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Studies on Effect of Various Seed Priming Treatments on Seed Yield in Barnyard Millet (*Echinochloa frumentacea)* cv CO1

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ABSTRACT

Field investigation was carried out to study the effect of various seed priming treatments on seed yield in barnyard millet cv CO 1. The seeds of barnyard millet cv CO 1 were given with following seed treatments i.e., dry dressing with Thiram @ 2 g/kg, Hydropriming, bio priming with Pungam leaf extract @ 5%, Moringa leaf extract @ 5%, organo priming with Vermiwash @ 5%, Panchagavya @ 5%, halo priming with $MnSO_4$ @ 2%, $ZnSO_4$ @ 2% along with control. The primed seeds were evaluated for the growth parameters, physiological parameters, gas exchange parameters and yield attributing characteristics. The Moringa leaf extract @ 5% seed priming treatment recorded higher values for the growth parameters such as field emergence, plant height at 45 days and plant height at 90 days. It also recorded early days to first flowering, early days to 50 % flowering when compared to other treatments. The Moringa leaf extract @ 5% seed priming treatment registered significantly higher values for the physiological parameters such as chlorophyll content at 45 DAS, chlorophyll content at 90 DAS, net assimilation rate at 30-50 DAS and 50-95 DAS, leaf area and gas exchange parameters such as photosynthetic rate, transpiration rate and stomatal conductance. In addition to the above characters, Moringa leaf extract @ 5% seed priming treatment also registered significantly higher values for the various seed yield attributing characteristics such as panicle weight plant^{-1}, panicle to seed recovery, seed yield plant^{-1}, seed yield plot^{-1} and 1000 seed weight.

Keywords Barnyard millet, Seed enhancement, Seed priming, Seed yield.

INTRODUCTION

Barnyard millet (*Echinochloa frumentacea* L.) also called as sawa millet and is often cultivated in India, China and Niger, Nigeria, also in Mali, Burkina Faso and Sudan. Ethiopia is the only country in Africa where it is grown. Due to its early maturity, it's a significant small millet crop that is easily adaptable to lesser and average rainfall regions (500-700 mm). It has its amazing dietary fiber source (13g/100 g) with excellent portions of both soluble and insolu-

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ble portions and decent source of easily digestible (81.13g/100g digestibility) proteins (Khatoniar and Das 2022). There are just a few states in India where this crop may be grown: Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Karnataka. In Tamil Nadu, Districts like Madurai, Ramanathapuram, Namakkal, Salem, Dindugal, Vilupuram, Erode and Coimbatore, it is grown in arid and hilly terrain (Suruthi *et al.* 2019). In 2018, the area under barnyard millet in India was around 0.146 m ha^{-1}, with a production of 0.147 million tonnes and an average productivity of 1034 kg/ha (IIMR 2018), while the area in Tamil Nadu was about 0.059 lakh hectares, with a production of 0.081 lakh MT and an average productivity of 1358 kg/ha during 2018-2019 (Department of Economics and Statistics 2019).

Crop status is heavily influenced by seed resources utilized during sowing. Compared to other resources, seeds needed to grow a crop are quite little and its cost is very low. A 20-25% boost in yield may be attributed to using high-quality seeds in improved varieties. The basic principle to successful agriculture is quality seed, which requires that each seed germinate quickly and produce an active seedling to provide a greater yield. A post-harvest treatment that enhances germination and seedling development or makes seed and other sowing inputs and materials easier at the time of sowing may be referred to as a seed enhancement treatment (Nagaraju *et al.* 2018). Seed priming is most cost-effective and easy-to-implement alternatives for farmers in arid areas. It is possible to induce pre-germinative biochemical and physiological changes with exposed seeds to lower water concentration during the seed priming phase, which is controlled hydration. Variety of plant species benefit from seed priming, a procedure that enhances seed quality, increases germination rates and prolongs seed storage. Seed priming is a pre-sowing approach that improves germination rate and performance of a plant by altering pre-germination metabolic activities before radicle emerging. Some evidence suggests that seed priming promotes embryonic development, fixes collapsed seed components, minimizes metabolite leakage, permitting early DNA replication, increasing RNA and protein synthesis (Abou-Zeid *et al.* 2021). Priming is a technique used to make better stand establishment in several crops. Increasing root and shoot length of seedlings in primed seeds recommended that priming treatments enhances the seed vigour, which in turn led to enhanced germination for all of the priming treatments (Sreelatha and Kumar 2018). With the above background, the present study was carried out to evaluate the effect of various seed priming treatments on seed yield in barnyard millet (*Echinochloa frumentacea*) cv CO 1.

