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Influence of Seed Invigoration with Seaweed, Panchagavya and Beejamrutha on Seed Quality Parameters of Quinoa (*Chenopodium quinoa Willd*.) under Salinity Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Quinoa is a saline-tolerant crop and highly nutritious compared with rice, wheat, and oats. Quinoa cultivar EC507704 were used to check the performance of seed invigoration with organic treatments under different salinity levels current experiment was conducted in 2021 at the seed testing laboratory department of Genetics and Plant Breeding, Naini Agriculture Institute, Prayagraj (U. P.). Experimentation was carried out by using Complete Randomized Design with four replications by using top of the paper method. The salinity levels were obtained by dissolving 0mM, 100mM, and 200mM NaCl in one liter of distilled water. Filter papers were supplied with a salt solution to place the treated seeds. The treatments used in this experiment are T_0 distilled water as Control, T_1 and T_2 Seaweed 5% and 10%, T_3,T_4,T_5 Panchagavya 4%,6% and 10%, T_6,T_7,T_8 and T_9 Beejamrutha 25%,50%,75% and 100%. The results indicated the superiority with the interaction of

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treatment and salinity of T_9S_0 Beejamrutha 100% in 0mM NaCl shows 92% in germination percentage, 3.60cm in shoot length, 6.85cm in root length, 10.45cm in seedling length, 0.25g in dry weight, 961.32 in Seedling vigour index compared with control. The better performance of Beejamrutha increases the seed quality parameters due to the presence of beneficial microorganisms, nutrients, and growth-inducing hormones.

Keywords: Beejamrutha; quinoa; quality parameters; salinity; and significant.

1. INTRODUCTION

Quinoa (*Chenopodium quinoa* Willd.) is a dicotyledonous annual species scientifically called pseudo-cereal but it is not classified under cereal and is botanically allied to Amaranth Spp, belonging to the Chenopodiaceae family. Quinoa is one among them that has a high tolerance to salinity. The crop is originated from the Andean region of South America. The top three largest producers of Quinoa in the world are Peru, Bolivia, and Ecuador with an annual production of about 89,775 MT, 67,135 MT, and 4,505 MT respectively [1]. Based on environmental conditions, plant height varies from 0.5 to 1.5 m, the stem is hollow with robust and scaly reddish bark. The plant has a well spread of fibrous roots with a highly bisected taproot system. Due to the presence of natural pigments like beta-cyanine, the colour of leaves will vary from green to red. It has gyno-monecious flowers that mean both hermaphrodite and unisexual female flowers are present in the same plant.

Quinoa contains all nine essential amino acids especially lysine and it is rich in Thiamine, Riboflavin, Niacin, Pantothenic acid, Vitamin- B6, E, and Vitamin- C **[**2]. It is considered a good source of dietary minerals like Magnesium, Phosphorus, Iron, Zinc, Potassium, and also Omega-6 fatty acids [3] and Alpha- linoleic acids (ALA). Every 100 grams of Quinoa provides energy-399 Kcal, protein – 16.5 g, fat - 6.3 g, total carbohydrates – 69 g, iron – 13.2 mg, zinc – 4.4 mg. For these high values of nutrition in quinoa, the UN Food and Agriculture Organization has declared the year 2013 as the International Year of Quinoa. It is also called "superfood", "food for the future" because this unique food can deliver all the essential nutrients to increase both physical and mental strength to humans [4].

It contains a small amount of Omega-3, Omega-6 fatty acids which increase the level of good cholesterol. The presence of Quercetin makes it beneficial for treating asthma, viral infections, circulatory problems, and heart diseases. It has a low glycemic index that aids in the prevention of cancer and decreases chronic prostrate infection. Saponin in Quinoa helps to strengthen the immune system by vanishing the digestive toxins and reduction of blood cholesterol.

Salinity in soils is one of the great difficulties challenging by the farming community as it affects the growth and development of plants and on the soil structure. In semi-arid zones, due to high evaporation rates, the accumulation of salt making it vulnerable to crop cultivation. It is reported that nearly 14.5% of flooded land and 2.1% of arid land is pretentious by salinity pressure [5]. To overcome this salinity stress, an alternative i.e., the use of halophytes that are tolerant to any saline condition can be used. One such crop is Quinoa which is highly tolerant to both saline and drought conditions. The organic seed treatments were used in this experiment to enhance the quality parameters of Quinoa. The main objectives of the experimentation are to standardize the best seed treatment method favourable for Quinoa and to compare the seed quality parameters under different salinity levels.

