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Effect of Seed Polymerization with Micronutrients on Seed Yield and Quality in Biofortified Genotypes of Pearl Millet [*Pennisetum glaucum* (L.)]

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ABSTRACT

Keywords

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The field cum laboratory experiment was carried out in the Department of Seed Science and Technology, College of Agriculture, Vijayapur, University of Agricultural Sciences, Dharwad, during *Kharif* season of 2018-19 with an objective to study the effect of seed polymerization with micronutrients on seed yield and quality in biofortified genotypes of pearl millet (*Pennisetum glaucum* L.). The experiment was laid out in a factorial randomized block design with thirteen biofortified genotypes and twelve treatments including control with four replications. The results revealed that seeds treated with combined application of 5ml polymer per kg seed along with micronutrients namely, $ZnSO_4 + FeSO_4 + Boron$ + each at 2 g per kg of seed was recorded higher the seed yield and better quality in pearlmillet.

Introduction

Nutritional security is the key to improve the health status of the world's population as mankind is primarily dependent on plant-based diets. Plants are the major source of nutrients essential for normal growth and development. However, half of the global population, especially people from Asia and Africa suffer from nutrition deficiency as they rely on cereal crops for food (Hirschi, 2009). Pearl millet is a good source of energy, carbohydrate, protein, fat, ash, dietary fiber, iron and zinc. Pearl millet is a rich source of

energy (361 Kcal/100g), The carbohydrate content of pearl millet is 67.5 g per 100g, with 56 to 65 percent starch comprising 20 to 22 percent amylase and 2.6 to 2.8 per cent free sugars.

Pearl millet is rich in fat content (5mg/100g) with better fat digestibility. It is rich in unsaturated fatty acids (75 %) with higher content of nutritionally important n-3 fatty acids. It is rich source of vitamins and minerals with overall minerals with overall mineral content of 2.3 mg per 100g constituting potassium, phosphorous,

magnesium, iron, zinc, copper and manganese. It is rich in B-vitamins (thiamine, riboflavin and niacin).

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) perform well under harsh environmental conditions with the annual rainfall about less than 250 mm and the temperature required is about 30 °C in loamy soils (Anon., 1996). It covers about 31 million hectares in the world. India is a competent pearl millet producer and it is grown over an area of 7.48 million hectares with a production of 9.21 million tonnes and mean productivity of 1231 kg ha⁻¹ during 2017-18 (Anonymous, 2020). Rajasthan, Haryana, Gujarat, Uttar Pradesh and Maharashtra are the key pearl millet cultivating states accounting beyond 90 % of the India's pearl millet area. In India pearl millet is grown predominantly in *kharif* season. It is also grown during the summer season in certain regions of Uttar Pradesh, Gujarat and Rajasthan; and during the *rabi* season at a little extent in Gujarat and Maharashtra. In Karnataka, pearl millet is one of the major *kharif* crops, grown over an area of 2.42 lakh hectares with an annual production of 2.55 lakh tonnes with a mean productivity of 1054 kg ha⁻¹ (Anonymous, 2020).

Seed polymer is used for coating as a thin, uniform layer over the seeds without any significant increase in seed size or weight. The major benefits of using this seed polymer is that the seed enhancement materials (fungicides, microbiological agents and micronutrients) can be directly placed on to the seed which requires smaller amount of chemicals as compared to broadcasting or surface dressing. Seed coating is one of the most economical approaches for improving seed performance besides it has provoked the interest among many seed traders and seed companies, as it improves its marketability, brand identity and helps the farmers for easy

identification of the crops and varieties based on colour. Modern seed technology provides a wide selection of enhancements that can be aimed at translating a variety's genetic potential into improved harvest and quality (Bharathi. A and Srinivasan. J. 2010).

