

Original Research Article

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Effect of Soaking in Hot and Cold water with and without Replacement of water and Leaching on Seed Dormancy Breaking in Little Millet Seeds cv. CO (Samai) 4

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ABSTRACT

Millet product on in India is an important sector in the country's agricultural sector. Millet product on has been steadily increasing in India over the past few decades, driven by increasing demand for the crop due to its growing popularity as a health food Millet product on in India is an important sector in the country's agricultural sector. Millet product on has been steadily increasing in India over the past few decades, driven by increasing demand for the crop due to its growing popularity as a health food Millet product on in India is an important sector in the country's agricultural sector. Millet product on has been steadily increasing in India over the past few decades, driven by increasing demand for the crop due to its growing popularity as a health food Millet product on in India is an important sector in the country's agricultural sector. Millet product on has been steadily increasing in India over the past few decades, driven by increasing demand for the crop due to its growing popularity as a health food Millet product on in India is an important sector in the country's agricultural sector. Millet production in India is an important sector in the country's agricultural sector. It is a major source of income for millions of smallholder farmers. Millet production has been steadily increasing in India over the past few decades, driven by increasing demand for the crop due to its growing popularity as a health food. The little millet seeds cv. CO (Samai) 4 were soaked in hot and cold water with and without replacement of water and leaching, at different duration and also given leaching treatment in running water for different durations Among these leaching recorded the highest germination, seedling length, dry matter production and vigour index.

Keywords

Little millet, hot and cold water, leaching and germination

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Introduction

The world population is expected to reach 9.7 billion people by 2050, and the demand for food is expected to double in the same period. This increase in demand for food necessitates the need to develop sustainable agriculture practices that can support and sustain the global population (Chapke *et al.*, 2018).

India is the biggest producer of millets worldwide, with a share of around 40% of the world's total production and second-largest supplier of millets, generating nine popularly known millets (Gowri and Shivakumar, 2020). Samai or Little millet (*Panicum sumatrense* Roth. ex. Roem. & Schult.) is one of the important small grain crops belongs to the family Poaceae and is indigenous to Indian sub-continent.

It comes up well in dry lands, which are characterized by high temperature, low fertile soil and poor management by resource poor farmers. It is another reliable catch crop in view of its earliness and resistance to adverse agro-climatic conditions of high drought as well as water logging. Little millet is cultivated by tribal and poor farmers in low fertile soils with low or no cash input for food and feed. It has an excellent rejuvenating capacity compared to other cereal crops.

It is grown both in the tropics and sub-tropics and even at an altitude of 7000 feet (Daniel Sundararaj and Thulasidas, 1993). It is widely cultivated as a cereal across India, Nepal, Western Burma, Sri Lanka, Pakistan and South East Asian countries. According to Blatter and McCann (1935), this crop is cultivated or naturalized throughout India and it is a traditional crop of Karnataka.

In Tamil Nadu small millets the crop is cultivated in an area 29.9 thousand hectares with annual production 39.8 thousand tonnes and productivity (1263 kg ha⁻¹) in year 2023 - 2024. In India small millets the crop is cultivated in an area 590 thousand hectares with annual production 390 thousand tonne and productivity (654 kg ha⁻¹) in year 2023-2024. This is very less as compared to other cereal crops. Andhra Pradesh, Chattisgarh, Gujarat, Jharkhand, Karnataka Madhya Pradesh, Odisha, Tamil Nadu and are major little millet growing states in the country.

The great merit of little millet is that it can be stored for a period of up to ten years or more without deterioration. Consequently, it has traditionally played an important role as reserve food crop. Moreover, it is considered to be

free of the major pest and diseases. In spite of these advantages, the national average grain yield of little millet is low, although it has a potential to yield up to 3 t ha⁻¹. Its low productivity has been due to lack of improved varieties, frequent drought in rain fed condition and unimproved traditional cultivation practices.

