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EFFECT OF PRESOWING CHEMICAL AND ORGANIC SEED HARDENING ON SEED QUALITY, GROWTH AND YIELD CHARACTERS IN RICE cv. IR 36

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Abstract

Rice cv. IR 36 seeds were given chemical and organic seed hardening treatment with 1% $CaCl_2$, l% KCl, 1% KNO_3, l% NaCl, 10% Cow dung and 3% Panchakavya of seed. The hardened seeds were evaluated initially both under laboratory and field experiments for seed quality, growth and yield attributing characters along with control. The results reveals that seeds hardened with 1% $CaCl_2$ recorded higher values for initial seed quality characters such as germination percentage, speed of germination, root length, shoot length, seedling length, dry matter production, vigour index I and vigour index II under laboratory evaluation and the same treated seeds sown in field condition recorded higher values in growth and yield characters.

Key words: Rice, chemical and organic seed hardening, $CaCl_2$, growth, quality, yield.

Introduction

Rice (*Oryza sativa* L.) is one of the staple food crops in South and Southeast Asia. More than 90% of the world's rice is grown and consumed in Asia, where 60% of the world's population lives. It is estimated that 40% of the world's population use rice as a major source of energy. White rice is a good source of magnesium, phosphorus, manganese, selenium, iron, folic acid, thiamin and niacin. It is low in fiber and its fat content is primarily omega-6 Fatty acids, which are considered pro-inflammatory. The total world area, production and productivity for rice is 159.17 million hectares, 472.16 MMT and 4.42 metric tons per hectare. Major Rice producing countries are China, India, Indonesia, Bangladesh, Vietnam, Thailand, Burma, Philippines, Brazil and Japan. In India, Rice was cultivated in an area of 43.5 million hectares with a production of 104.41 MMT and productivity of 3.60 metric tons per hectare (World Agricultural Production, Anon, 2017). In Tamilnadu area under rice cultivation is 21 lakh hectares with a production of 93 L.M.T. and productivity of 4.43 metric tons per hectare (Urban Development and Agriculture, Policy Note 2015-16). Quality seeds play a major role, along with improved package of practices leading to enhanced productivity. The low productivity under rainfed condition is due to use of poor quality seeds, soil moisture deficit, low and erratic rainfall and improper crop management. Rapid uniform field emergences of seedlings are two essential pre-requisites to increase yield and quality in a number of field crops (Krishnotar *et al.,* 2009). Seed enhancement may be defined as post-harvest treatments that improve germination and seedling growth or facilitate the delivery of seeds and other inputs/materials required at the time of sowing smoothly. Seed enhancement technology predominantly possess a central objective to further improve seed performance by treating with specific additives/chemical/organics/ botanicals etc., under very specific regimes and with the aid of certain planting equipments to grow uniform crop obviously to harness higher productivity and production (Halmer, 2006). Chemicals at variable concentrations promote germination of seeds, improve seedling growth, activity of various hydrolysis, solubilization and mobilization of nitrogen from cotyledons to growing embryo, rate of water uptake, resulting in improvement of nitrate content and enhanced

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yield in crops. Organic seed hardening provides hardiness to high temperature, low moisture especially in semi arid tropics. It promotes faster germination, higher seedling vigour leading to higher crop productivity. The main benefits of organic seed treatments include increased phosphate levels, nitrogen fixation and root development. “I have modified this Panchagavya by adding a few more ingredients and the modified version has a lot of beneficial effects on a variety of crops and livestock”, said Dr. K. Natarajan, President of the Rural Community Action Centre (RCAC), a nongovernmental organization, actively engaged in promoting the concepts of organic farming and biodiesel in the rural areas of Tamil Nadu.

