vigour index in three rice cultivars during 12 and 16 hrs of priming.

Conclusion

On the basis of results obtained from the present experiment, it is concluded that the hormonal priming with GA_3 @ 200 ppm or halo priming with KNO_3 or KCL @ 200ppm for either 12 or 16 hrs. could be exploited for significant enhancing the seed quality parameters viz., germination, speed of germination, root length, shoot length, seedling length and vigour index in rice.

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