Original Research Article

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Effect of Different Pre-sowing Seed Treatments for Improving Growth, Yield and Yield Attributes in Foxtail Millet [*Setaria italica* (L.) P. Beauv]

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ABSTRACT

The experiment was conducted in post graduate Seed Testing Laboratory and field, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during *Kharif* season 2019-2020, in order to standardize the suitable fortification seed treatment of Foxtail millet. Pre-sowing seed treatments with control (Unhardened) were evaluated by screening 12 hour viz., T₀ – Control, T₁ – CaCl₂ @ 1%, T₂ – CaCl₂ @ 3%, T₃ – KNO₃ @ 1%, T₄ – KNO₃ @ 3%, T₅ – GA₃ @ 50 ppm, T₆ – GA₃ @ 100 ppm, T₇ – IAA @ 50 ppm, T₈ – IAA @ 100 ppm, T₉ – CuSO₄ @ 50 ppm, T₁₀ – CuSO₄ @ 100 ppm, T₁₁ – ZnSO₄ @ 50 ppm and T₁₂ – ZnSO₄ @ 100 ppm. It was found that all the fortified seed treatments showed significance difference with the control and in laboratory condition highest germination per cent, seedling length, seedling fresh weight, seedling dry weight, vigour indices were observed for T₅- GA₃ (50 ppm). In field lowest taken days to 50% flowering by T₇ – IAA @ 50 ppm and number of leaves per plant, number of seeds per plant, seed yield per plot, biological yield, harvest index were observed for T₅- GA₃@ 50 ppm. Observed highest germination, growth and yielding attributes in GA₃@ 50 ppm. Pre-sowing seed treatment with GA₃ enhance germinability, vigour and seedling character, its simplicity and no requirement for expensive equipment and chemical could be used as a simple method for overcoming related to a poor germination and seedling establishment.

Keywords

Foxtail millet,
CaCl₂, KNO₃,
GA₃, IAA, CuSO₄,
ZnSO₄, Quality
parameters

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Introduction

Millets – The Miracle Grains are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food. Millets are important crops in the semiarid tropics of Asia

and Africa (especially in India, Mali, Nigeria, and Niger), with 97% of millet production in developing countries. Small millets are a group of grassy plants with short slender culm and small grains possessing remarkable ability to survive under adverse conditions like limited rainfall, poor soil fertility and land

terrain making them an attractive crop for marginal farming environments (Saleh *et al.*, 2013). The crop is favored due to its productivity and short growing season under dry, high-temperature conditions.

The term millet is employed for several related genera, some used to produce grain, or forage or both. Millets are cereal species growing in an equally broad range of environments. The most widely cultivated millets are finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), pearl millet (*Pennisetum typhoides*), proso millet (*Panicum miliaceum*), barnyard millet (*Echinochloa colona*) etc. Millets are considered the least important of cereals, with annual production less than 2% of the world's grain.

However, they are of great local importance as staples and as reserve crops in marginal areas. Millet contains an average of 10 - 12% protein. While its protein is superior to that of wheat or corn in terms of content of essential amino acids, and it contains less than half the amount of the essential amino acid lysine that is found in high quality protein sources such as meat. Millet lacks gluten, the wheat protein that makes dough prepared from wheat flour elastic; hence millet flour is not suitable for leavened breads. Millet flour is used in making flat cakes and breads (Robert Ronzio 2004).

Foxtail millet (*Setaria italica* (L.) P. Beauv.) (Synonym *Panicum italicum* L.), family Paniceae/Poaceae, subfamily Panicoideae, tribe Chloridoideae, is diploid with nine chromosomes $2n = 18$. It is, however, closely related to tetraploid and polyploid species of *Setaria* (Benabdelmouna *et al.*, 2001). It is an annual grass grown for human food. It is the second-most widely planted species of millet, and the most important in East Asia. It is the second-most cultivated millet (also known as

"Korralu" in Andhra Pradesh and "Thinai" in Tamil Nadu and "Kang" or "Rala" in Maharashtra, "Kakum" in Hindi) in India (Lata *et al.*, 2011).