2. MATERIALS AND METHODS

The current experimentation was held in 2021 at the seed testing laboratory of the Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (U.P.). A laboratory experiment was conducted using Complete Randomized Design with four replication. The Quinoa cultivar EC507704 were used for experiment with different organic seed treatments T_0 to T_9 under different salinity levels designated as S_0, S_1, and S_2. The salinity levels were obtained by dissolving S_0 Control, S_1 induced by addition of 100mM NaCl(Dissolve 5.844g NaCl in 1liter of distilled water), S_2 induced by addition of 200mM NaCl(Dissolve 11.688gm NaCl in 1liter of distilled water)Filter paper were supplied with salt solutions and placed in the bottom of Petri plates.

Ten different treatments are designated as T_0-Control, T_1-Seaweed 5% (50ml in 1liter of

distilled water), T_2-Seaweed 10% (100ml in 1liter of distilled water), T_3-Panchagavya 4% (40ml in 1liter of distilled water), T_4-Panchagavya 6% (60ml in 1liter of distilled water), T_5-Panchagavya 10% (100ml in 1liter of distilled water), T_6-Beejamrutha 25% (250ml in 1liter of distilled water), T_7-Beejamrutha 50% (500ml in 1liter of distilled water), T_8-Beejamrutha 75% (750 ml in 1liter of distilled water), and T_9-Beejamrutha 100% (1000ml in 1liter of distilled water) the seeds soaked in the prepared treatment solutions for 8 hours and then drained out the solution from the beaker and the treated seeds were air-dried to retain its original weight.

The seeds treated with ten treatments were placed on three different salt-treated filter papers in Petri plates with 4 replications. Seed quality parameters were determined according to the standard procedures prescribed at the top of the paper method in germination cabinets with the application of standard temperature of 20 $\pm 10^0$C for 7 days with 95% relative humidity took the first count on 4th day observe the seeds and on final count on 7th day of the germinated seeds [6]. Noted the Quality parameters like germination percentage, shoot length (cm), root length (cm), seedling length (cm), dry weight (g), and vigour index are assessed. Lab experiment data analysis was done by bi-factorial ANOVA (salinity and treatments as elements) carried out according to the procedure of Completely Randomized Design [7].

3. RESULT AND DISCUSSION

3.1 Germination (%)

Remarkably highest germination percentage was observed in seeds treated with T_9 Beejamrutha 100% recorded 87.67% followed by T_8 Beejamrutha 75% recorded 86.91%, followed by T_7 Beejamrutha 50% recorded 86.5%, T_6 Beejamrutha 25% recorded 85.66%, T_2 Seaweed 10% recorded 84.83%, T_1 Seaweed 5% recorded 84.16%, T_3 Panchagavya 4% recorded 83.75%, T_4 Panchagavya 6% recorded 83%, T_5 Panchagavya 10% recorded 81.66%, and the least is T_0 Control recorded 81.33%. In salinity, the germination was decreased with an increase in salinity levels highest germination percentage was observed in S_0-0mM NaCl recorded 87.85%. The Maximum germination % with the interaction treatments and salinity (T×S) was recorded with T_9S_0-Beejamrutha100% at 0mM NaCl is 92%, followed by T_8S_0-Beejamrutha75% at 0mM NaCl is 91% and the minimum germination percentage was observed in T_0S_2-Control at 200mM NaCl is 79.75%. Showed in Fig 1.

