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SEED HARDENING WITH ORGANICS AND INORGANICS ON SEEDLING, GROWTH AND YIELD CHARACTERS IN RICE CV. ADT 37

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Abstract

Organic and inorganic seed hardening treatments were prior given to the seeds to conduct an experiment on seedling, growth and yield characters in rice cv. ADT 37 under laboratory and field conditions. Seeds were hardened with different solutions *viz.,* 1% $CaCl_2$, 1% KCl, 1% KNO_3, 1% NaCl, 10% cow dung and 3% Panchakavya along with control as untreated seed. Among the organic and inorganic seed hardening treatments seed hardened with 1% $CaCl_2$ records maximum values for seedling characters such as germination percentage, speed of germination, root length shoot length, seedling length, dry matter production, vigour index I, vigour index II, growth and yield characters when compared to control.

Key words: ADT 37, rice, inorganic, organic, seedling characters, growth, yield.

Introduction

Rice (*Oryza sativa* L.) is the staple food crop in India and belongs to the family graminae. Globally, rice ranks second 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. For almost three decades since the "Green Revolution", the rice yield growth rate was approximately 2.5% per year. During the 1990s, however this has decreased to only 1.1% (Riveros and Figures, 2000). India ranks first in area and second in production. 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.MT and productivity of 4.43 metric tons per hectare (Urban Development and Agriculture, Policy Note 2015-16). In India, nearly 70 per cent of cultivated land is rainfed, but accounts for about 42 per cent of the total quantity of produced food grains. 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.

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Seed hardening will modify the physiological and biochemical nature of seeds, so as to get the characters that are favourable for drought tolerance. Although, it varies from crop to crop, the principle remains same. When dry seeds are soaked in water/chemical solutions, the quiescent cells get hydrated and germination initiated. It also results in enhanced mitochondrial activity leading to the formation of high energy compounds and vital biomolecules. The latent embryo gets enlarged. When the imbibed seeds are dried again, triggered germination is halted. When such seeds are sown, reimbibition begins and the germination event resumes from where it previously ceased (Sujatha *et al*., 2013).

Chemical seed hardening is the hydrating of seed to initiate the pre-germinating metabolism followed by dehydration which fixes the biochemical events to impart resistance against stress conditions like drought, cold and given protection to the seedling. The soaking and drying of the seeds (hardening) may generate/modulate some mechanism inside the seed system which carried over to the vegetable phase of the plants life consequently that improves the stress ameliorating characters in the growing plant even in the normal condition by improving status of amino acids. The beneficial effects of seed hardening are primarily due to pre-enlargement of the embryo, bio chemical changes like enzyme activation and improvement of germination rate (Lee and Kim, 2000; Basra *et al.*, 2005).

Materials and methods

Genetically and physically pure seeds of ricecv. ADT 37 were obtained from the Tamil Nadu Rice Research Institute (TRRI), Aduthurai, for this study. Laboratory analysis was conducted at Seed Technology Laboratory, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University. Field experiments were carried out at Plant Breeding Farm, Faculty of Agriculture, Annamalai University during the year 2015-2017. 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.

Climate and Weather

The weather at Annamalai Nagar is moderately warm with hot summer months. The mean maximum temperature fluctuates between 29.2^0C and 37.3^0C with a mean of 32.99^0C while the minimum temperature ranges from 20.9^0C to 26.6^0C with a mean of 23.75^0C. The relative humidity ranges from 76 to 96 percent with a mean of 86 per cent. The mean annual rainfall received was 1500 mm with a distribution of 1000 mm during North East monsoon, 400 mm during the South West monsoon and 100 mm during hot weather period spreaded over 60 rainy days. The mean hour of bright sunshine per day was 9.5 hours.

Soil characteristics

The soil of the experimental field was clayey loam with a pH of 9.3 and EC of 0.4 (dSm^{-1}). The soil was low in available nitrogen, medium in available phosphorus and high in available potassium.

Methods

The laboratory experiment was laid out in completely randomized block design and field experiment was laid out in randomized block design with 3 replications. Before sowing seeds were soaked overnight (12 hrs) separately in water (control) and different chemical and organic solutions.

