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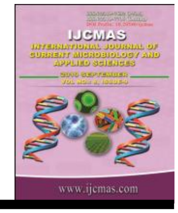

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Investigation on Maximization of Seed Quality and through Integrated Approach in Prosomillet (*Panicum miliaceum* L.)

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ABSTRACT

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 KH_2PO_4 (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 fluroscens* (20 %) along with 150 % RDF among all the treatments.

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 Kazakhastan, 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)**
P_1 – Control - No priming	N_1 – 100% RDF
P_2 - Hydro priming	N_2 – 125% RDF
P_3 – Seed priming with 20 % *Pseudomonas fluorescens*	N_3 - 150% RDF
P_4 - Seed priming with 2% KH_2PO_4	

Results and Discussion

All the seed quality parameters differed significantly due to seed priming treatments. The prosomillet seeds primed with KH_2PO_4 @ 2 per cent (P_4) recorded significantly higher seed germination per cent (86.3%). *Pseudomonas fluorescens* @ 20 per cent (P_3)

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_2PO_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_1N_1	76.3	9.41	9.82	19.23
P_1N_2	80.7	10.32	10.58	20.90
P_1N_3	81.3	10.76	10.63	21.39
P_2N_1	74.7	10.31	10.40	20.71
P_2N_2	76.3	10.49	10.48	20.97
P_2N_3	78.7	10.73	10.73	21.46
P_3N_1	82.0	12.35	10.55	22.90
P_3N_2	87.7	12.93	11.44	24.37
P_3N_3	89.2	13.02	11.63	24.65
P_4N_1	86.4	10.46	11.20	21.46
P_4N_2	86.7	11.37	11.22	23.59
P_4N_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				
P_1: Control	350	1588	26740	0.018
P_2: Hydro priming for 8 h	400	1653	33432	0.017
P_3:*Pseudomonas fluroscens* @20%	420	2067	35342	0.016
P_4: KH_2PO_4 @ 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				
N_1: 100 % RDF	390	1770	31512	0.017
N_2: 125% RDF	400	1838	33080	0.017
N_3: 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**
P×N (Priming × Nutrient management)				
P_1N_1	320	1436	28386	0.018
P_1N_2	330	1689	31473	0.016
P_1N_3	390	1726	32046	0.017
P_2N_1	390	1595	31707	0.017
P_2N_2	490	1619	31283	0.017
P_2N_3	410	1664	33054	0.016
P_3N_1	400	1887	32960	0.017
P_3N_2	410	2138	35957	0.016
P_3N_3	430	2198	38356	0.015
P_4N_1	380	1955	28413	0.017
P_4N_2	410	1997	28446	0.017
P_4N_3	420	2067	34008	0.017
Mean	**390**	**1831**	**32174**	**0.0166**
SEm±	**0.002**	**65.879**	**85.356**	**0.000**
CD @ 1%	**0.005**	**105.385**	**103.897**	**0.000**

While significantly minimum was recorded in control (P_1) (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 prosomillet 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 (N_1) (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 (P_3N_3) 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 KH_2PO_4 with 150 % RDF (P_4N_3) which showed (12.36 cm).

While significantly minimum recorded in control along with 100 % RDF (P_1N_1) (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 KH_2PO_4 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 KH_2PO_4 was found to increase enzyme activity which leads to increased metabolic activity Srimati *et al.,* (2013). Mirabi and Hasanabadi (2012) observed beneficial effect of KH_2PO_4 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, protein 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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