MATERIALS AND METHODS

Genetically pure seeds of barnyard millet (*Echinochloa frumentacea*) cv CO 1 obtained from Centre of Excellence for Millets, at Athiyandal in Thiruvannamalai served as the base material for the study. The field experiments were conducted in the farmers field, Kappaluthu Village, Rasipuram Taluk, Namakkal District, Tamil Nadu, India (located at 11°29'N latitude and 78°20'E longitude with an altitude of +433.12 mts above mean sea level) during 2019 – 2021. Freshly harvested bulk seeds of barnyard millet cv CO 1 were imposed with the following seed treatments.

Treatment details

T_0- Unprimed (Control)
T_1- Dry dressing with Thiram @ 2g/kg
T_2- Hydropriming
T_3- Bio priming with Pungam Leaf Extract @ 5%
T_4– Bio priming with Moringa Leaf Extract @ 5%
T_5– Organo priming with Vermiwash @ 5%
T_6– Organo priming with Panchagavya @5%
T_7– Halo priming with Manganese sulphate @ 2%
T_8- Halo priming with Zinc sulphate @ 2%

For hydro priming, seeds were soaked in equal volume of water for 6 h and shade dried to original moisture content. For halo priming, the nutrient solutions of 2% $MnSO_4$ and 2% $ZnSO_4$ were prepared by dissolving respective 2 g salt in to 100 ml distilled water, in which barnyard millet seeds were soaked for 6 h. After priming, the seeds were removed from the solutions and shade dried. For bio priming, the fresh leaves of Pungam (*Pongamia pinnata*), Moringa (*Moringa oleifera*), were collected separately and dried under shade. The shade dried leaves were powdered using mortar and pestle. Then exactly weigh five gram of leaf powder using weighing balance and dissolved in 100 ml of distilled water which was measured already in the beaker to make 5% leaf extract. The leaf extract was filtered by using muslin cloth to remove unwanted materials and leaf debris. The seeds were soaked in equal volume of (1:1) leaf extract for 6 hrs along with water. The soaked seeds were dried back to original moisture content. For organo priming, the seeds of barnyard millet cv CO 1 added with 5% vermicompost extract and 5% panchagavya at 1:1 ratio for 6 hrs. After priming for 6 hrs, the seeds are removed from the solution, rinsed in distilled water, shade dried in room temperature and the unprimed seeds are used as control. The above treated seeds were assessed for various characters in field trial.

Field trial was conducted during *kharif* 2020 adopting (RBD) with three replications. The crop was raised with the spacing of 25×10 cm and recommended package of practices for barnyard millet were followed. The data pertaining to the observations in the field experiments were statistically analyzed adopting the procedure described by Panse and Sukhatme (1985). Wherever necessary, suitable transformation was made before analysis.

RESULTS AND DISCUSSION

Seed vigour enhancement treatments have shown to be quite successful in achieving rapid as well as uniform seed germination. Plants that are enduring water shortages might benefit from seed priming, which provides an early boost to plants and helps them in achieving higher yields under stress condition. Priming researches has shown that primed seeds germinate earlier, have rapid root and shoot development, grow more vigorously, and have a much longer seedling length over non-primed seeds (Nawaz *et al.* 2013).