3.2 Shoot Length

The influence of seed invigoration on shoot length of Quinoa got highest in T_9 Beejamrutha 100% recorded 3.14cm, followed by T_8 Beejamrutha 75% recorded 3.03cm, T_7 Beejamrutha 50% recorded 2.94cm, T_6 Beejamrutha 25% recorded 2.89cm, T_2 Seaweed 10% recorded 2.75cm, T_1 Seaweed 5% recorded 2.67cm, T_3 Panchagavya 4% recorded 2.52cm, T_4 Panchagavya 6% recorded 2.4cm, T_5 Panchagavya 10% recorded 2.29cm, and the least is T_0 Control recorded 2.18cm. In salinity, the shoot length was decreased with an increase in salinity levels highest shoot length was observed in S_0-0mM NaCl recorded 3.18cm. The highest shoot length with the interaction of both treatments and salinity (T×S) was recorded with T_9S_0-Beejamrutha100% at 0mM NaCl stress level 3.6cm, followed by T_8S_0-Beejamrutha75% at 0mM NaCl 3.47cm, and the minimum shoot length was observed in T_0S_2-Control at 200mM NaCl is 1.75cm Showed in Fig 2.

3.3 Root Length

The seed treatment with organics shown an effect on maximum root length in Quinoa got in T_9 Beejamrutha 100% recorded 6.34cm, followed by T_8 Beejamrutha 75% recorded 6.21cm, T_7 Beejamrutha 50% recorded 6.15cm, T_6 Beejamrutha 25% recorded 6.02cm, T_2 Seaweed 10% recorded 5.69cm, T_1 Seaweed 5% recorded 5.64cm, T_3 Panchagavya 4% recorded 5.5cm, T_4 Panchagavya 6% recorded 5.36cm, T_5 Panchagavya 10% recorded 5.22cm, and the least is T_0 Control recorded 5.09cm. In salinity, the root length was decreased with an increase in salinity levels highest root length was observed in S_0-0mM NaCl recorded 6.27cm. The maximum root length with the interaction of both treatments and salinity (T×S) was recorded with T_9S_0-Beejamrutha100% at 0mM NaCl stress level of 6.85cm, followed by T_8S_0-Beejamrutha75% at 0mM NaCl 6.8cm. The minimum root length was observed in T_0S_2-Control at 200mM NaCl is 4.52cm Showed in Fig. 3.

3.4 Seedling Length

The seedling length of Quinoa that has shown highest in T_9 Beejamrutha 100% recorded 9.48cm, followed by T_8 Beejamrutha 75%

recorded 9.25cm, T_7 Beejamrutha 50% recorded 9.1cm, T_6 Beejamrutha 25% recorded 8.92cm, T_2 Seaweed 10% recorded 8.45cm, T_1 Seaweed 5% recorded 8.31cm, T_3 Panchagavya 4% recorded 8.02cm, T_4 Panchagavya 6% recorded 7.77cm, T_5 Panchagavya 10% recorded 7.51cm, and the least is T_0 Control recorded 7.27cm. In salinity, the seedling length was decreased with an increase in salinity levels highest seedling length was observed in S_0-0mM NaCl recorded 9.45cm. The highest seedling length with the interaction of both treatments and salinity (T×S) was recorded with T_9S_0-Beejamrutha100% at 0mM NaCl stress level of 10.45cm, followed by T_8S_0-Beejamrutha75% at 0mM NaCl 10.27cm, and the minimum seedling length was observed in T_0S_2-Control at 200mM NaCl is 6.27cm. Showed in Fig 4.

3.5 Seedling Dry Weight

The influence of seed invigoration shown statistically significant on dry weight has obtained highest weight in T_9 Beejamrutha 100% recorded 0.22g followed by T_8 Beejamrutha 75% recorded 0.20g, T_7 Beejamrutha 50% recorded 0.18g, T_6 Beejamrutha 25% recorded 0.17g, T_2 Seaweed 10% recorded 0.16g, T_1 Seaweed 5% recorded 0.15g, T_3 Panchagavya 4% recorded 0.14g, T_4 Panchagavya 6% recorded 0.13g, T_5 Panchagavya 10% recorded 0.10g, and the least is T_0 Control recorded 0.06g. In salinity, the seedling dry weight was decreased with an increase in salinity levels highest seedling length was observed in S_0-0mM NaCl recorded 0.20g. The highest seedling dry weight with the interaction of both treatments and salinity (T×S) was recorded with T_9S_0-Beejamrutha100% at 0mM NaCl stress level of 0.25g, followed by T_8S_0-Beejamrutha75% at 0mM NaCl 0.24g, and the minimum seedling dry weight was observed in T_0S_2-Control at 200mM NaCl is 0.04g. Showed in Fig 5 highest seedling dry weight was obtained in Beejamrutha 100% compared to control.

