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Effect of presowing seed hardening treatment on seed quality, crop growth and seed yield in rice cv. IR 64

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Abstract

A study was carried out to investigate the effect of pre-sowing seed hardening treatment with different chemicals such as 1% $CaCl_2$, 1% KCl, 1% KNO_3 and 1% NaCl and organics such as 10% cow dung and 3% panchakavya on seed quality, crop growth and seed yield in rice cv. IR 64. Presowing seed hardening treatment significantly increased the seed quality characteristics and yield attributing characters when compared to untreated seeds in major crops. From the result, it was revealed that 1% $CaCl_2$ seed hardening treatment enhanced the seed quality characters such as germination percentage, speed of germination, shoot length, root length, seedling length, dry matter production, vigour index and yield attributing characters such as number of productive tillers per plant, number of seeds per panicle and seed yield per plant. Hence, rice seeds hardened with 1% $CaCl_2$ may be recommended to get higher seed yield and seed quality.

Keywords: Rice, IR 64, seed hardening, $CaCl_2$, seed quality, seed 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. In world, rice ranks second next only to wheat in terms of area harvested, but in terms of importance as a food crop, rice provides more energy per hectare than any other cereal crops. Major rice growing countries are China, India, Indonesia, Bangladesh, Vietnam, Thailand, Burma, Philippines, Brazil and Japan. India ranks first in area and second in production. In India, major rice cultivating states are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab and Tamilnadu. In Tamilnadu, area under rice cultivation is 21 lakh hectares with a production of 93L. MT and productivity of 4.43 metric tons per hectare.

Quality seeds play a major role in crop production along with improved cultural package of practices to enhance productivity in rice. The low productivity is due to use of poor quality seeds, improper selection of pre-sowing seed treatment and treating agent and improper crop management. Rapidity and uniformity in seedling emergences are the two essential pre-requisites to increase seed yield and seed quality in a number of field crops (Krishnotar *et al.*, 2009) [3]. Seed hardening is one of the pre-sowing conditioning of seed to withstand adverse environment and adaptive conditions. It is a creation of resistance in the seed for better outgrowth of seedling. Such physiological reorganization is induced by hydration and dehydration process.

Seed hardening will give beginning nourishment for germinating seeds and hardened seedling can put forth better root and shoot growth. This enhances the drought tolerance of the plants resulting in increased seed yield and increased seed quality of the resultant seeds. The favourable effect of seed hardening with different chemicals and organic products was decisively recommended by several scientists for various crops to improve the seed yield and quality. With this background an experiment was designed to study the effect of pre-sowing seed hardening treatment on seed quality and seed yield in rice cv. IR 64.

Materials and Methods

The present investigation was carried out both in the laboratory as well as in the field condition. Genetically and physically pure seeds of rice cv. IR 64 were given hardening treatment with the following chemicals and organics *viz.*, T_0 - Control, T_1 - 1% $CaCl_2$, T_2 - 1% KCl, T_3 - 1% KNO_3, T_4 - 1% NaCl, T_5 - 10% cow dung, T_6 - 3% panchakavya. The lab experiment was conducted with the above treatment by adopting completely randomized design (CRD) with three replications. During pre-sowing seed treatment, seeds were soaked in the respective chemical solutions and organics for 12 hours at the ratio of 1:1 of the seeds. After soaking, seeds were dried back to the original moisture content and then evaluated for seed quality characteristics *viz.,* germination percentage, speed of germination, root length, shoot length, dry matter production and vigour index I and II.

The field experiment was conducted with the same treatment by adopting RBD with three replications. Observation on growth and yield parameters such as number of productive tillers per plant, plant height, panicle length, leaf length, leaf breadth, number of seeds per panicle, 100 seed weight, seed length, seed breadth, seed yield per plant, fresh weight, dry weight and harvest index. The recommended package of practices was adopted for raising the crop. The data collected were subjected to statistical analysis as described by Panse and Sukhatme (1985) [6].

Results and Discussion

Pre-sowing hardening is one of the best methods that results in modifying the physiological and biochemical nature of seed so as to get the characters that are favourable for drought resistance. Pre-sowing hardening is the result of extensive physiological reorganization induced by hydration and dehydration process (Sujatha *et al*., 2013) [11].

During hardening process, a number of physicochemical changes occur that modify the protoplasmic characters, increasing the embryo physiological activity and associated structures, eventually leading to higher absorption of water, increase in the elasticity of the cell and development of a stronger and efficient root system.

