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Influence of Seed Priming with Chemicals, Micronutrients and Bio-Inoculants on Growth and Yield Attributes in Foxtail Millet (*Setaria italica* L.)

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Foxtail millet is an important nutri cereals which sustains well in adverse conditions like limited rainfall, poor soil fertility. It has capacity to withstand drought, adaptable to poor environment and input management. A field experiment was conducted at agriculture Research Station, Hagari during *Kharif* 2018-19 to know the influence of seed priming with chemicals, micro nutrients and bio-inoculants on growth and seed yield in Foxtail millet. In the present study the twelve priming treatments were used. Among the treatments, T_{12} (Seed priming with *Azospirillum* (20 %) + *Pseudomonas fluorescens* (20 %) + *Phosphobacter* (20 %) + Zn SO_4 (0.1 %) + Boron (0.1 %) recorded significantly highest plant height and number of tillers at 30, 60 DAS and at harvest (52.25 cm, 133.70 cm and 134.12 cm respectively and 5.18, 5.37 and 5.37 tillers per plant respectively). Days to 50 per cent flowering and days to maturity was lower (52 and 92 days respectively). In addition to this, significantly highest panicle length (27.58 cm), panicle weight (42.87 g), seed yield per plant (16.28 g), seed yield per hectare (2720 kg ha^{-1}), fodder yield per hectare (8196 kg ha^{-1}) and test weight (3.66 g) were observed for T_{12} (Seed priming with *Azospirillum* (20 %) + *Pseudomonas fluorescens* (20 %) + *Phosphobacter* (20 %) + Zn SO_4 (0.1 %) + Boron (0.1 %) compared to control (21.90 cm, 26.83 g, 9.23g, 1480 kg ha^{-1}, 4681 kg ha^{-1} and 2.80 g respectively).

Introduction

Foxtail millet is commonly known as Italian millet, German millet, Siberian millet, and foxtail bristle grass. Foxtail millet grows 2–5 feet tall and can be cultivated in drier and cooler regions when compared with other millets. It is currently grown in China, India, Europe, particularly in Portugal, Turkey, Hungary, France and Spain, in Asia, primarily in Korea, Pakistan, Myanmar, Bhutan, Nepal, and South Africa. It is used for feeding birds and as livestock feed in the developed countries and for food in some parts of Asia. It is suitable for inclusion in multiple or intercropping systems because of its short duration nature.

Seed enhancement is a term used in industry and in scientific literature to describe beneficial techniques performed on seeds, after harvesting but prior to sowing for improving a crop's harvested yield and quantity. Rapid germination and emergence is an important determinant of successful plant establishment (Heydecker *et al.*, 1975) and seed priming has presented promising results, for many crop seeds (Bradford, 1986).

Seed priming is a controlled hydration process that involves exposing seeds to low water potentials that restrict germination (radicle protrusion), but permits pre germinative physiological and biochemical changes to occur (Heydecker and Coolbear, 1977; Bradford, 1986; Khan, 1992). Upon rehydration, primed seeds may exhibit faster rate of germination, more uniform emergence, greater tolerance to environmental stresses, and reduced dormancy in many species (Khan, 1992). The present investigation was carried out to know the different seed priming effect on growth and grain yield of foxtail millet.

Materials and Methods

The experiment was carried out at Agricultural Research Station, Hagari, Ballari during *kharif* season 2018. Under the present investigation twelve treatments were taken to study their effect on the crop growth and quality of foxtail millet. The experiment was laid out in randomized block design (RBD) comprising twelve treatment combinations *viz*. Control (T_1), Hydro priming (T_2), Seed priming with KH_2PO_4 (2%) (T_3), Halo priming with NaCl (2%) (T_4), Seed priming with *Azospirillum* sp. @ 20% (T_5), Seed priming with *P. fluorescens* @ 20% (T_6), Seed priming with *Phosphobacter* @ 20% (T_7), Seed priming with *Azospirillum* sp. @ 20% + *P. fluorescens* @ 20% + *Phosphobacter* @ 20% (T_8), Seed priming with $ZnSO_4$ (0.1%) (T_9), Seed priming with Boron (0.1%) (T_{10}), Seed priming with $ZnSO_4$ (0.1%) + Boron (0.1%) (T_{11}), T_8 + T_{11} (T_{12}). Seeds of foxtail millet cv.HN - 46 were soaked with chemicals and bio inoculants with seed to solution ratio (w/v) of 1:1 under ambient conditions for 8 hours. Each treatment was replicated thrice.