Treatments details

$\mathbf{T_0}$ - Control
$\mathbf{T_1}$ - 1% $CaCl_2$
$\mathbf{T_2}$ - l% KCl
$\mathbf{T_3}$ - 1% KNO_3
$\mathbf{T_4}$ - l% NaCl
$\mathbf{T_5}$ - 10% Cow dung
$\mathbf{T_6}$ - 3% Panchakavya

The recommended practices was followed for raising the crop. Seedling characters such as germination percentage, speed of germination, shoot length, root length, seedling length, dry matter production, vigour index I, vigour index II, growth characters such as days to 50% flowering, plant height, number of productive tillers and yield characters such as number of seeds/panicle, 100 seed weight and seed yield/lant were observed and recorded. Data were analysed statistically by using ANOVA.

Results and discussion

The laboratory and field experiments were conducted to study the effect of seed hardening treatment on seedling, growth and yield characters in rice were studied and the results are discussed below. Among the treatments, the maximum germination percentage was observed in treatment ($\mathbf{T_1}$) 93% followed by $\mathbf{T_2}$ 92%. The minimum germination percentage was recorded by $\mathbf{T_0}$ control. Among the treatments, the maximum speed of germination was observed in treatment ($\mathbf{T_1}$) 34.29 followed by $\mathbf{T_2}$ 34.00. The minimum speed of germination was recorded by $\mathbf{T_0}$ control. Among the treatments, the highest root length was observed in treatment ($\mathbf{T_1}$) 18.10 cm followed by $\mathbf{T_2}$ 17.66 cm. The lowest root length was recorded by $\mathbf{T_0}$ control. Among the treatments, the increased shoot length was observed in treatment ($\mathbf{T_1}$) 13.06 cm followed by $\mathbf{T_2}$ 12.93 cm. The minimum shoot length was recorded by $\mathbf{T_0}$ control. Among the treatments, the maximum seedling length was observed in treatment ($\mathbf{T_1}$) 31.16 cm followed by $\mathbf{T_2}$ 30.59 cm. The minimum seedling length was recorded by $\mathbf{T_0}$ control. Among the treatments, the increased dry matter production was observed in treatment ($\mathbf{T_1}$) 0.3800 followed by $\mathbf{T_2}$ 0.3767. The minimum dry matter production was recorded by $\mathbf{T_0}$ control. Among the treatments, the increased vigour index I and II was observed in treatment ($\mathbf{T_1}$) 2897.88 and 35.34 followed by $\mathbf{T_2}$ 2814.28 and 34.65. The minimum vigour index I and II was recorded by $\mathbf{T_0}$ control.

Days to 50 per cent flowering was maximum in $\mathbf{T_0}$ (79.06) the minimum days to 50 per cent flowering was recorded in the treatment $\mathbf{T_3}$ (73.02) when compared to the other treatments. Among the treatments, 1% $CaCl_2$ hardened seed records the more number of protective tillers per plant in treatment ($\mathbf{T_1}$) 22.40 followed by $\mathbf{T_2}$ 21.00. The minimum number of protective tillers per plant was recorded by $\mathbf{T_0}$ control. Among the treatments, the increased plant height was recorded by 1% $CaCl_2$

Table 1: Effect of seed hardening on seed quality characters in rice cv. ADT 37.

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	80 (63.43)	26.00	16.06	10.63	26.69	0.3567	2135.20	28.53
T_1	93 (74.66)	34.29	18.10	13.06	31.16	0.3800	2897.88	35.34
T_2	92 (73.57)	34.00	17.66	12.93	30.59	0.3767	2814.28	34.65
T_3	91 (72.54)	30.94	16.73	11.40	28.13	0.3700	2559.83	33.67
T_4	87 (68.87)	32.03	16.96	11.93	28.89	0.3700	2513.43	32.19
T_5	85 (67.21)	30.00	16.23	11.06	27.29	0.3600	2319.65	30.60
T_6	82 (64.89)	27.40	16.13	11.00	27.13	0.3667	2224.66	30.06
Mean	87.14 (69.3119)	30.67	16.83	11.71	28.55	0.3686	2494.99	32.14
SEd	0.2321 (0.2009)	0.0868	0.0500	0.0470	0.1737	0.0012	7.6278	0.1623
CD (P = 0.05)	0.4989 (0.4319)	0.1867	0.1076	0.1401	0.3735	0.0022	6.3999	0.3490