From the present experiment it was revealed that T_1 (1% $CaCl_2$) recorded the highest germination percentage and speed of germination when compared to T_0 (control). The reason for higher germination percentage and speed of germination may be due to greater hydration of colloids, higher viscosity and elasticity of protoplasm, offer an increase in bound water content, lower water deficit and increased metabolic activity (Maitraa *et al.,* 1999) [4]. 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, calcium in $CaCl_2$ improves cell water status and also Act as cofactors in the activities of numerous enzymes during reserve metabolization and radical protrusion (Taiz and Zieger, 2002) [13]. Treatment (T_1) 1% $CaCl_2$ hardened seeds recorded lengthier root and shoot and dry matter production when compared to other hardening treatments and untreated seeds. Improved vigour index was also recorded by T_1 over the T_0 (Table 1).

Higher seedling length including root 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 (Ganesh *et al*., 2013) [1].

The increased dry matter production recorded by T_1 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) [10].

Higher seedling vigour index recorded by T_1 over control was due to the increased germination percentage, root length, shoot length and dry matter production of seedlings. In $CaCl_2$ treatment, seeds increased the synthesis of protein and soluble sugar in the first phase of germination, which have advantages for earlier germination and in turn produces longer seedlings there by increases the vigour of seedling (Mulsanti and Wahyuni, 2011) [5].

In the field experiment plant height was maximum in T_1 followed by T_2 when compared to control T_0 and other treatments. Same trend was observed in case of number of productive tillers per plant and panicle length (Table 2). Among the treatments, T_1 registered the more value for panicle length, leaf length and leaf breadth over other treatments and control. The hike in vegetative growth parameters (number of productive tillers per plant, plant height, panicle length, leaf length and leaf breadth) might be due the cumulative effect of hardening and $CaCl_2$ that 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 (Pawar *et al*., 2003) [8]. In case of the untreated seeds (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 (Karivaratharaju and Ramkrishna, 1985) [2].

In case of yield attributing characters more number of seeds per panicle was observed in T_1 when compared to other treatments and control. Increased 100 seed weight noticed in T_1 followed by T_2 and the inferior was recorded by T_0. The same trends were observed in seed yield per plant in T_1 when compared to other treatments and control (Table 3).

The treatment (T_1) 1% $CaCl_2$ recorded the more number of productive tillers per plant which might 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 Patil *et al*. (2014) [7]; Roohul Amin *et al*. (2016) [9].

The probable reasons for improvement in yield attributes (number of seeds per panicle, seed yield per plant and harvest index) might be due to the hardening chemicals ($CaCl_2$) which accelerate the synthesis of protein and nucleic acid bound water content and repair germination and growth of seedling resulting in increasing uptake of nutrients and ability of treated plants to unfavourable condition when compared to control.

Improvement in 100 seed weight might be due to the increased mobilization of nutrient towards the panicle which resulted in lower number of chaffy seeds and increase in normal seed might be due uniform distribution of photo assimilates within the seeds.

In contrast, the control registered the minimum values for yield attributing characters might be due to the slow starch hydrolysis and in efficient mobilization and utilization of seed resources (Sushila Kanwar *et al*., 2015) [12]. From the present study, it was clearly evident that the control plants have a poor plant establishment, poor vegetative growth which results in lesser photosynthesis and reduced translocation of photo assimilate from sources to sink.

Hardening with $CaCl_2$ recorded the best seed quality *viz.,* germination percentage, speed of germination, root length, shoot length, seedling length, dry matter production and vigour index I and II from the resultant seeds among the seed treatments when compared to the control (Table 4).

The seed quality of the resultant seeds harvested from T_1 1%

$CaCl_2$ hardened plant recorded significantly higher values for all the seed quality parameters 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 II, which might be due to the enhanced crop stands, growth and yield characters that ultimately results in the improvement of seed quality (Rehman *et al*., 2011; Patil *et al*., 2014; Roohul Amin *et al*., 2016) [7, 9]. 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 which favoured this positive effect.