Foxtail millet is a member of the Paniceae tribe (subfamily Panicoideae of the Poaceae) and came from green millet domestication in northern China about for 8000 years ago (Barton *et al.*, 2009). Foxtail millet and its ancestor green foxtail (*Setaria viridis*) became more attractive to plant scientists as an alternative model plant because of several distinct characteristics, such as their short stature, rapid life cycle, sufficient seed production per plant, self-compatibility, true diploid nature, and small genome size (515 and 395 Mb, respectively) (Doust *et al.*, 2009; Huang *et al.*, 2016; Pant *et al.*, 2016).

More importantly, foxtail millet and green foxtail are typical C_4 plants, similar to maize, sorghum and sugarcane, and therefore can be a valuable model plant for studies of C_4 photosynthesis (Pant *et al.*, 2016; Huang *et al.*, 2017; Yang *et al.*, 2018). Cereal proteins including millets are limited in lysine and tryptophan content and vary with cultivar.

However, most cereals contain the essential amino acids as well as vitamins and minerals (Devi *et al.*, 2011; FAO, 2009). Foxtail millet is extensively cultivated in the developing countries in semiarid and arid regions of Africa, Americas, Asia (Lata *et al.*, 2013) because of its health benefits (a particular balance of nutrients, e.g., starch, protein, dietary fibers, fat, vitamins, and low-glycemic and hypolipidemic effects), good yield with minimal agricultural inputs, and adaptation to different biotic and abiotic stresses such as salinity (Lata *et al.*, 2011), drought (Feldman *et al.*, 2017), and fungal diseases (Xu *et al.*, 2011). A healthy and environmentally friendly small crop of foxtail is an increasingly attractive alternative for crop production.

Foxtail millet contains a pertinent number of nutritional components, especially starch, protein, vitamins, and minerals. Nutritional constituents of foxtail millet per 100 g. - protein (12.3 g.), carbohydrate (60.9 g.), fat (4.3 g.), crude fiber (8.0 g.), mineral matter (3.3 g.), energy (351 kcal) (Muthamilarasan *et al.*, 2016). Morphologically, foxtail millet grains have layers of husk and bran, similar to other millet grains. The husk forms 13.5% (w/w) of the grain, and the bran and the germ only constitute 1.5–2% (w/w) (Dharmaraj *et al.*, 2016). It has a short generation time of 5–8 weeks from planting to flowering, 8–15 weeks from planting to seed maturity, and can produce hundreds of seeds per inflorescence (Doust *et al.*, 2009).

The use of millets not only provides farmers with a market for their products but also saves foreign exchange, which would otherwise be required to import cereals. Particularly in the developed countries, there is a growing demand for gluten-free foods and beverages from people with celiac disease and other intolerances to wheat that cannot eat products from wheat, barley, or rye.

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” (Talebian *et al.*, 2008).

Seed fortification is a physiological method of seed invigoration that aids in improving the initial stamina of the seed that helps in improving the initial field establishment and that of the final yield. It is the impregnation of the needy substance into the seed through the imbibition's phase enriching the endogenous

level of needy bioactive substances. In seed fortification, seeds are partially hydrated to allow metabolic events to occur without actual germination, and then re-dried (near to their original weight) to permit routine handling. Such seeds germinate faster than non-fortified seeds. Hence, the utility of inorganic nutrients as seed fortification agents were evaluated for improving the germination and field emergence of maize, paddy and ragi (Goto *et al.*, 1999).

Seed treated with halogens is one of the very important seed treatment technique apply with salt solution like as KCl, CaCl₂, NaCl, CaCl₂ and KNO₃ solution concentration. Seeds were soaked in salt solution, after dried and at room temperature and subjected to germination test, done at 25⁰C for 24 hrs. Germination percentage of primed seeds was greater than that of un- primed seeds (Bajehbaj, 2010).

The seed bio-priming is an effective seed treatment to increase the rate, rapid emergence, uniformity of emergence and crop establishment in most of the crops (Rawat *et al.*, 2011). It integrates the biological and physiological aspects of enhancing growth, disease control and increase in yield, which involves coating the seed with biological agents and incubating the seed under warm, moist conditions.