Materials and methods

Genetically and physically pure seeds of rice cv. IR 36 were obtained from the Tamil Nadu Rice Research Institute (TRRI), Aduthurai, for this study. Field experiments were carried out at Plant Breeding Farm, Faculty of Agriculture, Annamalai University during the year 2015-2017. Laboratory analysis was conducted at Seed Technology Laboratory, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University. The Plant Breeding farm was situated at $11^{0}24'$ North latitude and $79^{0}44'$ East longitude at an altitude of +5.79 m above mean sea level. Thus, a pre-treatment or hardened plant might survive adverse environmental stresses more easily because of its advanced state of development. A day before sowing, fresh seeds of rice cv. IR 36 were soaked in the respective solutions for 12 h in 1:1 proportion for hardening purpose. Later, seeds were dried back to 10 per cent moisture content under shade and dibbled.

Treatment details

T_0 - Control

T_1 - 1% $CaCl_2$

T_2 - l% KCl

T_3 - 1% KNO_3

T_4 - l% NaCl

T_5 - 10% Cow dung

T_6 - 3% Panchakavya

The recommended package of practices was followed for raising the crop. The seeds were subject to evaluation in both laboratory and field experiment. In laboratory experiment (completely randomized design) the treated seeds were shade dried to the original moisture content of 10 per cent and then the seeds were evaluated for their performance in initial seed quality parameters. The field experimental trial was conducted in a Randomized Block Design replicated thrice. The treated seeds were sown in raised nursery bed. Twenty five days old seedlings were transplanted to the main field at the rate of one seedling per hill with the spacing of 15 cm between rows and 10 cm within plants. Recommended cultural practices were followed and then the seeds were evaluated for their performance in growth and yield parameters.

Statistical analysis

The data collected from the field and laboratory experiments were analysed statistically by adopting the technique described by Panse and Sukhatme (1978). Wherever necessary, the values expressed in percentage were transformed into arcsine values before analysis. The significance of treatment effect was tested with the help of F-test and the differences between treatments by Critical Difference (C.D) at 5% level of significance were determined.

Results and discussion

The present study was under taken to observe the effect of various seed treatments on yield and its contributing characters in IR 36. The effect of following seed treatments namely 1% $CaCl_2$, l% KCl, 1% KNO_3, l% NaCl, 10% Cow dung, 3% Panchakavya, under laboratory and field conditions during the year 2015-2017. The results of the various treatments are discussed below. Higher germination per cent in **T_1** may be due to the benefits of hardening which may be due to number of physico chemical changes occur that modify the protoplasmic characters, increasing the embryo physiological activity and associated structures (Ganesh *et al*., 2013). The improvement in germination by $CaCl_2$ hardened seeds may be attributed to stimulation of hydrolytic enzyme activity known to be induced by $CaCl_2$ agents. Since, $CaCl_2$ improving cell water status and also act as cofactors in the activities of numerous enzymes (Joseph and Nair, 1989). Taiz and Zieger (2002) most of which are active when reserve metabolization and radical protrusion were in progress. Subsequent improved in germination and speed of germination **T_1** of the hardened seed could be due to the fact that such advanced seed would retain viability to carry on where they left off upon germination. The improvements in seedling length (both root length and shoot length) may due to the enhanced metabolic activity and enzyme activity which hydrolysis the stored reserved food material and make available high energy bio molecules and vital components to growing points and also due to the presence of growth promoting substance GA_3, auxin, IAA which induces elongation of cells there by increasing root and shoot length

Table 1: Effect of seed hardening treatment on initial seed quality characters in rice cv. IR 36.