One of the factors that hamper germination of the freshly harvested seeds is seed dormancy that temporarily suspends visible growth of meristems. In nature, dormancy can be an advantage for some species because it renders resistance to pre-harvest sprouting and prevents germination until favourable conditions for plant development prevail (Das, 1989). However, it is problematic when the seeds are to be sown immediately with the onset of monsoon. Numbers of chemicals are used as pre-treatment to enhance seed germination of dormant seeds.

There are several reports which indicate increase in germination percentage by plant growth regulators and other chemicals. The promoting effect of growth regulators and pre-sowing chemicals on germination may be attributed to their indirect effect through change in membrane permeability (Shivanna *et al.*, 2007) and alteration of chemical imbalance. Some other method like, hot water treatments have also been reported to enhance germination of hard coated seeds by elevating water and O₂ permeability of testa (Msanga and Maghembe, 1986; Teketay, 1996 and Aydin and Uzun, 2001).

To achieve higher productivity, the mother plants can be supplemented with nutrients through foliar application. Foliar fertilization is a simple and effective method of providing nutrients to crops.

It is widely used in all crops, that contain various macro and micronutrients, which are essential for the proper growth and yield. It will be more efficient than soil application at the late growth stage when there is preferential assimilates translocation to seeds for nutrient uptake is limited.

Foliar feeding has proved to be the fastest way of curing nutrient deficiencies and boosting plant performances at specific physiological stages. This will reduce the loss through absorption, leaching and other process associated with soil application (Vasilas *et al.*, 1980). It brings manifold changes in seed composition and its viability and vigour which lead to enhanced seed yield.

Materials and Methods

The laboratory and field experiments were conducted during 2023 - 24 to study the seed dormancy breaking methods of seeds in Little Millet [*Panicum sumatrense* Roth ex Roem. & Schult.] cv. CO (Samai) 4 at the Department of Seed Science and Technology, Imayam institute of Agriculture Technology (Affiliated to Tamil Nadu Agriculture University, Coimbatore kannanur (po), Thuraiyur (TK), Tiruchirappalli – 621206, Tamil Nadu, India.

Freshly harvested little millet seeds were subjected to the following soaking treatments with hot and cold water for specified duration and leaching in running water for different duration and then the germination and seedling growth potential were analysed.

For hot water treatment, the water was allowed to boil and the boiled water was taken out from the heating source. In this hot water, the seed were soaked for the specified time duration. The treated seeds along with untreated (control) seeds were tested for germination and seedling

Growth parameters

Treatments

- T₁ - Control
- T₂ - Hot water soaking for 30 minutes
- T₃ - Hot water soaking for 1 hour
- T₄ - Hot water soaking for 1 hour 30 minutes
- T₅ - Hot water soaking for 2 hours
- T₆ - Cold water soaking without water replacement for 6 hours
- T₇ - Cold water soaking without water replacement for 12 hours
- T₈ - Cold water soaking without water replacement for 18 hours
- T₉ - Cold water soaking for 6 hour with water replacement at 3 hours
- T₁₀ - Cold water soaking for 12 hours with water replacement at 6 hours
- T₁₁ - Cold water soaking for 18 hours with water replacement at every 6 hours
- T₁₂ - Leaching in running water for 6 hours
- T₁₃ - Leaching in running water for 12 hours
- T₁₄ - Leaching in running water for 18 hours

Germination (%)

Germination test was carried out in quadruplicate using 100 seeds each in rolled paper towel method (ISTA, 1999) in a germination room maintained at $25 \pm 1^\circ\text{C}$ temperature and $96 \pm 2\%$ relative humidity (RH) with diffused light during the day. On tenth day of germination test, number of normal seedlings were counted and the average was expressed as per cent.

Root length (cm)

Ten normal seedlings were selected randomly from the germination test and root length was measured from tip of primary root to base of shoot and mean root length was expressed in cm.

Shoot length (cm)

Ten normal seedlings chosen for measurement of root length were used for measurement of shoot length. It was measured from tip of primary leaf to base of shoot and mean shoot length was expressed in cm.

Seedling dry matter production (g 10 seedlings⁻¹)

Ten normal seedlings chosen earlier for measuring shoot and root lengths were used to determine seedling dry weight. The seedlings kept in paper cover and dried under shade for 24 h and then in a hot air oven at $85 \pm 1^\circ\text{C}$ for 24 hours. The average weight was expressed in gram per ten seedlings.