Materials and Methods

The experiment was carried out to study the Effect of different pre-sowing seed treatments for improving growth, yield and seed quality parameters in Foxtail millet (*Setaria italica* (L.) P. Beauv.).

The experiment was carried out at the Laboratory and field of Seed Science and Technology at the Department of Genetics and Plant Breeding, SHUATS, Prayagraj UP. The seed treatments are T⁰-control, T¹- Calcium

chloride 1%, T² -Calcium chloride 3%, T³ - Potassium nitrate 1%, T⁴ - Potassium nitrate 3%, T⁵ – Gibberellic acid 50_{ppm}, T⁶ – Gibberellic acid 100_{ppm}, T⁷ -Indole acetic acid 50_{ppm}, T⁸ – Indole acetic acid 100_{ppm}, T⁹ – Copper sulphate 50_{ppm}, T¹⁰ – Copper sulphate 100_{ppm}, T¹¹ – Zinc sulphate 50_{ppm}, T¹² – Zinc sulphate 100_{ppm}.

To carryout the experiment the seeds were sown in thirteen plots each in three replications with spacing of 22.5x10 cm using line sowing methods following Randomize Block Design.

Data collected of field emergence, it was expressed in percentage, Days to 50% flowering, Plant height of 60 and 90 days, it was expressed in centimeter, number of fingers per panicle, seed yield per plot expressed in grams, seed yield per plant expressed in grams, Biological yield and Harvesting index.

The data recorded from field were analysed statistically following the method of analysis of variance(Fisher, 1948).

Preparation of solution

For the preparation of salt solution, Ten gram CaCl₂ was taken in a beaker. The chemical were added in 1000 ml. of distilled water with constant stirring. The volume of solution will finally constitute to one litter, and then it became 1% stock solution of CaCl₂ chemical and so on.

The flasks containing chemicals were covered with muslin cloth to avoid any contamination. For the preparation of solution of the Plant growth regulators, to prepare 50 ppm solution of GA₃, 50 mg Gibberellic Acid were taken in a beaker and the chemical were added in 1000 ml. of distilled water with constant stirring. The volume of solution will finally constitute

to one litter, and then it became 50 ppm stock solution of Gibberellic Acid chemical and so on. The flasks containing chemicals were covered with muslin cloth to avoid any contamination. For the preparation of solution of the Sulphate ions, to prepare 100 ppm solution of ZnSO₄, 100 mg Zinc sulphate were taken in a beaker and the chemical were added in 1000 ml. of distilled water with constant stirring. The volume of solution will finally constitute to one litter, and then it became 100 ppm stock solution of Zinc sulphate chemical and so on. The flasks containing chemicals were covered with muslin cloth to avoid any contamination.

Seeds soaking in the solution

After preparation of solution of CaCl₂, KNO₃, GA₃, IAA, CuSO₄ and ZnSO₄, foxtail millet seeds were soaked in required solution for 12 hours at 25⁰C temperature. Untreated seed is called as control. After 12 hours of soaking the solution were drained out from the beaker and dried 24 hours at 25⁰C temperature to original weight and then placed for germination in laboratory under controlled condition.

Results and Discussion

The field experiment was conducted to study the Effect of different pre-sowing seed treatments for improving growth, yield and yield attributes in Foxtail millet [*Setaria italica* (L.) P. Beauv.].

The mean performance of field emergence percent ranged from 77.67% to 87.33% with mean value of 82.38%. Significantly highest field emergence percentage (87.33%) was reported in the pre-sowing treatment with T₅ - Gibberellic acid (GA₃) @ 50 ppm it was followed by T₇ - (86.00%) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T₃ - (85.00%) with application of Potassium

nitrate (KNO_3) @ 1%. Minimum field emergence percentage was recorded by T_0 - (77.67%) with control. Days to 50% flowering ranged from 47 to 56 with mean value of 51.08. Significantly taken lowest days to 50% flowering (47.00) was reported in pre-sowing treatment with T_7 - Indole 3 Acetic Acid (IAA) @ 50 ppm it was followed by T_5 - (48.00) with application of Gibberellic acid (GA_3) @ 50 ppm and T_4 - (49.00) with application of Potassium nitrate (KNO_3) @ 3%. Maximum days to 50% flowering was recorded by T_0 - (56.00) with control