3.6 Seedling Vigour Index

The significant effect of seedling vigour index was observed in priming solutions shows highest vigour index in T_9 Beejamritha 100% recorded 833.5, followed by T_8 Beejamrutha 75% recorded 806.0, T_7 Beejamrutha 50% recorded 789.4, T_6 Beejamrutha 25% recorded 766.7, T_2 Seaweed 10% recorded 718.7, T_1 Seaweed 5% recorded 701.9, T_3 Panchagavya 4% recorded 674.0, T_4 Panchagavya 6% recorded 647.0, T_5 Panchagavya 10% recorded 614.9, and the least is T_0 Control recorded 592.8. In salinity, the seedling vigour index was decreased with an increase in salinity levels highest seedling vigour index was observed in S_0-0mM NaCl recorded 832.4. The highest seedling vigour index with the interaction of both treatments and salinity (T×S) was recorded with T_9S_0-Beejamrutha100% at 0 mM NaCl stress level of 961.3, followed by T_8S_0-Beejamrutha75% at 0mM NaCl recorded 934.9, and the minimum seedling vigour index was observed in T_0S_2-Control at 200mM NaCl is 500.4. Showed in Fig 6.

In the present experiment to generate osmatic stress, NaCl is used as a salinity trigger [8]. The seed quality parameters such as germination%, root length, shoot length, seedling length, seedling dry weight, and seedling vigour index were decreased by increasing the salinity concentrations. Many findings are concurrent with the present observations, which is particularly halophytes are also susceptible to salinity during seed germination and seedling growth [2]. In the control S_0 @ 0mM of NaCl shows highest germination% and other quality parameters compared with S_1 @ 100mM of NaCl & S_2 @ 200mM of NaCl.

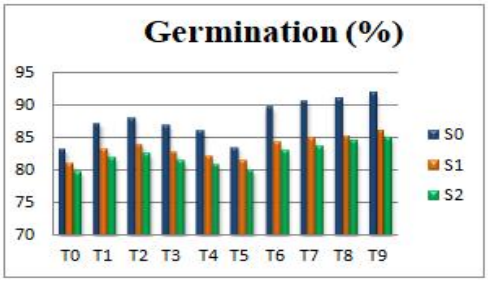

Fig. 1. Histogram showing germination percentage with treatment variables under salinity

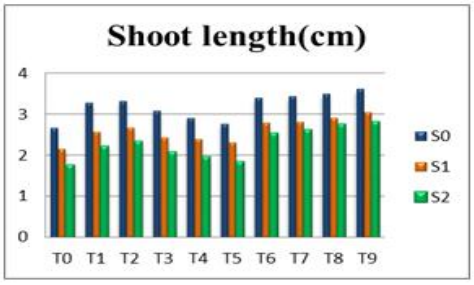

Fig. 2. Histogram showing shoot length with treatment variables under salinity

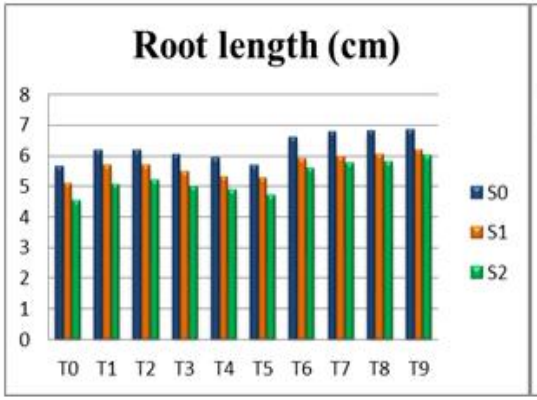

Fig. 3. Histogram showing root length with treatment variables under salinity

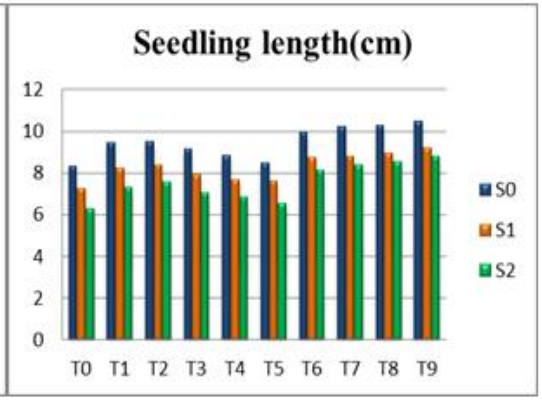

Fig. 4. Histogram showing seedling length with treatment variables under salinity