Results and Discussion

Foxtail millet seeds primed with T_{12}(Seed priming with *Azospirillum* sp. @ 20% + *Pseudomonas fluorescens* @ 20% + *Phosphobacter* @ 20%+ $ZnSO_4$ 0.1% + Boron 0.1%) recorded highest plant height (52.25cm, 133.70cm and 134.12cm), number of tillers (5.18, 5.37 and 5.37 respectively)at 30, 60 DAS and at harvest respectively. Days to 50% flowering and days to maturity recorded lower number of days (52 and 92 days respectively) in T_{12}. While, control (T_1) recorded lowest plant height (35.70cm, 109.30cm and 116.80cm) and number of tillers (3.54, 3.85 and 3.8) at 30,60DAS and at harvest respectively. Days to 50% flowering and days to maturity recorded highest number of days (55 and 96 DAS respectively) in control (T_1) (Table 1).

Improvement in growth parameters might be due to combined effect of bio fertilizers and micronutrients. The enhanced plant height may also be due to the improved and faster plant emergence in bio-primed seeds which might have created nitrogen fixation by the plant, phosphorous solubilization and also cooperative competition among the plants for light and resulted in taller plants. In addition increased the nutrient availability, *Azospirillum* and PSB also effects the plant growth through production of growth harmone like IAA, GA_3, Cytokinin (Sattar and Gaur, 1987).

Table.1 Influence of seed priming with chemicals, micronutrients and bio inoculants on, days to 50%flowering, days to maturity, plant height and number of tillers in foxtail millet

Treatments	Days to 50% flowering	Days to maturity	Plant height(Cm)			Number of tillers		
			30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1: Control	55	96	35.70	109.30	116.80	3.54	3.85	**3.85**
T_2: Hydro priming	55	96	39.90	113.80	119.00	3.73	4.02	**4.02**
T_3 : Seed priming with KH_2PO_4 (2%)	54	95	40.60	119.80	124.20	4.02	4.26	**4.26**
T_4: Halo priming with NaCl (2%)	54	95	40.33	114.67	119.00	3.90	4.22	**4.22**
T_5: Seed priming with *Azospirillum* sp. @20%	53	95	44.13	125.00	125.93	4.23	4.38	**4.38**
T_6: Seed priming with *Pseudomonas fluorescens* @20%	54	95	44.07	123.33	125.20	4.17	4.36	**4.36**
T_7: Seed priming with *Phosphobacter* @ 20%	54	95	43.40	120.73	124.30	4.07	4.29	**4.29**
T_8: Seed priming with *Azospirillum* sp. @ 20% *Pseudomonas fluorescens* @ 20%+*Phosphobacter* 20%	53	93	49.00	129.80	131.00	5.10	5.15	**5.15**
T_9: Seed priming with $ZnSO_4$ (0.1%)	53	94	46.37	126.83	130.53	4.97	5.05	**5.05**
T_{10}: Seed priming with Boron 0.1%)	53	94	46.33	125.67	126.13	4.43	4.44	**4.44**
T_{11}: Seed priming with $ZnSO_4$ (0.1%) + Boron 0.1%)	53	94	46.67	128.80	130.00	5.00	5.07	**5.07**
T_{12} : T8 + T11	52	92	52.25	133.70	134.12	5.18	5.37	**5.37**
Mean	**53.63**	**94.75**	**44.06**	**122.61**	**125.51**	**4.36**	**4.18**	**4.18**
S. Em±	0.69	0.711	1.94	2.39	1.70	0.11	0.11	**0.11**
C.D at 5%	**NS**	**NS**	**5.70**	**7.01**	**5.0**	**0.32**	**0.33**	**0.33**

Table.2 Influence of seed priming with chemicals and bio inoculants on panicle length, panicle weight, test weight seed yield per plant, seed yield per hectare and fodder yield per hectare in foxtail millet

