Original Research Article

Investigation on Maximization of Seed Quality and through Integrated Approach in Prosomillet (Panicum miliaceum L.)

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A B S T R A C T

A laboratory experiment was conducted at seed science and technology, college of agriculture, Raichur during December, 2018. Aim is to study the effect of seed quality through integrated approach in prosomillet of resultant seeds. The experiment consisted of 4 priming treatment combinations viz., Control, hydropriming for 8h, biopriming with Pseudomonas fluorescens (20 %) and KH₂PO₄ (2%) with three levels of fertility (100 %, 125 % and 150% RDF). The seeds produced from the field experiment are evaluated in the laboratory for quality assessment. The seed quality parameters differed significantly between the treatments. Seed priming with Pseudomonas fluorescens (20 %) along with 150 % RDF recorded higher germination percentage (89.2 %), shoot length (13.02 cm), root length (11.63 cm), seedling length (24.65 cm), seedling dry weight (430 mg), seedling vigour index I and II (2198 and 38356) and electrical conductivity (0.015) were influenced significantly by Pseudomonas fluorescens (20 %) along with 150 % RDF among all the treatments.

Key words: Priming, Quality, Prosomillet, KH₂PO₄, RDF

Introduction

Proso millet (Panicum miliaceum L.) is commonly known as broomcorn millet, common millet, hog millet, Russian millet and so on, in different parts of the world. Proso millet is currently grown in Asia, Australia, North America, Europe, and Africa (Gavit et al., 2017), and used for feeding birds and as livestock feed in the developed countries and for food in some parts of Asia. Proso millet is likely to have originated in Manchuria (Patil et al., 2015), and it is widely grown in temperate climates across the world. It is an important crop in Northwest China and is grown in Kazakhstan, the Central and Southern states of India and Eastern Europe, USA, and Australia. It is generally cultivated in the cooler regions of Asia, Eastern Africa, southern Europe, and the United States. Prosomillet has adapted well to temperate plains and high altitudes compared to other millets.

Seed is a basic input in agriculture in which 25 % yield increase can be achieved by quality seeds. Quality seed is the key for successful agriculture, which demands each and every
seed should be readily germinable and produce a vigorous seedling ensuring higher yield. To provide higher quality seeds, many researchers have developed new technologies called “Seed Enhancement Techniques”.

Priming technique is the need of present time to get the enhanced germination and establishment in order to utilize the soil moisture and solar radiation to a maximum extent. In this way plants would be able to complete their growth before the stresses arrive (Subedi and Ma, 2005). Osmopriming is commercially used technique for improving seed germination and vigour. It involves controlled imbibition of seeds to start the initial events of germination followed by seed drying up to its original weight. Osmopriming has many advantages including rapid and uniform emergence, improved seedling growth and better stand establishment under any environmental and soil conditions (Chiu et al., 2002).

Research on priming has proved that crop seeds primed with water germinated early, root and shoot development started rapidly, grew more vigorously and seedling length was also significantly greater than nonprimed seeds. It could also improve the performance of crop by alleviating the effect of salts under saline soil conditions (Mohammadi et al., 2008). Soaking seed in water overnight before sowing can increase the rate of germination and emergence even in soil conditions where moisture content is very low (Clark et al., 2001).

Biopriming with Pseudomonas fluorescens improves growth of the plants and also induces resistance to downy mildew. treatment results in enhancement of germination, seedling vigour, plant height, leaf area, tillering capacity, seed weight and yield. And also reduces the time of flowering. (Niranjan Raj et al., 2007)

Seed priming is widely recommended pre-sowing seed treatment, proven for its invigourative effect. Seed priming is a technique for enhancing the seed quality and improving the overall germination and seed storage in a wide range of crop species (McDonald, 2000).

Effect of integrated nutrient approach on yield and quality of crops is reported by many workers from India and elsewhere in different millets. Fertilizer application plays an important role in vegetative growth of plants and finally increases biomass and yield.

**Materials and Methods**

Treatment details are given below.