The micronutrients may be supplied to the plants through soil application, foliar spray or applied to seed through seed treatment. Although the required amount of micronutrients can be supplied by any of these methods, foliar sprays have been more effective in yield improvement and grain enrichment. Application of micronutrients through foliar spray is taken up at later growth stages when crop stands are already established. Hence, an alternative acceptable method of supplying micronutrients during the early stage of seedling establishment is the need of the hour. Micronutrients often act as cofactors in enzyme systems and participate in redox reactions, in addition to having several other vital functions in plants. Most importantly, micronutrients are involved in the key physiological processes of photosynthesis and respiration and their deficiency can impede these vital physiological processes thus limiting yield gain in many crops. Owing to this, the productivity of many crops has reduced substantially over the years. It is estimated that, the extent of micronutrient deficiency in the Indian soils are 47, 35, 15, 13, 4 and 2 per cent for Zinc, Boron, Molybdenum, Iron, Manganese and Copper, respectively. While, in Karnataka it is 78, 39, 32 and 5 per cent for Zinc, Iron, Boron and Copper respectively (Anon., 2011).

Among the micronutrients zinc, ferrous sulphate and boron are very important for pearl millet. Zinc is involved in biosynthesis of plant hormone, indole acetic acid (IAA), auxin metabolism and is component of variety of enzymes which plays an important role in

nucleic acid and protein synthesis and helps in utilization of phosphorus and nitrogen in seed formation and development. The second phase of seed development requires adequate amount of zinc dependent upon auxin for seed development. Ferrous sulphate is an important constituent of chlorophyll biosynthesis, regulates respiration, photosynthesis, reduction of nitrates and sulphates, also activates several enzymes involved in respiration (Kaleeswari *et al.*, 2013). While, boron plays an important role in flower retention, pollen tube growth, seed formation and seed setting and mainly involved in translocation of metabolites from source to sink (Dell and Huang, 1997; Tanaka and Fujiwar, 2008).

Micronutrient application through seed treatment improves the stand establishment, advances phenological events, increases yield and micronutrient contents in grain in most of the crops. In many cases, micronutrient application through seed treatment performed better or similar to other application methods (Singh *et al.*, 2003). Being an easy and cost effective method, micronutrient application through seed treatment by polymer coating offer an attractive option for resource-poor farmers (Johnson *et al.*, 2005).

Keeping in view of the above aspects, the present investigation was taken up in biofortified genotypes of pearl millet on the effect of seed polymerization with micronutrients on seed yield and quality in biofortified genotypes of pearl millet [*pennisetum glaucum* (L.)].

Materials and Methods

The Field cum Laboratory experiment was conducted in the Department of Seed Science and Technology, College of Agriculture, Vijayapur. University of Agricultural Sciences, Dharwad. The experiment consisted

of thirteen biofortified lines and twelve different treatments (including control) with four replications. The treatments were T₀: Control, T₁: ZnSO₄ @ 2g per kg of seed, T₂: ZnSO₄ @ 4g per kg of seed, T₃: FeSO₄ @ 2g per kg of seed, T₄: FeSO₄ @ 4g per kg of seed, T₅: Boron @ 2g per kg of seed, T₆: Boron @ 4g per kg of seed, T₇: ZnSO₄ + FeSO₄ (each @ 2g / kg of seed), T₈: ZnSO₄ + FeSO₄ (each @ 4g / kg of seed), T₉: ZnSO₄ + FeSO₄ + Boron (each @ 2g / kg of seed), T₁₀: ZnSO₄ + FeSO₄ + Boron (each @ 4g / kg of seed), T₁₁: Only polymer. The genotypes were G₁: Fe & Zn 2019-2R, G₂: Fe & Zn 2019-4R, G₃: Fe & Zn 2019-6R, G₄: Fe & Zn 2019-7R, G₅: Fe & Zn 2019-10R, G₆: Fe & Zn 2019-12R, G₇: Fe & Zn 2019-16R, G₈: Fe & Zn 2019-21R, G₉: Fe & Zn 2019-22R, G₁₀: Fe & Zn 2019-26R, G₁₁: DHANASHAKTHI, G₁₂: ICTP 8203, G₁₃:VPMH-7.