Vigour index

Seedling vigour index was computed by adopting the following formula as suggested by Abdul-Baki and Anderson (1973) and was expressed in whole number.

Vigour index = Germination percentage x Total seedling length in centimeter

Vigour index II

Seedling vigour index was computed by adopting the following formula as suggested by Abdul-Baki and Anderson (1973) and was expressed in whole number

Vigour index II = Germination (%) × dry weight of seedling⁻¹

Results and Discussion

Germination (%)

The germination per cent differed significantly due to various soaking treatments. Among the treatments, leaching in running water for 18 hours registered the highest germination of 55 per cent while, the lowest germination was recorded in control with 35 %.

Seedling length (cm)

Among the different treatments, leaching in running water for 18 hours recorded more seedling length (24.45 cm) and was followed by leaching in running water for 12 hours (24.37 cm). The minimum seedling length was registered by control (22.46 cm).

Seedling dry matter production (g 10 seedling⁻¹)

The seedling dry matter production significantly differed due to various soaking treatments. Among the treatments, leaching in running water for 18 hours recorded maximum dry matter production of 0.019 g 10 seedlings⁻¹. The minimum dry matter production was registered in control (0.013 g 10 seedlings⁻¹).

Vigour index I

The results on vigour index I values significantly differed by the influence of duration of various soaking treatments. The treatment T₁₄ (leaching in running water for 18 hours) recorded significantly highest vigour index I (1345) and was followed by leaching in running water for 12 hours (1340). The lowest vigour index I (786) was noticed in control (T₁).

Vigour index II

The results on vigour index II values significantly differed by the influence of duration of various soaking treatments. The treatment T₁₄ (leaching in running water for 18 hours) recorded significantly highest vigour index II (0.95) and was followed by leaching in running water for 12 hours (0.94). The lowest vigour index II (0.45) was noticed in control (T₁).

A high germination percentage is an essential characteristic of high quality seed. Problems are encountered in the germination of fresh little millet seeds

such as poor and protracted germination. In order to make the dormant seeds of little millet cv. CO (Samai) 4 germinable, present study was undertaken by subjecting fresh seeds with water soaking treatments as well as seed dormancy pattern and dormancy breaking methods were also studied.

In the present study, the seeds of little millet cv. CO (Samai) 4 were soaked in hot and cold water with and without replacement of water at different duration and also given leaching treatment in running water for different durations leaching to find out the improvement in germination and seedling vigour.

The fresh seeds of little millet seeds cv. CO (Samai) 4 recorded only 35 per cent germination, indicating the presence of seed dormancy. Germination was improved to 55 per cent when the seeds were leached in running water for 18 hours.

This is in conformity with the findings of Geetha (2001) who studied germination in *Cenchrus sp.* in which the seeds were soaked in hot water for 1 hour 30 minutes, cold water soaking without water replacement for 12 hours and cold water soaking for 12 hours with water replacement at 6 hours could improve germination up to 48 per cent only.

Though, there was no difference in seedling length due to hot and cold water treatments, the leaching in running water for 18 hours followed by 12 hours recorded maximum vigour index of 1345 and 1340 respectively as compared to control which recorded only 786.

The higher vigour index could be attributed to higher germination per cent in the above treatments. Shanmugavalli *et al.*, (2007) reported that water soaking might have leached out some of the water soluble inhibitors present in the glumes resulting in germination improvement of seeds of fodder sorghum. Zobaer *et al.*, (2007) reported that hot water treatment of wheat seeds at 52°C for 5 minutes increased seed germination up to 75 per cent.