The botanical priming process had the potential to be more effective than simple seed coating. When the seeds are immersed in water and then dried, this is known as hydro priming, and it prevents the radicle from emergence. Micronutrients are employed as osmotica in seed priming with micronutrients (nutri priming) (Gupta *et al.* 2022). Faster germination and higher seedling vigour contribute to greater agricultural crop production when using this organic seed priming. Bio priming is a biological seed treatment that combines seed hydration (a physiological component of disease control) with seed inoculation (a biological component of disease control) with helpful organisms to protect the seed. The study revealed that the 5% Moringa leaf extract primed seeds recorded higher values followed by 5 % panchagavya for the growth parameters viz., field emergence, plant height at 45 DAS and plant height at 90 DAS which were 9.52, 6.04 and 10.7 percentage higher than the control respectively with the above-mentioned characters. It recorded early days to 1st flowering and days to 50% flowering parameters which was 38.5 and 41.3 days respectively when compared to control and other treatments (Table 1).

Table 1. Effect of various seed priming treatments on field emergence (%), plant height (cm) and days to first and 50% flowering in barnyard millet cv CO 1.

Treatments	Field emergence (%)	Plant height (cm) 45 DAS	Plant height (cm) 90 DAS	Days to first flowering	Days to 50% flowering
T_0	84 (66.42)	72.8	124.3	47.5	50.7
T_1	89 (70.63)	73.6	131.6	41.2	43.5
T_2	88 (69.73)	73.1	130.9	44.3	49.0
T_3	86 (68.03)	75.1	130.3	46.1	49.4
T_4	92 (73.57)	77.2	137.6	38.5	41.3
T_5	86 (68.03)	73.7	128.6	44.6	46.6
T_6	90 (71.57)	75.9	135.2	39.7	42.8
T_7	87 (68.87)	74.6	129.7	41.5	44.5
T_8	88 (69.73)	74.2	133.7	40.4	43.5
Mean	88 (69.66)	74.5	131.3	42.6	45.7
SEd	0.544 (0.486)	0.656	0.957	0.916	0.828
CD (p=0.05)	1.154 (1.030)	1.390	2.029	1.941	1.755

Figures in parenthesis are arcsine transformed value.

MLE is high in PGR hormone, zeatin, Indole acetic acid, ascorbic acid, alkaloids, calcium, iron, magnesium and potassium, all of which are essential for plant growth and development (Yousof *et al.* 2017). When seeds primed with Moringa leaves extract, cytokinin (CK) related hormone improves crop growth. Many researchers believed that the presence of growth promoting compounds as well as nutrient elements in Moringa contributes to the improved growth and yield of the crop when seeds primed with MLE. The presence of zeatin, a cytokinin found in Moringa leaves, improved growth and yield. MLE effectiveness might potentially be attributed to an increased zeatin content in *Moringa oleifera* leaves (5–200 μg g^{-1} of fresh weight), as reported by Fuglie (1999).

Moringa leaf extract is high in antioxidants including proline, tannins, saponins, and tocopherols, as well as osmo protectants such as amino acids and soluble sugars. In addition, phytohormones such as indole-3-acetic acid, cytokinin and gibberellins are abundant. The availability of alkaloids, zeatin, ascorbates, glucosinolates, quercetin, antioxidants, and important plant nutrients in moringa leaf extract as seed primer has been reported to work as a growth enhancer (Yasmeen *et al.* 2013), and play a crucial role in cell division, cell expansion, and chlorophyll biosynthesis and an increased concentration of growth-promoting hormones including auxins and cytokinines may have contributed to the acceleration of growth characteristics by allowing for accelerated cell division, multiplication, and enlargement (Elzaawely *et al*. 2017). Similar results were reported by Junaid *et al.* (2019) in maize, Yazhini *et al.* (2019) in ragi, Prakash *et al*. (2019) in sesame and Ehtaiwesh and Yarboa (2020) in wheat.