The experiment was laid in factorial completely randomized design for seed of different treatment combination treated with polymer along with micronutrients. The standardized dosage of polymer coating of 5 ml per kg of seed was used. The crop was raised by adopting recommended fertilizer dose of 100:65:25 NPK kg/ha was applied as basal dose at the time of sowing, sowing of polymer coated seeds of pearl millet was done as per the treatment details with two seeds per hill by hand dibbling on one side of the ridge at a spacing of 45 × 15 cm. Soon after sowing, the experimental plots were irrigated lightly to ensure uniform germination and optimum plant stand. The observations were recorded on seed yield and quality parameters.

Procedure for polymer coating of seeds

The polymer used in the present study was Disco Agro DC Red L-603 procured from Incotec Pvt. Ltd. Ahmedabad, Gujarat. The cleaned and graded seeds were coated with

different micronutrients as per the treatments either individually or in combination with polymer @ 5 ml per kg of seed using rotary seed coating machine. Subsequently the seeds were air dried to bring back to original moisture content and then used for seed quality testing.

The Seed germination test was conducted as per ISTA (Anon., 2014), shoot length, root length, seedling dry weight as per Evans and Bhatt (1977), seedling vigour index was worked out as per the formula given by Abdul-Baki and Anderson (1973). The data of the laboratory experiment were analyzed statistically by the procedure prescribed by Gomez and Gomez (2010).

Results and Discussion

The seed yield differed significantly due to seed polymerization with a micronutrients. The higher seed yield of 24.65 per cent over control recorded due to seed polymerized with $\text{ZnSO}_4 + \text{FeSO}_4 + \text{boron}$ each @ 2g per kg (Table 1). The maximum seed yield (2520 kg/ha) noticed in seed polymerized with $\text{ZnSO}_4 + \text{FeSO}_4 + \text{boron}$ each @ 2g per kg of seed, followed by $\text{ZnSO}_4 + \text{FeSO}_4 + \text{boron}$ each @ 4g per kg of seed (2393 kg/ha), and seed polymerized with $\text{ZnSO}_4 + \text{FeSO}_4$ each @ 2g per kg of seed (2345 kg/ha). While, the lowest seed yield was seen in control (1898.32 kg/ha).

Increase in yield attributing characters due to seed treatment with micronutrients and these might be due to accumulation of photo assimilates and partitioning in different parts of the plant. The yield is strongly influenced by the application of micronutrients, that indicating the role of these micronutrients in increasing the yield through their effect on various morpho- physiological traits. These results were in conformity with Sharma *et al.*, (2017), Shinde *et al.*, (2018).

Seed quality parameters were influenced significantly due to the seed polymerization with a micronutrients treatments (Table 2 to 6). The higher Seedling Vigour index - I (3452) and Seedling Vigour index - II (7796) observed due to seed polymerized with $\text{ZnSO}_4 + \text{FeSO}_4 + \text{boron}$ each @ 2g per kg of seed.

The increased Seedling Vigour index - I and Seedling Vigour index - II mainly attributed by higher Germination percentage, seedling length and Seedling dry weight were recorded in seed polymerized with $\text{ZnSO}_4 + \text{FeSO}_4 + \text{boron}$ each @ 2g per kg (94.65 %, 36.80 cm and 82.28 g respectively) followed by seed polymerized with $\text{ZnSO}_4 + \text{FeSO}_4 + \text{boron}$ each @ 4g per kg (93.34 %, 34.78 cm and 80.43 g, respectively) and seed polymerized with $\text{ZnSO}_4 + \text{FeSO}_4$ each @ 2g per kg of seed (92.31 %, 35.61 cm and 79.52 g respectively).

