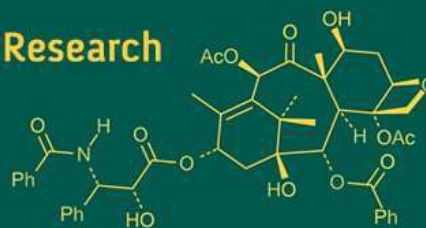


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Integrated nutrient management and seed priming on seed quality in barnyard millet (*Echinochloa frumentacea* L.)

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Abstract

Barnyard millet is an important minor millet crop cultivated owing to its high level of protein, calcium, iron and fibre content. Farmers generally refrain from fertilizer application and also there is lack of seed production, inspite increase in demand. Keeping these in view a field and laboratory experiment was carried out at Department of Seed Science and Technology and Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad during *kharif* 2023-24 with four nutrient managements in main plot *viz.*, N₁-control, N₂-organic manures, N₃- integrated, N₄- chemical fertilizers and four seed priming treatments in sub plot *viz.*, P₁-control, P₂- hydropriming, P₃-osmopriming and P₄- bio-priming and the treatment combinations were arranged in split plot design with three replications. Results indicated that, the treatment integrated use of organic and inorganic fertilizers and biopriming with *Pseudomonas fluorescens* (N₃P₄) recorded significantly higher seed quality parameters *viz.*, seed germination (93.67%), shoot length (12.83 cm), root length (7.92 cm), seedling dry weight (29.42 mg/10 seedlings), seedling vigour index-I and II (1944 and 2756 respectively), total dehydrogenase activity (0.382), lower electrical conductivity (14.29 μ S/cm) and seed infection (7.10%). Hence, combining seed priming and integrated fertilizer application offers the best plant growth and seed quality in barnyard millet.

Keywords: Barnyard millet, integrated nutrient management, *Pseudomonas fluorescens*, seed priming

Introduction

Millets are small grained cereal crops known for their exceptional resilience to drought, requiring minimal chemical inputs like fertilizers and pesticides in cultivation. Small millet grains are abundant in vitamins, dietary fibres, various minerals (Particularly micronutrients like calcium, zinc and iron), phytochemicals and antioxidant properties (Bouis, 2000) [2]. They are often referred to as Nutri-cereals and serve as important staple crops in semi-arid tropical regions of Africa and Asia, where limited precipitation and poor soil fertility constrain the growth of major food crops. The prime reason for lower productivity of millets is due to lack of adoption of advanced production technologies and farmers generally refrain from fertilizer application and there is lack of seed production technology, inspite increase in demand.

Quality seeds are essential for successful agriculture, requiring each seed to germinate quickly and yield vigorous seedlings for higher productivity. To improve seed quality, researchers have developed new technologies known as 'Seed quality enhancement techniques' seed priming is one among them, in which seeds are partially hydrated until the germination process trigger (Bradford, 1986) [19]. This technique is used for improvement of seed yield and seed quality (Talebian *et al.*, 2008) [16] and often results in quick and uniform seedling emergence, offering potential benefits in unfavorable soil conditions. Various seed priming methods such as hydro priming, chemo-priming, solid matrix priming, nutri-priming, osmo priming, hormo-priming and biopriming are effective for enhancing seed quality and mitigating abiotic stress. Integrated approach represents a comprehensive strategy for managing farms, characterized by its dynamic nature. Promoting sustainable agriculture, mitigating secondary and micronutrient deficiencies, optimizing fertilizer usage,

improving seed yield and quality, fostering overall soil health by positively impacting its physical, chemical and biological properties is one of its primary objectives. Organic manures, known for their gradual nutrient release and improve water retention, soil structure, soil physical and biological properties, exhibit limited nutrient supply during seed germination and seedling establishment. Conversely, reliance on inorganic fertilizers has been associated with soil degradation and quick loss of nutrients, leading to nutrient deficiency during crucial seed development stages and reduced seed size. Therefore, integrating both organic and inorganic fertilizers along with seed quality enhancement techniques like seed priming can effectively fulfill crop nutrient requirements and accelerate early and uniform seedling emergence, improve nutrient uptake and trigger defense mechanism, and is essential for millet cultivation due to uneven field emergence and to augment seed yield and quality. Keeping these in views, the present investigation is carried out in barnyard millet (*Echinochloa frumentacea* L.) to study the effect of integrated nutrient management and seed priming techniques on seed quality.