The physiological parameters such as chlorophyll content at 45 DAS, chlorophyll content at 90 DAS, net assimilation rate at 30-50 DAS, net assimilation rate at 50-95 DAS, leaf area and gas exchange parameters such as photosynthetic rate, transpiration rate and stomatal conductance also higher in moringa leaf extract @ 5% seed priming treatment which was 13.16, 65.56, 60.71, 90.48, 10.54, 21.71, 18.21 and 74.51 percentages higher followed by 5 % panchagavya than control respectively with the above mentioned characters (Table 2). Moringa leaf contains significant amounts of plant pigments with antioxidant properties, such as carotenoids (lutein, α-carotene, β-carotene, and xanthin) and chlorophyll. Furthermore, the leaves of moringa possess many macroelements, including Ca and Mg, a constituent of chlorophyll, which would contribute for the rise of chlorophyll a and chlorophyll b levels in crop plants. Furthermore, seed fortification with MLE may promote early cytokinin synthesis, preventing premature leaf senescence and ultimately in larger leaf area with higher photosynthetic pigments (Rehman *et al.* 2017).

Table 2. Effect of various seed priming treatments on physiological and gas exchange parameters in barnyard millet cv CO 1.

Treatments	Chlorophyll content (mg g^{-1} of fresh leaf) 45 DAS	Chlorophyll content (mg g^{-1} of fresh leaf) 90 DAS	Net assimilation rate (mg cm^{-2} day^{-1}) 30-50 DAS	Net ssimilation rate (mg cm^{-2} day^{-1}) 50-95 DAS	Leaf area (cm^2)	Photosynthetic rate Pn - (mg CO^2 m-1S^{-1}) $m^{-1}S^{-1}$)	Transpiration rate Tr - (mg H_2O CO_2 $m^{-1}S^{-1}$)	Stomatal conductance CS - (mol/mol^{-1} S^{-1})
T_0	1.132	0.511	0.28	0.21	773.11	34.60	10.93	0.51
T_1	1.184	0.707	0.31	0.27	817.48	38.53	11.53	0.66
T_2	1.201	0.597	0.35	0.31	793.21	36.35	12.11	0.61
T_3	1.177	0.623	0.41	0.35	788.12	37.11	11.56	0.55
T_4	1.281	0.846	0.45	0.40	854.62	42.11	12.92	0.89
T_5	1.167	0.663	0.29	0.25	800.12	35.65	11.23	0.63
T_6	1.211	0.729	0.43	0.37	837.12	40.15	12.61	0.80
T_7	1.158	0.612	0.37	0.29	807.11	38.12	11.48	0.74
T_8	1.197	0.684	0.39	0.31	821.23	39.33	11.68	0.70
Mean	1.190	0.664	0.36	0.31	810.24	37.99	11.78	0.68
SEd	0.005	0.003	0.015	0.012	9.446	0.509	0.477	0.027
CD (p=0.05)	0.010	0.007	0.031	0.026	20.026	1.079	1.010	0.058

Moringa leaf extract was found to stimulate chlorophyll concentration in plant leaves. MLE's efficiency may possibly be due to greater protein and antioxidant levels, as well as mineral content (particularly Ca and K) in Moringa leaves, which aids in metabolic processes. This study backs up the findings of Xiong *et al.* (2015), who found that increasing leaf area and photosynthetic capability were correlated with increasing nitrogen on the cells and tissue formation. Adequate growth factors availability can effectively delay leaf senescence, allowing the leaf green pigment and functioning to be maintained for a longer duration. Cytokinins are significant hormones present in Moringa leaf extract that have been shown to stimulate cell division by activating the mitosis process. Mitosis increases plant growth and the development of shoots and buds, as well as the development of fruits and seeds.

The increased accumulations of total protein and chlorophyll in response to Moringa leaf treatments were attributed to the high protein, sugar, and starch content of the complete *Moringa oleifera* plant (Abdalla 2013). This might be because Moringa leaves are high in Zeatin and can be utilised as a natural source of cytokinin. The leaves also contain potassium, calcium, ascorbates, carotenoids and phenol, which aid in the development of biochemicals in plants that promote plant development and are used as exogenous plant growth enhancers. Moringa leaf extract is high in zeatin, ascorbate, and minerals, particularly potassium, which helps to prevent ageing in less-than-ideal conditions (Yasmeen *et al.* 2013). By priming with MLE, this relates to enhanced chlorophyll contents and physiological characteristics. Cytokinins play a significant role in Moringa leaf extract by promoting cell division, cell elongation, chlorophyll production, and modifying apical dominance in plants (Jiang and Asami 2018). Similar results were reported by Azra *et al*. (2013) in wheat, Abohassan and Abusuwar (2018) in legumes, Yazhini *et al.* (2019) in ragi and Prakash *et al*. (2019) in sesame.