While, the lower seed quality parameters was recorded in control (85.56 %, 30.65 cm and 70.88 g respectively). This is having a positive relation to seed development which is reflected through the size and test weight of seed and the micronutrients present in it.

This in turn dependant on efficient synthesis, accumulation of food metabolites such as protein, carbohydrates and their translocation from source to the developing seed at greater ease. Seed with higher initial capital food reserves always showed higher and rapid germination which is also true in present study.

Similarly, the micronutrients also participate in catalytic activity and breakdown of complex food source to simple form (glucose, amino acids and fatty acids). These in turn reflected on enhancing the rate of germination and elongation of root and shoot.

Table.1 Effect of seed polymerization with micronutrients on seed yield (kg/ha) in different biofortified genotypes of pearl millet

G/T	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	T ₁₁	Mean
G ₁	2218	2079	2141	2105	1722	1902	2054	2252	2120	2317	2282	1703	2075
G ₂	1668	1916	1776	1891	1820	1971	1699	2065	2215	2195	2254	1724	1933
G ₃	1756	2075	2156	1893	2045	2017	2120	2349	2162	2369	2279	2021	2103
G ₄	1842	2305	2043	2121	1949	2113	1971	1854	2063	2480	2317	1847	2076
G ₅	1824	1873	1849	1843	1849	1794	1809	2372	2143	2579	1866	2305	2009
G ₆	1778	2097	2178	1916	2067	2039	2142	2372	2184	2391	2301	2043	2126
G ₇	1990	2592	2471	2492	2495	2369	2579	2454	2559	2813	2782	2606	2517
G ₈	1758	2114	2117	1940	1992	1866	1944	2192	1973	2441	2233	2191	2063
G ₉	1701	1703	2070	1823	2005	1743	1828	2279	2153	2395	2252	2043	2000
G ₁₀	2113	2481	2567	2566	2780	2658	2504	2775	2633	2819	2805	2606	2609
G ₁₁	1971	2225	2424	2172	2410	2152	2425	2405	2394	2466	2388	1737	2264
G ₁₂	1990	2435	2408	2417	2465	2497	2420	2356	2423	2637	2536	2278	2405
G ₁₃	2068	2471	2772	2718	2765	2716	2780	2754	2764	2855	2811	2533	2667
Mean	1898	2182	2229	2146	2182	2141	2175	2345	2291	2520	2393	2126	
For comparing the means of	S.Em ±	CD at 5 %											
T	36.71	102.14											
G	38.21	106.32											
T X G	132.35	NS											

Note: NS-Non significant

LEGEND: Treatments (T) T₀ : Control, T₁ : ZnSO₄ @ 2g per kg of seed, T₂ : ZnSO₄ @ 4g per kg of seed, T₃ : FeSO₄ @ 2g per kg of seed, T₄ : FeSO₄ @ 4g per kg of seed, T₅ : Boron @ 2g per kg of seed, T₆ : Boron @ 4g per kg of seed, T₇ : ZnSO₄ + FeSO₄ (each @ 2g / kg of seed), T₈ : ZnSO₄ + FeSO₄ (each @ 4g / kg of seed), T₉ : ZnSO₄ + FeSO₄ + Boron (each @ 2g / kg of seed), T₁₀ : ZnSO₄ + FeSO₄ + Boron (each @ 4g / kg of seed), T₁₁ : Only polymer

Genotypes (G): G₁: Fe & Zn 2019-2R, G₂ : Fe & Zn 2019-4R, G₃ : Fe & Zn 2019-6R, G₄ : Fe & Zn 2019-7R, G₅ : Fe & Zn 2019-10R, G₆ : Fe & Zn 2019-12R, G₇ : Fe & Zn 2019-16R, G₈ : Fe & Zn 2019-21R, G₉ : Fe & Zn 2019-22R, G₁₀: Fe & Zn 2019-26R, G₁₁: DHANASHAKTHI, G₁₂: ICTP 8203, G₁₃: VPMH-7