Table 1: Effect of seed enhancement treatment on initial seed quality parameters in rice cv. IR 64

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 (64.16)	25.40	16.06	10.60	27.20	0.3500	2203.20	28.35
T_1	93 (74.68)	31.37	18.03	13.13	31.16	0.3867	2907.22	35.34
T_2	91 (72.54)	30.84	17.40	12.86	30.26	0.3800	2753.65	34.58
T_3	90 (71.56)	29.26	16.43	11.43	27.86	0.3700	2507.39	32.40
T_4	88 (69.73)	28.26	17.06	11.90	28.96	0.3700	2548.48	32.56
T_5	85 (67.21)	27.29	16.30	10.96	27.26	0.3767	2317.10	31.45
T_6	86 (68.03)	26.21	16.33	11.00	27.33	0.3700	2350.38	31.82
Mean	89 (69.70)	28.37	16.80	11.70	28.57	0.3719	2512.49	32.35
SEd	0.4878 (0.4459)	0.1623	0.1671	0.0803	0.2974	0.0025	6.5506	0.0650
C.D (P = 0.05)	1.0487 (0.9586)	0.3490	0.3593	0.1726	0.6394	0.0054	14.08	0.1397

Table 2: Effect of seed enhancement treatment on number of productive tillers per plant, plant height, panicle length, leaf length and leaf breadth rice cv. IR 64

Treatments	Number of productive tillers per plant	Plant height (cm)	Panicle length (cm)	Leaf length (cm)	Leaf breadth (cm)
T_0	25.20	72.20	23.20	28.36	0.90
T_1	28.00	77.60	26.90	33.76	1.12
T_2	27.20	77.06	26.60	33.10	1.10
T_3	25.80	76.20	24.40	31.82	1.00
T_4	26.00	75.10	25.42	32.10	1.09
T_5	25.60	74.60	24.40	31.22	1.00
T_6	21.40	73.50	24.00	30.34	1.00
Mean	25.60	75.18	24.99	31.52	1.03
SEd	0.0526	0.2015	0.1095	0.3180	0.2429
C.D (P = 0.05)	0.1148	0.4393	0.2387	0.6932	0.5295

Table 3: Effect of seed enhancement treatment on number of seeds per panicle, 100 seed weight, seed length, seed breadth, seed yield per plant, fresh weight, dry weight and harvest index in rice cv. IR 64

Treatments	Number of seeds per panicle	100 seed weight (g)	Seed length (mm)	Seed breadth (mm)	Seed yield per plant (g)	Fresh weight (g)	Dry weight (g)	Harvest index
T_0	82.50	1.93	8.50	2.20	20.56	65.00	34.75	33.90
T_1	111.50	2.06	9.05	2.60	28.86	115.50	62.40	48.90
T_2	96.00	2.05	8.87	2.56	28.60	109.00	61.35	47.50
T_3	88.50	2.00	8.62	2.30	23.76	92.50	52.20	46.10
T_4	91.00	2.03	8.62	2.30	22.50	106.00	61.00	51.40
T_5	86.00	2.00	8.62	2.30	24.96	88.00	60.10	35.10
T_6	84.50	1.96	8.62	2.30	21.70	83.00	47.70	46.10
Mean	91.43	2.00	8.67	2.33	24.42	94.14	54.21	44.14
SEd	0.7057	0.0104	0.0847	0.1198	0.0735	1.1746	0.3077	0.6425
C.D (P = 0.05)	1.5385	0.0226	0.1847	0.2611	0.1602	2.5606	0.6708	1.4007

Table 4: Effect of seed enhancement treatment on resultant seed quality in rice cv. IR 64

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	82 (64.90)	26.72	16.46	10.96	27.42	0.3700	2248.44	29.52
T_1	95 (77.08)	32.25	18.43	13.60	32.03	0.3900	3042.85	36.10
T_2	93 (74.66)	31.03	17.83	13.06	30.89	0.3867	2872.77	35.34
T_3	92 (73.57)	30.35	16.70	11.66	28.36	0.3700	2609.12	34.04
T_4	89 (70.63)	29.15	17.23	12.03	29.26	0.3767	2604.14	32.93
T_5	87 (68.87)	28.36	16.33	11.13	27.46	0.3800	2389.02	33.06
T_6	88 (69.73)	27.07	16.46	11.30	27.76	0.3767	2442.88	32.56
Mean	89 (71.34)	29.27	17.06	11.96	29.02	0.3786	2601.32	33.36
SEd	0.1952 (0.2218)	0.2755	0.1522	0.1255	0.2825	0.0031	1.8524	12.5599
C.D (P = 0.05)	0.4197 (0.4769)	0.5923	0.3273	0.2698	0.6074	0.0066	3.9826	27.0037

Conclusion

Hence, from the present study it was concluded that 1% $CaCl_2$ hardening treatment improves the seedling quality and seed yield compared to control due to the cumulative effect of hardening and $CaCl_2$.

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