The seed primed with MLE @ 5% was also recorded the higher yield parameters such as panicle weight plant^{-1}, panicle to seed recovery, seed yield plant^{-1}, seed yield plot^{-1} and 1000 seed weight were also 44.88, 23.39, 98, 32.24 and 19.68 percentage higher followed by panchagavya @ 5 % than control respectively with the above-mentioned characters (Table 3). This is due to the Moringa leaf aqueous extract's high mineral and hormone content, which is directly/indirectly engaged in the fruit growth and development process, resulting in an increase in the quantity of fruits/trees (Abdalla 2013). This improvement in fruit weight, length, and diameter is attributed to the high content of K and Zn in Moringa leaf aqueous extract. Potassium increases seed quality by promoting carbohydrate formation and transportation from the shoot to storage organs (seeds). It could be attributed to the Moringa leaf extract's content of proteins, carotene, phenolic, sugars, minerals such as Ca, Mg, Na, Fe, P and K, and vitamins such as A, B1, B2, B3, C and E as well as several plant hormones such as auxin, gibberellin and cytokinins, which regulate internal mechanisms for controlling seed setting and ovaries abscission. MLE priming may enhance root-to-shoot ratio due to cell wall expansion and higher metabolic activity at low water potential. Zinc is a precursor of tryptophan, which is essential for the production of indole acetic acid (IAA), which is necessary for fruit growth and development (Prasad *et al.* 2015). Furthermore, the higher amount of cytokinin, which play an important role in cell division and growth and improved seed yield. Fuglie (1999) observed that the existence of growth promoting substances in Moringa leaf extract increased seasonal leaf area duration, grain filling

Table 3. Effect of various seed priming treatments on yield parameters in barnyard millet cv CO 1.

Treatments	Panicle weight /plant (g)	Panicle to seed recovery (%)	Seed yield /plant (g)	Seed yield/ plot (g)	1000 seed weight (g)
T_0	18.85	42.11	7.50	1836	2.49
T_1	24.53	47.72	9.69	1967	2.58
T_2	23.40	44.05	11.16	2219	2.71
T_3	19.48	48.13	11.58	2253	2.74
T_4	27.31	51.96	14.85	2428	2.98
T_5	21.26	45.27	9.91	2174	2.69
T_6	26.72	49.22	13.46	2388	2.86
T_7	23.89	45.36	9.77	2031	2.64
T_8	19.18	48.54	8.82	1915	2.55
Mean	22.74	46.93	10.75	2135	2.69
SEd	0.911	0.406	0.435	13.881	0.110
CD (P=0.05)	1.932	0.860	0.923	29.427	0.232

period, and yield characteristics, resulting in higher economic and biological yield in wheat. Due to the presence of high endogenous levels of cytokinin like compounds such as zeatin, kinetin, which resulted in an increase in fruit size and quantity of fruits per plant and increased in yield. These findings provide evidence that Moringa leaf includes growth hormones and cytokinins can increase yield (Soliman 2019). According to some investigators, the zeatin, a cytokinin-related hormone, was responsible for the enhanced growth and production. Similar results were reported by Abohassan and Abusuwar (2018) in legumes, Prakash *et al.* (2019) in sesame, Yazhini *et al.* (2019) in ragi and Pazhanisamy *et al*. (2020) in rice.

CONCLUSION

From the aforementioned investigation effect of various seed priming treatments on seed yield in barnyard millet cv CO 1 revealed that Moringa leaf extract @ 5% primed seeds recorded the higher seed yield when compared to other treatments and control. It is also on par with the treatment in which the seeds primed @ 5% panchagavya.

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