Table.2 Effect of seed polymerization with micronutrients on germination percentage of resultant seeds of biofortified genotypes of pearl millet

G/T	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	T ₁₁	Mean
G ₁	84.27 (66.63)	84.43 (66.76)	85.43 (67.56)	84.33 (66.68)	84.03 (66.45)	84.43 (66.76)	88.47 (70.15)	93.97 (75.59)	89.43 (71.03)	94.43 (76.35)	91.43 (72.98)	84.93 (67.16)	87.47 (69.52)
G ₂	84.13 (66.52)	84.67 (66.95)	85.33 (67.48)	84.33 (66.68)	89.33 (70.93)	86.67 (68.59)	87.70 (69.47)	85.83 (67.89)	86.33 (68.30)	86.92 (68.80)	90.33 (71.88)	88.83 (70.48)	86.70 (68.66)
G ₃	82.83 (65.52)	85.33 (67.48)	85.33 (67.48)	94.33 (76.22)	85.33 (67.48)	84.33 (66.68)	87.03 (68.89)	92.20 (73.78)	91.33 (72.88)	93.57 (75.31)	93.67 (75.43)	84.83 (67.08)	88.34 (70.35)
G ₄	87.83 (69.58)	85.33 (67.48)	91.33 (72.88)	84.80 (67.05)	89.33 (70.93)	86.67 (68.59)	91.03 (72.57)	93.20 (74.88)	91.33 (72.88)	95.67 (77.99)	90.00 (71.57)	85.83 (67.89)	89.36 (71.19)
G ₅	85.33 (67.48)	93.83 (75.62)	86.83 (68.72)	83.83 (66.29)	87.83 (69.58)	94.83 (76.86)	84.53 (66.84)	88.70 (70.36)	90.83 (72.37)	94.50 (76.44)	92.17 (73.75)	87.33 (69.15)	89.21 (71.12)
G ₆	84.17 (66.56)	85.33 (67.48)	84.67 (66.95)	86.33 (68.30)	83.83 (66.29)	84.33 (66.68)	84.03 (66.45)	93.53 (75.26)	88.33 (70.02)	95.67 (77.99)	90.67 (72.21)	84.83 (67.08)	87.14 (69.27)
G ₇	86.66 (68.58)	84.93 (67.16)	92.83 (74.47)	85.73 (67.81)	95.50 (77.75)	88.23 (69.94)	90.87 (72.41)	94.93 (76.99)	95.33 (77.52)	96.47 (79.17)	95.50 (77.75)	93.33 (75.03)	91.69 (73.71)
G ₈	87.50 (69.30)	84.33 (66.68)	89.33 (70.93)	87.33 (69.15)	86.33 (68.30)	78.33 (62.26)	94.70 (76.69)	95.53 (77.79)	88.33 (70.02)	95.87 (78.27)	95.31 (77.49)	85.63 (67.72)	89.04 (71.22)
G ₉	84.83 (67.08)	95.33 (77.52)	86.33 (68.30)	85.33 (67.48)	91.33 (72.88)	85.67 (67.76)	89.33 (70.93)	86.53 (68.47)	89.33 (70.93)	93.57 (75.31)	94.33 (76.22)	84.83 (67.08)	88.90 (70.83)
G ₁₀	85.93 (67.97)	88.63 (70.29)	95.60 (77.89)	94.63 (76.60)	92.63 (74.25)	95.60 (77.89)	91.33 (72.88)	94.83 (76.86)	92.63 (74.25)	96.63 (79.42)	95.83 (78.22)	86.13 (68.13)	92.53 (74.55)
G ₁₁	86.33 (68.30)	85.83 (67.89)	90.83 (72.37)	88.83 (70.48)	91.83 (73.39)	84.83 (67.08)	93.53 (75.26)	91.03 (72.57)	94.73 (76.73)	94.93 (76.99)	94.83 (76.86)	85.33 (67.48)	90.24 (72.12)
G ₁₂	87.65 (69.43)	91.33 (72.88)	95.13 (77.25)	87.13 (68.98)	85.47 (67.59)	90.13 (71.69)	85.83 (67.89)	94.33 (76.22)	95.13 (77.25)	95.13 (77.25)	93.47 (75.19)	89.63 (71.21)	90.86 (72.74)
G ₁₃	84.83 (67.08)	94.43 (76.35)	94.23 (76.10)	93.62 (75.37)	94.10 (75.94)	95.63 (77.93)	92.13 (73.71)	95.43 (77.66)	95.33 (77.52)	97.13 (80.25)	95.93 (78.36)	86.27 (68.25)	93.26 (75.38)
Mean	85.56 (67.69)	87.98 (70.04)	89.48 (71.41)	87.73 (69.78)	88.99 (70.91)	87.67 (69.90)	89.27 (71.09)	92.31 (741.19)	91.41 (73.21)	94.65 (76.89)	93.34 (75.22)	86.75 (68.75)	
For comparing the means of	S.Em ±	CD at 1 %											
T	0.65	2.40											
G	0.68	2.50											
T X G	2.36	NS											