**Treatment Details**

**Factor-I: Seed priming (P) Factor-II: Nutrient management (N)**

- P₁ – Control - No priming
- P₂ - Hydro priming
- P₃ – Seed priming with 20% *Pseudomonas fluorescens*
- P₄ - Seed priming with 2% KH₂PO₄

- N₁ – 100% RDF
- N₂ – 125% RDF
- N₃ - 150% RDF

**Results and Discussion**

All the seed quality parameters differed significantly due to seed priming treatments. The prosomillet seeds primed with KH₂PO₄ @ 2 per cent (P₄) recorded significantly higher seed germination per cent (86.3%). *Pseudomonas fluorescens* @ 20 per cent (P₃)
noticed highest germination percentage (86.2\%), seedling dry weight (420 mg), lower electrical conductivity (0.016 dSm$^{-1}$), root length (12.77 cm), shoot length (11.99 cm), seedling length (24.76 cm), seedling vigour index I and II (2067 and 35342 respectively) and lower seed moisture content (8.22) (Table 1 and 2).

**Table 1** Influence of seed priming treatments and nutrient management on germination (%), root length (cm), shoot length (cm), seedling length (cm) of proso millet cv. HP-4

| Treatments | Germination (%) | Root length (cm) | Shoot length (cm) | Seedling length (cm) |
|------------|-----------------|------------------|------------------|----------------------|
| Priming treatment | | | | |
| P$_1$: Control | 76.4 | 10.21 | 10.32 | 20.53 |
| P$_2$: Hydro priming for 8 h | 79.6 | 10.46 | 10.56 | 20.78 |
| P$_3$: *Pseudomonas fluroscens* @20\% | 86.2 | 12.77 | 11.99 | 24.76 |
| P$_4$: KH$_2$PO$_4$ @ 2 \% | 86.3 | 11.20 | 11.21 | 22.41 |
| Mean | 82.15 | 11.16 | 11.02 | 22.18 |
| SEm± | 0.442 | 0.085 | 0.079 | 0.107 |
| CD @ 1\% | 1.304 | 0.251 | 0.233 | 0.317 |
| Nutrient management | | | | |
| N$_1$: 100\% RDF | 80.8 | 10.97 | 10.94 | 21.91 |
| N$_2$: 125\% RDF | 82.7 | 11.02 | 11.05 | 22.09 |
| N$_3$: 150\% RDF | 83.0 | 11.49 | 11.07 | 22.54 |
| Mean | 82.14 | 11.16 | 11.02 | 22.18 |
| SEm± | 0.382 | 0.074 | 0.068 | 0.093 |
| CD @ 1\% | 1.129 | 0.217 | 0.201 | 0.275 |
| P×N (Priming × Nutrient management) | | | | |
| P$_1$N$_1$ | 76.3 | 9.41 | 9.82 | 19.23 |
| P$_1$N$_2$ | 80.7 | 10.32 | 10.58 | 20.90 |
| P$_1$N$_3$ | 81.3 | 10.76 | 10.63 | 21.39 |
| P$_2$N$_1$ | 74.7 | 10.31 | 10.40 | 20.71 |
| P$_2$N$_2$ | 76.3 | 10.49 | 10.48 | 20.97 |
| P$_2$N$_3$ | 78.7 | 10.73 | 10.73 | 21.46 |
| P$_3$N$_1$ | 82.0 | 12.35 | 10.55 | 22.90 |
| P$_3$N$_2$ | 87.7 | 12.93 | 11.44 | 24.37 |
| P$_3$N$_3$ | 89.2 | 13.02 | 11.63 | 24.65 |
| P$_4$N$_1$ | 86.4 | 10.46 | 11.20 | 21.46 |
| P$_4$N$_2$ | 86.7 | 11.37 | 11.22 | 23.59 |
| P$_4$N$_3$ | 87.2 | 11.79 | 11.36 | 24.15 |
| Mean | 82.14 | 11.16 | 11.02 | 22.18 |
| SEm± | 0.765 | 0.147 | 0.137 | 0.186 |
| CD @ 1\% | 2.258 | 0.434 | 0.404 | 0.549 |
Table 2 Influence of seed priming treatments and nutrient management on seedling dry weight (mg), seedling vigour index I, seedling vigour index II and electrical conductivity of proso millet cv. HP-4