Plant height at 45 DAS ranged from 56.57cm to 66.13 cm with mean value of 62.24 cm. Plant height at 45 DAS found to be highest (66.13 cm) in pre-sowing treatment with T_5 - Gibberellic acid (GA_3)@50ppm it was followed by T_7 -(65.60cm) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T_4 - (64.70 cm) with application of Potassium nitrate (KNO_3) @ 3%. Minimum plant height at 45 DAS was recorded by T_0 - (56.57cm) with control. Plant height at 90 DAS ranged from 78.80 cm to 90.50 cm with mean value of 84.78 cm. Plant height at 90 DAS found to be highest (90.50 cm) in pre-sowing treatment with T_7 - Indole 3 Acetic Acid (IAA) @ 50 ppm it was followed by T_5 - (89.10 cm) with application of Gibberellic acid (GA_3) @ 50 ppm and T_3 - (87.63 cm) with application of Potassium nitrate (KNO_3) @ 1%. Minimum plant height at 90 DAS was recorded by T_0 - (78.80 cm) with control.

Number of Leaves per plant ranged from 5.33 to 7.80 with mean value of 6.50. Significantly highest number of leaves per plant (7.80) was reported in the pre-sowing treatment with T_5 - Gibberellic acid (GA_3) @ 50 ppm it was followed by T_7 - (7.40) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T_3 - (7.13) with application of Potassium nitrate (KNO_3) @ 1%. Minimum number of leaves per plant was recorded by T_0 - (5.33) with

control. Number of seeds per plant ranged from 663.67 to 1210.00 with mean value of 933.38. Significantly highest number of seeds per plant (1210.00) was reported in the pre-sowing treatment with T_5 - Gibberellic acid (GA_3) @ 50 ppm it was followed by T_7 - (1180.00) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T_4 - (1130.00) with application of Potassium nitrate (KNO_3) @ 3%. Minimum number of seeds per plant was recorded by T_0 - (663.67) with control.

Seed yield per plant ranged from 1.45 gm to 3.82 gm with mean value of 2.58 gm. Significantly highest seed yield per plant (3.82 gm) was reported in the pre-sowing treatment with T_5 - Gibberellic acid (GA_3) @ 50 ppm it was followed by T_7 - (3.63 gm) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T_4 - (3.37 gm) with application of Potassium nitrate (KNO_3) @ 3%. Minimum seed yield per plant was recorded by T_0 - (1.45 gm) with control. Seed yield per plot ranged from 67.11 gm to 174.46 gm with mean value of 115.15 gm.

Significantly highest seed yield per plot (174.46 gm) was reported in the pre-sowing treatment with T_5 - Gibberellic acid (GA_3) @ 50 ppm it was followed by T_7 - (160.92 gm) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T_4 - (153.71 gm) with application of Potassium nitrate (KNO_3) @ 3%. Minimum seed yield per plot was recorded by T_0 - (67.11 gm) with control. Biological yield ranged from 310.02 gm to 531.36 gm with mean value of 411.93 gm. Significantly highest biological yield (531.36 gm) was reported in the pre-sowing treatment with T_5 - Gibberellic acid (GA_3) @ 50 ppm it was followed by T_7 - (503.60 gm) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T_4 - (493.73 gm) with application of Potassium nitrate (KNO_3) @ 3%. Minimum biological yield was recorded by T_0 - (310.02 gm) with control (Table 1).

Table.1 Mean performance of foxtail millet for ten growth and yield characters.