*Figures in the parenthesis indicate arcsine transformed values, Note: NS-Non significant

Table.3 Effect of seed polymerization with micronutrients on seedling length (cm) of resultant seeds of biofortified genotypes of pearl millet

G/T	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	T ₁₁	Mean
G ₁	29.13	33.57	33.90	27.30	30.54	25.52	33.80	34.42	36.01	37.70	36.20	29.10	32.27
G ₂	28.10	34.83	33.89	28.20	31.54	26.10	25.60	34.90	36.98	34.80	37.09	27.70	31.64
G ₃	28.82	33.87	32.00	35.92	32.49	29.60	36.18	33.84	33.30	36.45	35.70	32.50	33.39
G ₄	32.12	34.76	34.60	28.57	31.19	31.51	31.30	35.70	34.39	35.90	28.10	31.53	32.47
G ₅	28.80	31.17	28.60	33.00	33.87	36.70	32.90	37.10	31.00	36.04	33.20	32.23	32.88
G ₆	27.50	31.75	31.40	31.63	32.27	28.70	31.00	34.30	31.00	37.70	32.60	33.36	31.93
G ₇	28.81	33.76	35.59	35.16	33.58	39.39	36.09	37.09	39.29	34.49	35.32	34.89	35.29
G ₈	32.79	28.78	32.90	33.03	33.99	27.78	27.30	35.50	30.60	38.38	33.20	34.64	32.41
G ₉	28.33	28.00	32.33	34.19	32.02	29.89	27.03	36.23	32.17	36.43	34.13	33.18	31.99
G ₁₀	29.80	35.07	36.95	35.90	33.69	40.00	36.20	37.30	39.30	35.00	36.10	35.75	35.92
G ₁₁	31.40	32.63	34.00	33.60	34.59	28.58	31.70	32.20	34.50	38.20	40.40	35.10	33.91
G ₁₂	37.52	30.47	33.50	30.44	32.73	33.19	32.80	36.31	37.72	38.10	33.10	39.10	34.58
G ₁₃	35.30	36.37	38.09	37.20	37.39	37.70	32.60	38.11	40.34	39.20	37.00	36.40	37.14
Mean	30.65	32.69	33.67	32.63	33.07	31.90	31.89	35.61	35.12	36.80	34.78	33.50	
For comparing mean of	S.Em ±	CD at 1%											
T	0.22	0.61											
G	0.23	0.64											
T X G	0.79	NS											