Materials and Methods

A field and laboratory experiment was conducted at Department of Seed Science and Technology and Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad during *Kharif* 2023 to study “Integrated nutrient management and seed priming on seed quality in barnyard millet (*Echinochloa frumentacea* L.)”. Barnyard millet variety DHBM 93-3 was used for the study. The experiment was laid under split plot design with three replications in 16 treatment combinations. The treatments details are given below

Main plot: Nutrient management (N)

N₁ – No fertilizer (Control)

N₂ - Organic fertilizer (1250 kg ha⁻¹ vermicompost + 200 kg ha⁻¹ neem cake)

N₃ - Organic and inorganic fertilizers (Integrated - 625 kg ha⁻¹ vermicompost + 100 kg ha⁻¹ neem cake + 63 kg ha⁻¹ SSP + Top dressing 20 kg urea at 35-40 DAS)

N₄ - Inorganic fertilizers (RDF – N: P: K 20:20:0 kg ha⁻¹)

Sub plot: Seed priming treatments (P)

P₁ - No priming (Control)

P₂ - Hydropriming for 8 hours by adopting seed to solution ratio of 1: 1 and shade drying treated seeds to original moisture content before sowing

P₃ - Osmopriming with 1 percent Mannitol solution for 6 hours by adopting seed to solution ratio of 1:1 and shade drying treated seeds to original moisture content before sowing

P₄ - Biopriming with 20 percent liquid *Pseudomonas fluorescence*.

After imposing treatments, the crop was raised as per the standard cultural practices and the observations were recorded and subjected to statistical analysis as per Gomez and Gomez (1984) [3].

Results

The nutrient management treatments significantly influenced the plant growth, seed yield and quality of proso millet cv. DHBM 93-3. Among different nutrient

management treatments N₃ (Integrated - 625 kg ha⁻¹ vermicompost + 100 kg ha⁻¹ neem cake + 63 kg ha⁻¹ SSP + Top dressing 20 kg urea at 35-40 DAS) showed superiority with respect to various seed quality parameters viz., first count (51.24%), seed germination (88.33%), shoot length (10.25 cm), root length (6.73 cm), seedling dry weight (23.35 mg/10 seedlings), seedling vigour index-I (1507), seedling vigour index-II (2248), total dehydrogenase activity (0.343) and less electrical conductivity (15.44 μS/cm), seed infection (7.61%) against N₁ (Control).

Among the seed priming treatments, Biopriming (P₄) with 20 percent liquid *Pseudomonas fluorescence* recorded significant higher first count (52.46%), seed germination (89.42%), shoot length (10.67 cm), root length (7.04 cm), seedling dry weight (25.73 mg/10 seedlings), seedling vigour index I (1588), seedling vigour index II (2307), total dehydrogenase activity (0.346) and lower electrical conductivity (15.17 μS/cm) and seed infection (8.26%) over P₁ (Control).

Among interactions the treatment N₃P₄ (integrated nutrient sources and biopriming) recorded significantly higher seed germination (93.67%), shoot length (12.83 cm), root length (7.29 cm), seedling dry weight (29.42 mg/10 seedlings), seedling vigour index-I (1944), seedling vigour index-II (2756), total dehydrogenase activity (0.382) and lower electrical conductivity (14.29 μS/cm) and seed infection (7.10%) when compared to N₁P₁ (Control).

Discussion

Combining organic and inorganic sources positively impact plant metabolic processes, growth and consistent availability of vital nutrients in the soil throughout the crop's growth period provides nutrients with the crop's varying demands at different growth stages and enhanced accumulation of food reserves may have improved plant growth and seed quality according to Basavaraju and Purushotham (2009) [1]. The enhanced accumulation of food reserves may have improved seed germination, root length and shoot length, leading to greater mean seedling length and dry weight (Muthuswamy *et al.*, 1990) [7]. These results are in accordance with the findings of Patel *et al.* (2014) [8] in pearl millet, Sravani (2016) [13] in finger millet, Sahana and Siddaraju (2020) [11] in proso millet.