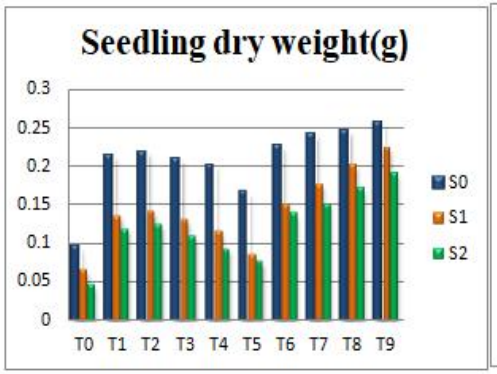

Fig. 5. Histogram showing seedling dry weight with treatment variables under salinity

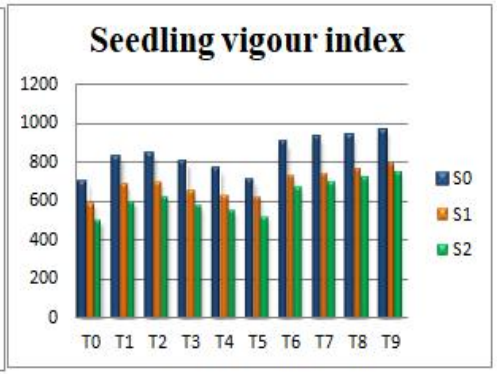

Fig. 6. Histogram showing seedling vigour index with treatment variables under salinity

Salinity levels:

S0- 0 mM NaCl

S1- 100 mM NaCl

S2- 200 mM NaCl

Treatments:

T0- Control

T1-Seaweed 5%

T2-Seaweed 10%

T3-Panchagavya 4%

T4-Panchagavya 6%

T5-Panchagavya 10%

T6-Beejamrutha 25%

T7-Beejamrutha 50%

T8-Beejamrutha 75%

T9-Beejamrutha 100%

The mean germination% observed highest in Seeds treated with T_9 Beejamrutha100% for 8 hours recorded 87.67% followed by T_8 Beejamrutha75% for 8 hours recorded 86.91%. Similar findings were observed by [9] in the groundnut. S_0 Control 0 mM NaCl recorded 87.85% Similar findings were observed by [10] in *puno* cultivar of Quinoa and the lowest readings were recorded in S_2 200Mm NaCl is 82.27%. The maximum germination % with interaction treatments and salinity (T×S) was recorded with T_9S_0-Beejamrutha100% at 0mM NaCl is 92% and also other quality parameters recorded highest in Beejamrutha 100% compared with other treatments and control. The greater execution of seed treatment with Beejamrutha is due to the presence of natural indigenous cow components like indigenous cow dung, cow urine, and other components such as soil, water, and lime. The germination was boosted by the presence of beneficial microorganisms like bacteria, yeasts, fungi, actinomycetes, and also it contains many vitamins, amino acids, macro & micronutrients, and growth- inducing hormones like gibberellic acid (GA_3), Indole Acetic Acid (IAA) [11], and it will make crop healthy and free from seed-borne diseases. Compared with Seaweed, panchagavya, and control, Beejamrutha showed better performance in seed quality parameters. Seaweed and Panchagavya were generally used as foliar sprays to enhance healthy plant growth and productivity, in this experiment seaweed and panchagavya were used as seed treatments to check the performance in seed quality parameters. Seaweed and panchagavya showed less effect on quality parameters.

4. CONCLUSION

The Result of this experiment showed significance in both salinity stress and treatments 0mM NaCl and Beejamrutha 100% in seed quality parameters of Quinoa. Beejamrutha can be used as an organic seed treatment that is easy to prepare from locally accessible ingredients. Instead of using chemical seed treatments, can use organic seed treatments to increase germination, seedling length, and seed vigour indices and these are low-cost compare with chemicals these treatments are advisable to farmers. The seed germination was decreased by increasing in salt concentration because some salt- tolerant crops also show sensitivity to salinity conditions at the germination stage.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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