Table 2: Effect of seed hardening on growth and yield characters in rice cv. ADT 37

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	79.06	15.20	68.30	101.00	1.83	16.46
T_1	73.02	22.40	75.86	128.00	2.10	28.04
T_2	73.87	21.00	74.22	127.00	2.03	27.42
T_3	74.41	19.60	73.16	119.50	2.00	24.42
T_4	74.29	20.80	71.96	124.00	2.00	26.86
T_5	74.75	19.60	69.70	118.00	1.93	22.62
T_6	75.05	18.40	68.40	116.50	1.90	20.96
Mean	74.92	19.57	71.65	119.14	1.97	23.82
SEd	0.1022	0.4659	0.4586	0.3077	0.0104	0.2015
CD (P = 0.05)	0.2229	1.0156	0.9997	0.6708	0.0226	0.4393

hardened seed in treatment (**T_1**) 75.86 cm followed by **T_2** 74.22 cm. The minimum plant height was recorded by **T_0** control. Among the treatments, 1% $CaCl_2$ records more number of seeds per panicle (**T_1**) 128.00 followed by **T_2**. The minimum number of seeds per panicle was recorded by **T_0** control. Among the treatments, the highest 100 seed weight was observed in treatment (**T_1**) 2.10 g 1% $CaCl_2$ hardened seed followed by **T_2** 2.03 g. The lowest 100 seed weight was recorded by **T_0** control. Among the treatments, the maximum seed yield per plant was observed in treatment (**T_1**) 28.04 g 1% $CaCl_2$ hardened seed followed by **T_2** 27.42 g. The minimum seed yield per plant was recorded by **T_0** control.

The reason for higher germination percentage and rate 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). Increase in speed of germination was due to the advanced seed could retain viability to carry on where they left upon germination (Rangaswamy *et al*., 1993). The increase in seedling, root and shoot length might be possible due to an exhaustive utilization of amylase enzyme activity during the early and enhanced rate of germination in hardened seeds as compared to control. The increased activity of amylase further established a positive correlation with the increasing amount of soluble sugar (Kamalam and Nair 1989); (Farooq *et al*., 2010).

The increase in dry weight was due to enhanced lipid utilization through glyoxalate cycle, a primitive pathway which leads to faster growth and seedling development to reach well in advance and to produce relatively more dry matter (Jayaraj, 1977). $CaCl_2$ treatment seeds showed the increased seedling quality which may be due to the benefits effects of $CaCl_2$ in strengthening the cell membrane integrity and permeability. The increase in seed vigour was due to seed calcium concentration and germination percentage were positively correlated which suggests the role of calcium as an important in membrane stabilization and as an enzyme co-factor Christansen and Foy (1979); Hecht–Buchholz (1979).

Early flowering was due to the early accomplishment of initial stages and growth stages, the cumulative effect and also presence of some growth substance in the solution. The increase in number of productive tillers was due to the higher spacing, there is no competition or nutrients, air and light, thus creating a better environment for crop growth (Reuben, *et al.,* 2016). The increase in plant height might be due to the role of calcium involvement increased cell division strengthening of cell wall and cell enlargement which have a plant growth promoting capabilities and often applied as exogenous plant growth enhances (Maeshima, 1990; Magome *et al.,* 2004; Muhammad Aamir Iqbal *et al.,* 2014).

The increase in yield characters like, number of seeds per panicle, 100 seed weight and seed yield per plant might be due to the hardening chemicals 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.

Conclusion

1% $CaCl_2$ hardened seeds records maximum values for seedling, growth and yield characters in rice cv. ADT 37. This increase was due to the presence of enhanced lipid utilization, effects of $CaCl_2$ in strengthening the cell membrane integrity, cell enlargement, permeability and membrane stabilization. Hence 1% $CaCl_2$ hardened seeds adopted to improve seedling, growth and yield characters in rice cv. ADT 37.

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