The resultant increase in seedling vigour index-I and seedling vigour index-II of seeds treated with 20 percent liquid *Pseudomonas fluorescence* was to the extent of 17.64 percent and 19.21 percent respectively as against unprimed seeds. According to Sridevi and Manonmani (2016) [14], improved seed quality attributes due to seed priming may result from completion of early germination stages, enhanced water and nutrient uptake, increase in bio-protectants populations, faster and more uniform seedling emergence, and protection against pathogens. Ruttanaruangboworn *et al.* 2017 [10] showed that higher germination percentage in primed seeds is possibly because of reactivation of metabolic processes, leading to the biosynthesis of auxins. This, in turn, stimulates embryo growth and reduces the imbibition time and leads to increased internal activity during the second stage of germination, facilitating subsequent germination processes. The outcomes were in consistent with Tejaswini *et al.* (2019) [17] and Sahana and Siddaraju (2020) [11].

Table 1: Influence of nutrient management and seed priming treatments on first count, seed germination, shoot length, root length and seedling dry weight in barnyard millet cv. DHBM 93-3

Treatments	First count (%)	Seed germination (%)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg/10 seedlings)
Nutrient management (N)					
N ₁	49.19	85.42 (67.54)	8.75	5.77	21.25
N ₂	49.15	84.92 (67.13)	9.08	5.98	22.10
N ₃	51.24	88.33 (70.00)	10.25	6.73	25.35
N ₄	51.05	87.12 (69.04)	9.38	6.33	24.44
S.Em±	0.52	0.39	0.15	0.18	0.51
CD (P=0.05)	1.79	1.36	0.52	0.61	1.77
Seed priming treatments (P)					
P ₁	48.36	83.58 (66.11)	8.46	5.31	21.51
P ₂	49.47	85.75 (67.86)	8.88	6.02	22.45
P ₃	50.34	87.08 (68.95)	9.46	6.44	23.46
P ₄	52.46	89.42 (71.00)	10.67	7.04	25.73
S.Em±	0.65	0.49	0.18	0.14	0.27
CD (P=0.05)	1.89	1.44	0.53	0.41	0.78
Interactions (N x P)					
N ₁ P ₁	47.05	82.33 (65.14)	8.17	5.17	20.17
N ₁ P ₂	48.89	84.33 (66.68)	8.50	5.75	21.10
N ₁ P ₃	49.90	88.33 (70.02)	8.83	5.33	20.32
N ₁ P ₄	50.93	86.67 (68.59)	9.50	6.83	23.42
N ₂ P ₁	47.10	83.00 (65.65)	8.33	5.25	20.48
N ₂ P ₂	48.42	84.67 (66.95)	8.67	5.67	21.22
N ₂ P ₃	49.75	84.67 (66.95)	9.17	6.67	22.71
N ₂ P ₄	51.32	87.33 (69.15)	10.17	6.33	24.00
N ₃ P ₁	49.95	85.00 (67.21)	8.83	5.33	22.65
N ₃ P ₂	49.73	86.33 (68.30)	9.33	6.75	24.07
N ₃ P ₃	50.57	88.33 (70.02)	10.00	6.92	25.26
N ₃ P ₄	54.71	93.67 (75.43)	12.83	7.92	29.42
N ₄ P ₁	49.36	84.00 (66.42)	8.50	5.50	22.74
N ₄ P ₂	50.85	87.67 (69.44)	9.00	5.92	23.39
N ₄ P ₃	51.12	87.00 (68.87)	9.83	6.83	25.57
N ₄ P ₄	52.88	90.00 (71.57)	10.17	7.08	26.07
S.Em±	1.29	0.98	0.36	0.28	0.53
CD (P=0.05)	NS	2.87	1.06	0.82	1.56