Treatments	Germination percentage (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Dry matter production (g/10 seedling)	Vigour index I	Vigour index II
T_0	79 (62.72)	24.40	15.93	10.73	26.66	0.3700	2106.14	29.23
T_1	92 (73.57)	31.02	17.90	12.96	30.86	0.3900	2839.12	35.88
T_2	91 (72.54)	30.69	17.53	12.76	30.29	0.3800	2756.39	34.58
T_3	90 (71.56)	29.06	16.66	11.46	28.12	0.3800	2530.80	33.30
T_4	88 (69.73)	28.44	17.00	12.03	29.03	0.3800	2554.64	33.44
T_5	87 (68.86)	26.01	16.50	11.03	27.53	0.3767	2395.11	32.19
T_6	89 (70.63)	27.49	16.03	10.83	26.86	0.3800	2390.54	32.93
Mean	88(69.95)	28.15	16.79	11.68	28.47	0.3795	2510.39	33.07
SEd	0.2106 (0.2010)	0.0549	0.1123	0.0650	0.1737	0.0018	5.7206	0.0549
C.D (P = 0.05)	0.4527 (0.4322)	0.1179	0.2415	0.1397	0.3735	0.0038	12.2993	0.1179

Table 2: Effect of seed hardening treatment on growth and yield characters in rice cv. IR 36.

Treatments	Days to 50 per cent flowering	Number of productive tillers per plant	Plant height (cm)	Number of seeds per panicle	100 seed weight (g)	Seed yield per plant (g)
T_0	89.71	13.80	73.40	110.50	1.90	18.23
T_1	56.94	19.40	84.80	158.50	2.10	28.00
T_2	57.83	17.80	84.30	139.50	2.04	26.90
T_3	60.53	16.80	82.40	127.50	2.00	22.50
T_4	58.37	17.60	83.00	130.00	2.00	24.96
T_5	60.53	16.80	76.40	126.00	2.00	21.20
T_6	63.30	14.00	75.80	118.50	1.95	20.56
Mean	59.64	16.60	80.01	130.07	1.99	23.19
SEd	0.2230	0.3077	0.1509	0.7160	0.0209	0.5082
C.D (P = 0.05)	0.4862	0.6708	0.3290	1.5609	0.0456	1.1079

Table 3: Effect of seed hardening treatment on resultant seed quality in rice cv. IR 36.

Treatments	Germination percentage (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Dry matter production (g/10 seedling)	Vigour index I	Vigour index II
T_0	81 (64.15)	25.30	16.03	11.00	27.03	0.3767	2189.43	29.97
T_1	94 (75.82)	32.03	18.20	13.13	31.33	0.3933	2945.02	36.66
T_2	93 (74.66)	31.72	17.70	12.96	30.66	0.3900	2851.38	35.34
T_3	92 (73.57)	30.07	16.73	11.70	28.43	0.3800	2615.56	34.96
T_4	89 (70.63)	29.45	17.16	12.50	29.66	0.3800	2639.74	33.82
T_5	88 (69.73)	27.32	16.76	11.43	28.19	0.3800	2480.72	32.56
T_6	90 (71.56)	28.34	16.23	11.25	27.48	0.3800	2473.20	34.20
Mean	90 (71.44)	29.14	16.97	11.99	28.96	0.3829	2599.29	33.93
SEd	0.1154 (0.1142)	0.0970	0.1084	0.0602	0.2654	0.0025	6.5957	0.1303
C.D (P = 0.05)	0.2481 (0.2455)	0.20884	0.2330	0.1293	0.5706	0.0054	14.1808	0.28.01

(Ganesh *et al*., 2013).

The increased dry matter production over the control might be due to simultaneous effect of repair mechanism induced by hardened and synchronized earlier germination that makes seedling entry into the autotrophic state well in advance to produce more photo assimilate from source to sink there by increases the dry matter production. This was in conformity with earlier work of Shah (2007).

Higher seedling vigour index increased was recorded by $\mathbf{T_1}$ over control was due to the increased germination percentage of root length, shoot length and dry matter production of seedlings. The $CaCl_2$ activities the synthesis of protein and soluble sugar in first phase of germination which have advantages for earlier germination and in turn produces longer seedlings there by increases the vigour of seedling (Rangaswamy *et al*., 1993; Farooq *et al*., 2006; Mulsanti and Wahyuni, 2011). Among the treatments, $\mathbf{T_1}$ (1% $CaCl_2$) treated plants completed days to 50% flowering with in short duration, when compared to other treatment and control. This positive reduction in days to 50% of flowering is mainly due to the earlier and uniform emergence of seedlings, which was evident from the present study and might be also due to the role of calcium in plant growth and development (Pawar *et al.,* 2003).