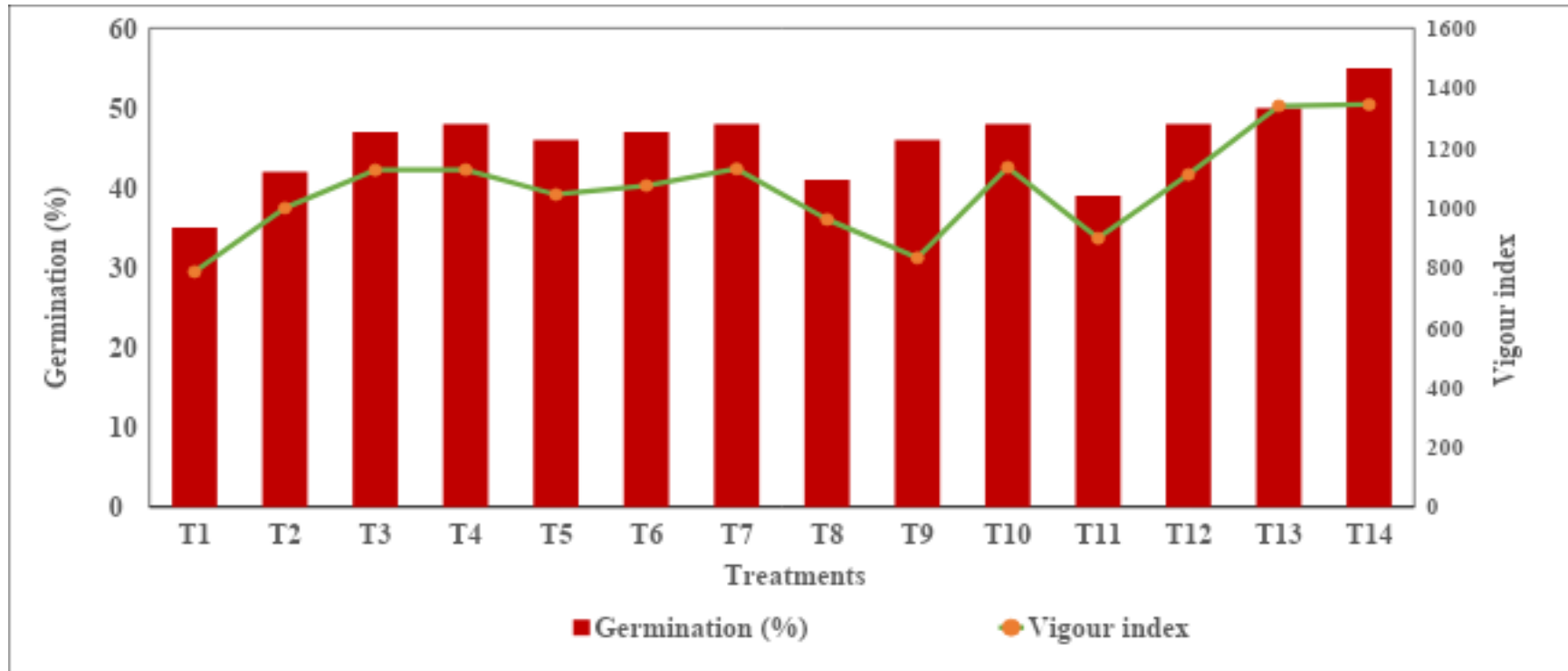
Keerthana *et al.*, (2021) concluded that an effective strategy for breaking seed dormancy and enhancing the germination rate of barnyard millet var. MDU 1 is through a combination of acid scarified seeds (dilute H₂SO₄) for 10 min with KNO₃ @ 3% for 12 h.

Table.1 Effect of soaking in hot and cold water with and without replacement of water and leaching on dormancy breaking in little millet cv. CO (Samai) 4