Table 2: Influence of nutrient management and seed priming treatments on seedling vigour index-I, seedling vigour index-II, electrical conductivity, total dehydrogenase activity and seed infection in barnyard millet cv. DHBM 93-3

Treatments	Seedling vigour index-I	Seedling vigour index-II	Electrical conductivity (µS/cm)	Total dehydrogenase activity (OD at A ₄₈₀ nm)	Seed infection (%)
Nutrient management (N)					
N ₁	1242	1816	16.73	0.290	10.04 (18.47)
N ₂	1281	1872	16.28	0.307	9.45 (17.90)
N ₃	1508	2248	15.44	0.343	7.61 (16.02)
N ₄	1371	2124	15.62	0.326	8.51 (16.96)
S.Em±	18.97	50.12	0.20	0.003	0.27
CD (P=0.05)	65.66	173.44	0.69	0.011	0.94
Seed priming treatments (P)					
P ₁	1151	1800	16.97	0.281	9.49 (17.94)
P ₂	1278	1918	16.26	0.309	9.09 (17.55)
P ₃	1384	2035	15.67	0.329	8.76 (17.22)
P ₄	1588	2307	15.17	0.346	8.26 (16.70)
S.Em±	22.09	33.01	0.16	0.005	0.12
CD (P=0.05)	64.49	96.34	0.47	0.015	0.36
Interactions (N x P)					
N ₁ P ₁	1098	1661	18.46	0.268	11.08 (19.44)
N ₁ P ₂	1202	1779	16.83	0.287	10.10 (18.53)
N ₁ P ₃	1251	1794	16.22	0.276	9.73 (18.18)
N ₁ P ₄	1415	2029	15.41	0.331	9.24 (17.70)
N ₂ P ₁	1127	1703	16.44	0.279	9.37 (17.82)
N ₂ P ₂	1214	1764	16.70	0.299	10.18 (18.61)
N ₂ P ₃	1341	1924	15.91	0.333	9.40 (17.85)
N ₂ P ₄	1441	2096	16.08	0.316	8.83 (17.29)
N ₃ P ₁	1204	1926	16.31	0.289	8.34 (16.78)
N ₃ P ₂	1388	2077	15.69	0.337	7.39 (15.78)
N ₃ P ₃	1495	2231	15.47	0.365	7.63 (16.03)
N ₃ P ₄	1944	2756	14.29	0.382	7.10 (15.45)
N ₄ P ₁	1176	1909	16.68	0.288	9.18 (17.63)
N ₄ P ₂	1308	2052	15.81	0.315	8.70 (17.15)
N ₄ P ₃	1449	2190	15.08	0.344	8.29 (16.74)
N ₄ P ₄	1553	2346	14.91	0.357	7.87 (16.29)
S.Em±	44.19	66.01	0.32	0.010	0.24
CD (P=0.05)	128.97	192.68	0.94	0.030	0.71

Lower electrical conductivity observed in primed seeds may be due to improved membrane repair, which is affected during maturation drying (Kurdikeri *et al.*, 1993) ^[5] and Sandhyarani (2020) ^[12] in cotton. Similar results were also reported in soybean (Sung and Chiu, 1995) ^[15], carrot (Maskari *et al.*, 2003) ^[6] and turnip (Khan *et al.*, 2005) ^[4]. However, priming may cause some electrolytes to leak out, which results in lower electrolyte levels in non-primed seeds and the improved seedling growth is likely due to suppression of harmful pathogens and microorganisms and by synthesis of plant growth regulators such as gibberellins, cytokinin and indole acetic acid and by the resultant increase in mineral and ion availability, along with improved water uptake. (Ramamoorthy *et al.*, 2009) ^[9]. The findings were in line with Sahana and Siddaraju (2020) ^[11].

Conclusion

Thus, findings from this study indicate that among various treatments, integrated approach through combination of organic and inorganic fertilizers and bio-priming with *Pseudomonas fluorescens* (N₃P₄) enhanced seed quality when compared to other treatments in barnyard millet variety DHBM 93-3.

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