| Treatments | Seedling dry weight (mg) | Seedling vigour index I | Seedling vigour index II | Electrical conductivity (dSm⁻¹) |
|------------|-------------------------|-------------------------|--------------------------|-------------------------------|
| **Priming treatments** | | | | |
| P₁: Control | 350 | 1588 | 26740 | 0.018 |
| P₂: Hydro priming for 8 h | 400 | 1653 | 33432 | 0.017 |
| P₃: *Pseudomonas fluroscens* @20% | 420 | 2067 | 35342 | 0.016 |
| P₄: KH₂PO₄ @ 2 % | 410 | 2001 | 34520 | 0.016 |
| Mean | 390 | 1827 | 32509 | 0.017 |
| SEm± | 0.001 | 63.42 | 81.98 | 0.0003 |
| CD @ 1% | 0.003 | 103.56 | 104.853 | 0.001 |
| **Nutrient management** | | | | |
| N₁: 100 % RDF | 390 | 1770 | 31512 | 0.017 |
| N₂: 125% RDF | 400 | 1838 | 33080 | 0.017 |
| N₃: 150 % RDF | 400 | 1864 | 33280 | 0.017 |
| Mean | 390 | 1824 | 32624 | 0.017 |
| SEm± | 0.001 | 62.572 | 82.54 | 0.0002 |
| CD @ 1% | 0.005 | 98.621 | 101.584 | 0.0008 |
| **PₓN (Priming × Nutrient management)** | | | | |
| P₁N₁ | 320 | 1436 | 28386 | 0.018 |
| P₁N₂ | 330 | 1689 | 31473 | 0.016 |
| P₁N₃ | 390 | 1726 | 32046 | 0.017 |
| P₂N₁ | 390 | 1595 | 31707 | 0.017 |
| P₂N₂ | 490 | 1619 | 31283 | 0.017 |
| P₂N₃ | 410 | 1664 | 33054 | 0.016 |
| P₃N₁ | 400 | 1887 | 32960 | 0.017 |
| P₃N₂ | 410 | 2138 | 35957 | 0.016 |
| P₃N₃ | 430 | 2198 | 38356 | 0.015 |
| P₄N₁ | 380 | 1955 | 28413 | 0.017 |
| P₄N₂ | 410 | 1997 | 28446 | 0.017 |
| P₄N₃ | 420 | 2067 | 34008 | 0.017 |
| Mean | 390 | 1831 | 32174 | 0.0166 |
| SEm± | 0.002 | 64.879 | 85.356 | 0.000 |
| CD @ 1% | 0.005 | 105.385 | 103.897 | 0.000 |

While significantly minimum was recorded in control (P₁) (76.4%, 350 mg, 0.018 dSm⁻¹, 10.21 cm, 10.32 cm, 20.53 cm, 1588 and 26740 and 13.89 respectively). All the seed quality parameters differed significantly due to nutrient management. The proso millet
seeds applied 150 % RDF recorded significantly higher seed germination per cent (83.0%), seedling dry weight (400 mg), lower electrical conductivity (0.017 dSm⁻¹), root length (11.49 cm), shoot length (11.07 cm), seedling length (22.54 cm), seedling vigour index I and II (1864 and 33280 respectively) and lower moisture content (9.67). While significantly minimum was recorded in 100% RDF (N₁) (80.8 %, 350 mg, 0.017 dSm⁻¹, 10.97 cm, 10.94 cm, 21.91 cm, 1770, 31512 and 11.33, respectively).

Among interaction between different seed priming treatments and nutrient management seed quality parameters differed significantly. The seeds treated with Pseudomonas fluorescens @ 20 per cent coupled with 150 % RDF (P₁N₃) recorded highest seed germination per cent (89.2 %), seedling dry weight (430 mg), lower electrical conductivity (0.015 dSm⁻¹), root length (13.02 cm), seedling length (24.65 cm), seedling vigour index I and II (2198 and 38356 respectively) and lower moisture content (7.67). But for shoot length is higher in KH₂PO₄ with 150 % RDF (P₄N₃) which showed (12.36 cm).

While significantly minimum recorded in control along with 100 % RDF (P₁N₁) (76.3 %, 330 mg, 0.018 dSm⁻¹, 9.41 cm, 9.82 cm, 19.23 cm, 1436 and 28386 and 17.33 respectively).