S.NO.	Treatments	Field emergence percentage	Days to 50% flowering	Plant height at 45 DAS (cm)	Plant height at 90 DAS (cm)	Number of leaves per plant	Number of seeds per plant	Seed yield per plant (g)	Seed yield per plot (g)	Biological yield (g)	Harvest index (%)
1	T ₀	77.67	53	56.57	78.80	5.33	663.66	1.45	67.11	310.02	21.68
2	T ₁	83.00	50	63.03	86.20	6.60	924.00	2.69	114.66	401.22	28.60
3	T ₂	81.67	51	62.03	83.80	6.27	873.67	2.43	105.13	412.09	25.54
4	T ₃	85.00	49	63.90	87.63	7.13	1030.67	3.14	143.26	466.25	30.72
5	T ₄	83.67	49	64.70	86.90	6.93	1130.00	3.37	153.71	493.73	31.12
6	T ₅	87.33	48	66.13	89.10	7.80	1210.00	3.82	174.46	531.36	32.83
7	T ₆	84.00	50	63.50	87.17	6.80	1020.00	2.73	118.86	394.44	30.14
8	T ₇	86.00	47	65.60	90.50	7.40	1180.00	3.63	160.92	503.60	32.09
9	T ₈	79.33	55	58.87	80.30	5.73	762.33	1.80	79.64	353.83	22.55
10	T ₉	80.33	52	61.70	83.10	6.13	858.67	2.18	98.95	376.40	26.33
11	T ₁₀	80.00	54	59.80	80.70	5.87	768.67	1.87	82.96	348.89	23.81
12	T ₁₁	82.00	50	62.50	85.57	6.47	903.67	2.47	107.78	399.41	27.02
13	T ₁₂	81.00	56	60.73	82.40	6.00	808.67	2.00	89.56	363.88	24.63
Grand Mean		82.38	51.08	62.24	84.78	6.50	933.38	2.58	115.15	411.93	27.47
C.D. (5%)		3.15	1.92	1.64	1.66	0.24	30.70	0.15	11.94	51.36	1.71
SE(m)		0.08	0.66	0.56	0.57	0.08	10.52	0.05	4.09	17.59	0.58
SE(d)		1.52	0.93	0.79	0.81	0.12	14.87	0.07	5.79	24.88	0.83
C.V.		2.27	2.23	1.56	1.16	2.24	1.95	3.48	6.15	7.40	3.69
Range	Max	87.33	56	66.13	90.50	7.80	1210.00	3.63	174.46	531.36	32.83
	Min	77.67	47	56.57	78.80	5.33	663.66	1.45	67.11	310.02	21.68

Harvest index ranged from 21.68% to 32.83% with mean value of 27.47%. Significantly highest harvest index (32.83%) was reported in pre-sowing treatment with T₅ - Gibberellic acid (GA₃) @ 50 ppm it was followed by T₇ - (32.09%) with application of Indole 3 Acetic Acid (IAA) @ 50 ppm and T₄ - (31.12%) with application of Potassium nitrate (KNO₃) @ 3%. Minimum Harvest index was recorded by T₀ - (21.68%) with control

Pre-sowing is a physiological method of seed invigoration that aids in improving the initial stamina of the seed that helps in improving the initial field establishment and that of the final yield. It is the impregnation of the needy substance into the seed through the imbibition's phase enriching the endogenous level of needy bioactive substances.

In pre-sowing treatment, seeds are partially hydrated to allow metabolic events to occur without actual germination, and then re-dried (near to their original weight) to permit routine handling. Such seeds germinate faster than non-pre sowed treatment seeds. Hence, the utility of inorganic nutrients as pre - sowing agents were evaluated for improving the germination and field emergence.

On the basis of results obtained from the present experiment following conclusions are drawn.

Pre-sowing seed treatment increases the germinability and vigour of foxtail millet seeds, significantly in field condition. Pre-sowing treatment with Gibberellic acid @ 50 ppm followed by Indole 3 Acetic Acid @ 50 ppm, Pre-sowing treatment with GA₃ and IAA showed maximum increase in germinability and vigour of foxtail millet seeds and found to be lowest in control seeds. These conclusions are based on the results of six months investigation and therefore further investigation is needed to arrive at valid

recommendations. The Pre-sowing seed treatment with GA₃ are eco -friendly, enhancing planting value and economic in use.

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