$\mathbf{T_1}$- 1% $CaCl_2$ recorded the more number of productive tillers per plant and improvement over control which might may be due improved mobilization of nutrient and moisture supply from hardened seeds and might have resulted enhanced fertilization, which ended in lower number of sterile spikelet's as reported by Harris *et al.* (2002); Rehman *et al.* (2011); Patil *et al*. (2014); Roohul Amin *et al*. (2016). In case of the untreated seeds $\mathbf{T_0}$ the plant registered the reduced plant height. The mechanism of reduction in plant height may be due to the reduced cell size, cell thickening, reduced rate of enzyme activity and poor availability of nutrients to the growing seedlings which favours delayed emergence and reduces vigour (Kamala Thirumalaiswamy and Sakharam Rao, 1977; Karivaratharaju and Ramkrishna, 1985).

Among the treatments, $\mathbf{T_1}$ registered the more value of panicle length, leaf length and leaf breadth over treatment and control. The improvement in vegetative growth parameters (days to 50% flowering, number of productive tillers per plant, plant height, panicle length, leaf length and leaf breadth) might be due the cumulative effect of hardening and $CaCl_2$ could have triggered the biosynthesis of nucleic acids, proteins and the consequential enhancement of cell division besides the enhanced metabolic activity of the plant resulting in the increased uptake of nutrients which are associated with improved crop growth (Sabir-Ahamed, 1999; Pawar *et al*., 2003). In contrast, the control registered the minimum values for yield attributing characters including harvest index and 100 seed weight might be due to the slow starch hydrolysis due to the poor availability of water and curtailed emergence of seedling seems to be relative to in efficient mobilization and utilization of seed resources (Manjunath and Dhanoji, 2011a; Manjunath and Dhanoji, 2011b; Sushila Kanwar *et al*., 2015). From the present study evident the control plants have a poor plant establishment, poor vegetative growth and which results in lesser photosynthesis and reduced translocation of photo assimilate from source to sink.

Improved seed yield by $\mathbf{T_1}$ as compared to the control might be due to the hardening chemicals which accelerate the synthesis of protein and nucleic acid bound water content, improved photoassimilation and its translocation and partitioning from source to sink, repair germination and growth of seedling resulting in increasing uptake of nutrients and ability of treated plants to unfavourable condition. Similar results were reported by Arjunan and Srinivasan (1989), Lai and Luo (1989); Narayanaswamy and Shambulingappa (1998); Ananda and Reddy (2002), Zheng *et al*. (2002), Solaimalai and Subburamu (2004), Ponnuswamy (2005); Paramasivam *et al.* (2007); Farooq *et al*. (2006); Rehman *et al*. (2011); Sujatha *et al*. (2013); Patil *et al.* (2014). In laboratory condition resultant seed quality ($\mathbf{T_1}$) 1% $CaCl_2$ recorded significantly higher values for all the treatments studied namely germination percentage (%), speed of germination, root length (cm), shoot length (cm), seedling length (cm), dry matter production (g/10 seedlings), vigour index I and vigour index II. The improved seed quality of resultant seeds might also due to the more food reserved materials in seeds and reduced stress condition during seed maturation and development favoured this positive effect.

Conclusion

The study reveals that seeds hardened with 1% $CaCl_2$ for 12 hrs ($\mathbf{T_1}$) recorded higher values for seed quality, growth and yield characters. The increase in seed quality, growth and yield characters was due to the presence of activities of numerous enzymes, enhanced metabolic activity, presence of growth promotors, make available high energy biomolecules, improved mobilization of nutrients and more food reserve materials in seeds. Hence 1% $CaCl_2$ hardened seeds recommends for improving the seed quality, growth and yield characters in rice.

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