The priming with Pseudomonas fluorescens was evident among all the treatments in improving the seed germination and seedling vigour in pearl millet by Raj et al., (2004). The enhancement in the seedling growth noticed in this study could be attributed to suppressions of deleterious microorganisms and pathogens; production of plant growth regulators such as gibberellins, cytokinins and indole acetic acid, which increased the availability of minerals and other ions and more water uptake (Ramamoorthy et al., 2000).

The increased germination percentage in primed seeds may be due to reactivation of metabolic process of seeds which cause biosynthesis of auxin, which ultimately triggers the growth of embryo (Khan, 1999) and shortening of imbibition time (Anisa et al., 2017) which leads to enhancement of internal activity during the second germination stage for any subsequent germination process (Sang In Shim et al., 2008). The KH₂PO₄ primed seeds have increased metabolic activity which leads to endosperm weakening and mobilization of storage proteins there by increasing the germination rate (De Castro et al., 2000) and during the increased metabolic activity enhanced ribonucleic acid (RNA) synthesis also leads to accumulation of 4C nuclei in the radicle meristem (Coolbear et al., 1979). The results are in accordance with the findings of Zheng et al., (1994) for canola, lettuce and onion, Nascimento (2003) and Nascimento and Aragao (2004) for muskmelon.

The increase in the seedling vigour index may be attributed to higher germination and dry matter, also priming with KH₂PO₄ was found to increase enzyme activity which leads to increased metabolic activity Srimati et al., (2013). Mirabi and Hasanabadi (2012) observed beneficial effect of KH₂PO₄ to improve seedling vigour index in tomato. These results are in accordance with Kavitha, 2007 in chilli and Ghassemi et al., (2010) in lentil.

Release of certain enzymes responsible for degradation of macromolecules into micro molecules within the seed are not influenced by different combinations of integrated nutrient management as applied to the soil. The similar results were reported by Kumar and Uppar (2007) in moth bean and Chawale et al., (1995) in groundnut. The metabolites
release certain enzymes responsible for degradation of macromolecules into micro molecules within the seed responsible for the higher growth of seedling increased the dry weight. Similar results were reported by Kumar and Uppar (2007) in moth bean.

The increase in root and shoot length with primed seeds might be due to the fact that, priming induced nuclear replication in root tips of seeds (Stofella et al., 1992). The higher seedling length in seeds primed with might be attributed to enlarged embryos, higher rate of metabolic activities and respiration, better utilization and mobilization of metabolites to growing points and higher activity of enzymes. The results corroborate with the findings of Hussaini et al., (1988) in tomato, Ramamoorthy et al., (1989) in coriander and Shahazad (2003) in wheat.

Significantly lowest electrical conductivity by priming might be due to enhanced repair of membrane, which is disrupted during maturation drying. Since electrolyte leakage is in part a result of damage cell membranes. However, electrolytes may leak out during priming, resulting in lower levels of electrolytes in non-primed seeds (Chiu et al., 1995). In the present, study the differential EC values which were recorded among the seed priming treatments indicate the nature and extent of membrane protection offered, which may not be the same for all seed priming treatments, thus resulting in difference in EC values as stated by Kurdikeri (1993) and Sandyarani (2002) in cotton. Similar results were also reported in soybean (Sung and Chiu, 1995), carrot (Maskari et al., 2003) and turnip (Khan et al., 2005).

The accumulation of higher quantities of seed constituents like carbohydrates, proteins and other enzymes due to different nutrient combinations. Increase in seedling length may be because of bolder seeds, having higher test weight which contains greater metabolites for resumption of embryonic growth during germination and these metabolites release certain enzymes responsible for degradation of macromolecules into micro molecules within the seed for the increase of seedling length. The results were reported by Kumar and Uppar (2007) in moth bean.

The application of inorganic fertilizers along with bio-fertilizers inoculation enhances the accumulation of higher quantities of seed constituents like carbohydrates, proteins as enzymes which increased the seedling vigour index of bolder seeds that contain greater metabolites for resumption of embryonic growth during germination. In addition to these metabolites release of certain enzymes responsible for degradation of macromolecules into micro molecules within the seed as stated by Kumar and Uppar (2007) in moth bean.

In conclusion, the prosomillet seeds primed with Pseudomonas fluorescens 20 per cent for 8 h along with 150 % RDF showed higher seed quality parameters viz., germination, shoot and root length, vigour index and lower electrical conductivity.

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