Treatments	Panicle length (cm)	Panicle weight (g)	Test Weight (g)	Seed yield /ha (kg)	Fodder yield/ha (kg)
T_1: Control	21.90	26.83	2.80	1480	**4681**
T_2: Hydro priming	22.33	31.58	2.84	1610	**5357**
T_3 : Seed priming with KH_2PO_4 (2%)	22.58	33.40	3.08	2032	**6482**
T_4: Halo priming with NaCl (2%)	22.57	31.87	3.01	1963	**6335**
T_5: Seed priming with *Azospirillum* sp. @20%	23.52	37.19	3.16	2183	**7160**
T_6: Seed priming with *Pseudomonas fluorescens* @20%	23.83	35.45	3.11	2241	**7123**
T_7: Seed priming with *Phosphobacter* @ 20%	23.58	34.20	3.09	2187	**6973**
T_8: Seed priming with *Azospirillum* sp. @ 20% +*Pseudomonas fluorescens* @ 20%+*Phosphobacter* 20%	25.17	41.63	3.30	2596	**7955**
T_9: Seed priming with $ZnSO_4$ (0.1%)	24.05	38.90	3.27	2195	**7259**
T_{10}: Seed priming with Boron 0.1%)	24.00	38.52	3.21	2215	**7218**
T_{11}: Seed priming with $ZnSO_4$ (0.1%) + Boron 0.1%)	24.43	40.08	3.29	2267	**7275**
T_{12} : T8 + T11	27.58	42.87	3.66	2720	**8196**
Mean	**23.79**	**36.04**	**3.15**	**2140.83**	**6834.55**
S. Em±	0.91	0.89	0.091	93.08	**265.04**
C.D at 5%	**2.68**	**2.61**	**0.36**	**273.00**	**777.34**

Janardan Yadav *et al.,* (2010) in chickpea concluded that the increase in plant height might be due to the early emergence of the bio-primed seeds which makes the plant to compete well with the weeds and higher rate of accumulation of dry matter due to atmospheric nitrogen fixation and phosphorous solubilization.

Raj *et al.,* (2004) and Abdullahi *et al.,* (2014) reported significant difference for number of tillers per plant in pearl millet, Gangwar and Sinha (2014) in rice. Increased leaf production due to seed bio-priming might be due to *Pseudomonas fluorescence* which contains physiologically active substances *viz.,* growth regulators and nutrients that promote profuse number of tillers per plant as noticed by Sharifi *et al.,* (2011) in maize.

Seed yield and yield attributing parameters differed significantly due to seed priming with chemicals and bio inoculants. Foxtail millet seeds primed with T_{12}(Seed priming with *Azospirillum* sp. @ 20% + *Pseudomonas fluorescens* @ 20% + *Phosphobacter* @ 20%+ $ZnSO_4$ 0.1% + Boron 0.1%) recorded highest panicle length (27.58 cm), panicle weight (42.87 g), test weight (3.66 g), seed yield per hectare (2720 kg) and fodder yield per hectare (8196 kg).While the lowest recorded in control (T_1) (21.9 cm, 26.83 g, 2.80 g, 9.23 g, 1880 kg, 4681 kg) (Table 2).

Significant difference is found for all the yield parameters due to seed priming treatment. The increase in the panicle length may be due to the synthesis of amino acid and chlorophyll and better carbohydrates transformation which resulted in better growth and length of panicle which ultimately produced more number of seed per panicle resulting in increasing panicle weight there by increasing the yield. Similar results were also reported by Niranjan raj *et al.,* (2004) in finger millet and Prasad *et al.,* (2009) in wheat. Increase in yield was also contributed by Zn which attributed to the enhanced synthesis of carbohydrates and their transport to the site of grain production crop (Pedda-Babu *et al.,* 2007). Similar results were also reported by various researchers due to Zinc seed priming on seed yield of wheat (Nazir *et al.,* 2000; Harris *et al.,* 2005; Aboutalebian *et al.,* 2012).

The influence of bio-inoculants on the grain yield might be through their effect on actively growing regions in such a way that they encourage nitrogen fixation, phosphorous solubilization and mobilize the nutrients absorbed elsewhere towards the shoot resulting in better vegetative growth and subsequently increased yield as noticed by Nezarat and Gholami (2009) in maize. *Azospirillum* sp. and phosphobacter have improved photosynthesis by increasing water and nutrients absorption leading to produce more assimilate and improves translocation of metabolites from sources to sink which in turn increased the test weight in seeds (Mirzaei *et al.,* 2010).

It may be concluded that seed priming with *Azospirillum* sp. @ 20% + *Pseudomonas fluorescens* @ 20% + *Phosphobacter* @ 20%+$ZnSO_4$ @0.1% + Boron @0.1% was found to be the better treatment for growth and yield attributes in foxtail millet.

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