Note: NS-Non significant

LEGEND: Treatments (T) T₀ : Control, T₁ : ZnSO₄ @ 2g per kg of seed, T₂ : ZnSO₄ @ 4g per kg of seed, T₃ : FeSO₄ @ 2g per kg of seed, T₄ : FeSO₄ @ 4g per kg of seed, T₅ : Boron @ 2g per kg of seed, T₆ : Boron @ 4g per kg of seed, T₇ : ZnSO₄ + FeSO₄ (each @ 2g / kg of seed), T₈ : ZnSO₄ + FeSO₄ (each @ 4g / kg of seed), T₉ : ZnSO₄ + FeSO₄ + Boron (each @ 2g / kg of seed), T₁₀ : ZnSO₄ + FeSO₄ + Boron (each @ 4g / kg of seed), T₁₁ : Only polymer

Genotypes (G): G₁: Fe & Zn 2019-2R, G₂ : Fe & Zn 2019-4R, G₃ : Fe & Zn 2019-6R, G₄ : Fe & Zn 2019-7R, G₅ : Fe & Zn 2019-10R, G₆ : Fe & Zn 2019-12R, G₇ : Fe & Zn 2019-16R, G₈ : Fe & Zn 2019-21R, G₉ : Fe & Zn 2019-22R, G₁₀: Fe & Zn 2019-26R, G₁₁: DHANASHAKTHI, G₁₂: ICTP 8203, G₁₃: VPMH-7

Table.4 Effect of seed polymerization with micronutrients on seedling dry weight (g) of resultant seeds of biofortified genotypes of pearl millet

G/T	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	T ₁₁	Mean
G ₁	67.03	69.93	72.87	69.67	70.27	68.51	70.23	81.03	77.67	84.27	80.45	68.9	73.4
G ₂	72.12	66.3	74.67	69.86	71.04	73.17	71.32	69.62	72.36	69.77	72.36	68.21	70.9
G ₃	69.07	72.81	69.08	70.67	74.56	67.03	70.27	71.27	73.17	83.2	76.95	65.37	71.95
G ₄	66.06	71.64	73.27	67.59	69.87	70.32	69.26	82.18	75.97	82.95	81.95	67.87	73.24
G ₅	67.97	68.56	75.69	72.75	74.17	73.43	71.17	82.77	81.12	83.3	80.07	80.31	75.94
G ₆	65.47	71.88	71.67	72.97	70.62	71.17	71.67	73.66	75.98	82.67	76.15	69.77	72.81
G ₇	81.42	82.62	82.87	77.57	71.36	83.2	80.62	81.36	82.32	84.23	83.4	68.87	79.99
G ₈	68.32	72.97	75.41	71.05	75.97	73.99	73.52	80.38	80.29	82.21	82.01	70.23	75.53
G ₉	67.67	69.57	68.52	68.87	67.97	67.77	69.87	82.28	77.27	80.73	82.95	66.67	72.51
G ₁₀	68.67	77.57	75.52	82.87	83.26	80.77	83.39	83.28	83.27	84.83	83.5	76.67	80.3
G ₁₁	73.67	74.88	72.42	71.47	78.67	68.52	82.87	81.59	82.18	83.21	83.3	77.87	77.55
G ₁₂	78.67	76.57	80.52	72.87	82.36	79.77	79.87	81.26	79.63	82.32	78.63	73.67	78.85
G ₁₃	75.32	75.93	83.4	81.67	82.32	72.51	83.23	83.03	83.21	85.89	83.84	83.09	81.12
Mean	70.88	73.17	75.07	73.07	74.8	73.09	75.18	79.52	78.8	82.28	80.43	72.12	
For comparing the means of	S.Em ±	CD at 1 %											
T	0.75	2.74											
G	0.78	2.85											
T X G	2.69	NS											