Treatments (T)	Germination (%)	Seedling length(cm)	Seedling dry matter production (g 10 seedling ⁻¹)	Vigour index I	Vigour index II
T ₁ - Control	35 (36.27)	22.46	0.013	786	0.45
T ₂ - Hot Soaking for 30 minutes	42 (40.40)	23.80	0.017	999	0.71
T ₃ - Hot Soaking for one hour	47(43.28)	23.98	0.016	1126	0.75
T ₄ - Hot water soaking for 1 hour 30 minutes	48 (43.86)	23.48	0.015	1127	0.72
T ₅ - Hot water soaking for 2 hours	46 (42.71)	22.70	0.013	1044	0.59
T ₆ - Cold water soaking without water replacement for 6 hours	47(43.28)	22.86	0.014	1074	0.64
T ₇ - Cold water soaking without water replacement for 12 hours	48 (43.86)	23.54	0.015	1130	0.72
T ₈ - Cold water soaking without water replacement for 18 hours	41 (39.82)	23.43	0.015	961	0.60
T ₉ - Cold water soaking for 6 hour with water replacement at 3 hours	46 (42.71)	23.78	0.015	832	0.53
T ₁₀ - Cold water soaking for 12 hours with water replacement at 6 hours	48 (43.86)	23.64	0.014	1135	0.67
T ₁₁ - Cold water soaking for 18 hours with water replacement at every 6 hours	39 (38.65)	23.02	0.014	898	0.55
T ₁₂ - Leaching in running water for 6 hours	48 (43.86)	23.14	0.015	1111	0.72
T ₁₃ - Leaching in running water for 12 hours	50 (45.00)	24.37	0.017	1340	0.94
T ₁₄ - Leaching in running water for 18 hours	55 (48.00)	24.45	0.019	1345	0.95
Mean	45.7 (42.13)	23.47	0.015	1065	0.69
SEd	0.85	0.58	0.0005	22.32	0.030**
CD (P=0.05)	1.75**	NS	0.0010**	45.88**	0.063**

(Figures in parentheses indicate Arcsine value)

Figure.1 Effect of soaking in hot and cold water with and without replacement of water and leaching on germination (%) and vigour index of fresh seeds in little millet cv. CO (Samai) 4



Treatments

T₁ – Control	T₂ – Hot Soaking for 30 minutes	T₃ - Hot Soaking for one hour
T₄ - Hot water soaking for 1 hour 30 minutes	T₅ - Hot water soaking for 2 hours	T₆ - Cold water soaking without water replacement for 6 hours
T₇ - Cold water soaking without water replacement for 12 hours	T₈ - Cold water soaking without water replacement for 18 hours	T₉ - Cold water soaking for 6 hour with water replacement at 3 hours
T₁₀ - Cold water soaking for 12 hours with water replacement at 6 hours	T₁₁ - Cold water soaking for 18 hours with water replacement at every 6 hours	T₁₂ - Leaching in running water for 6 hours
T₁₃ - Leaching in running water for 12 hours	T₁₄ - Leaching in running water for 18 hours	

In order to make the dormant seeds of little millet cv. CO (Samai) 4 germinable, the seeds of little millet cv. CO (Samai) 4 were soaked in hot and cold water with and without replacement of water and also given leaching treatment in running water for different durations. The untreated fresh seeds of little millet cv. CO (Samai) 4 recorded only 35 per cent germination, indicating the presence of seed dormancy. Germination was improved to 55 per cent when the seeds were leached in running water for 18 hours. The seeds given hot water soaking for 1 hour 30 minutes, cold water soaking without water replacement for 12 hours and cold water soaking for 12 hours with water replacement at 6 hours could improve germination up to 48 per cent only. Though, there was no difference in seedling length due to hot and cold water treatments, the leaching in running water for 18 hours followed by 12 hours recorded maximum vigour index of 1345 and 1340 respectively as compared to control which recorded only 786.

Author Contributions

R. Senthil Raj: Investigation, formal analysis, writing—original draft. S. Keerthana: Validation, methodology, writing—reviewing. P. E. Balaji:—Formal analysis, writing—review and editing. P. M. Dili Baabu: Investigation, writing—reviewing. G. Kirubakaran: Resources, investigation writing—reviewing. S. Kalpana: Validation, formal analysis, writing—reviewing. S. Pugazhenti: Conceptualization, methodology, data curation, supervision, writing—reviewing the final version of the manuscript. P. Sneha: Investigation, formal analysis, writing—original draft. R. Vignesh kumar: Validation, methodology, writing—reviewing. G. Vijayalakshmi:—Formal analysis, writing—review and editing. A. Bharathi: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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