Note: NS-Non significant

LEGEND: Treatments (T) T₀ : Control, T₁ : ZnSO₄ @ 2g per kg of seed, T₂ : ZnSO₄ @ 4g per kg of seed, T₃ : FeSO₄ @ 2g per kg of seed, T₄ : FeSO₄ @ 4g per kg of seed, T₅ : Boron @ 2g per kg of seed, T₆ : Boron @ 4g per kg of seed, T₇ : ZnSO₄ + FeSO₄ (each @ 2g / kg of seed), T₈ : ZnSO₄ + FeSO₄ (each @ 4g / kg of seed), T₉ : ZnSO₄ + FeSO₄ + Boron (each @ 2g / kg of seed), T₁₀ : ZnSO₄ + FeSO₄ + Boron (each @ 4g / kg of seed), T₁₁ : Only polymer
Genotypes (G): G₁: Fe & Zn 2019-2R, G₂ : Fe & Zn 2019-4R, G₃ : Fe & Zn 2019-6R, G₄ : Fe & Zn 2019-7R, G₅ : Fe & Zn 2019-10R, G₆ : Fe & Zn 2019-12R, G₇ : Fe & Zn 2019-16R, G₈ : Fe & Zn 2019-21R, G₉ : Fe & Zn 2019-22R, G₁₀: Fe & Zn 2019-26R, G₁₁: DHANASHAKTHI, G₁₂: ICTP 8203, G₁₃: VPMH-7

Table.5 Effect of seed polymerization with micronutrients on seedling vigour index-I of resultant seeds of biofortified genotypes of pearl millet

G/T	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	T ₁₁	Mean
G ₁	2286	2750	2811	2218	2482	2492	2902	3140	3131	3420	3127	2387	2762
G ₂	2070	2339	2892	2378	2759	2262	2245	2995	2942	2619	3152	2328	2582
G ₃	2304	2890	2475	2822	2772	2496	2995	3120	3041	3411	3344	2328	2833
G ₄	2645	2710	2612	2423	2786	2558	3213	2954	2867	3530	3159	2277	2811
G ₅	2458	2925	2483	2431	2975	3196	2781	2936	2907	3500	3244	2465	2858
G ₆	2315	2539	2659	2731	2705	2589	3109	3208	2738	3511	3075	2236	2784
G ₇	2593	2867	3304	3014	3207	3155	3280	3521	3527	3710	3170	3256	3217
G ₈	2607	2427	2939	2885	2934	2176	2585	3391	2703	3338	3164	2537	2807
G ₉	2448	2669	2791	2917	2924	2303	2415	3126	2874	3409	3378	2815	2839
G ₁₀	2561	3108	3532	3482	3121	3442	3306	3490	3447	3823	3610	3079	3333
G ₁₁	2538	2801	3270	2985	3176	2424	2965	2931	3268	3148	3379	2995	2990
G ₁₂	3113	2783	3187	2652	2797	3201	2815	3254	3389	3548	3243	3003	3082
G ₁₃	2995	3184	3472	3473	3509	3538	3331	3526	3518	3908	3653	3140	3437
Mean For comparing the means of	2533 S.Em ±	2769 CD at 1 %	2956	2801	2935	2756	2919	3200	3104	3452	3284	2680	
T	0.75	2.74											
G	0.78	2.85											
T X G	2.69	NS											

Note: NS-Non significant

LEGEND: Treatments (T) T₀ : Control, T₁ : ZnSO₄ @ 2g per kg of seed, T₂ : ZnSO₄ @ 4g per kg of seed, T₃ : FeSO₄ @ 2g per kg of seed, T₄ : FeSO₄ @ 4g per kg of seed, T₅ : Boron @ 2g per kg of seed, T₆ : Boron @ 4g per kg of seed, T₇ : ZnSO₄ + FeSO₄ (each @ 2g / kg of seed), T₈ : ZnSO₄ + FeSO₄ (each @ 4g / kg of seed), T₉ : ZnSO₄ + FeSO₄ + Boron (each @ 2g / kg of seed), T₁₀ : ZnSO₄ + FeSO₄ + Boron (each @ 4g / kg of seed), T₁₁ : Only polymer

Genotypes (G): G₁: Fe & Zn 2019-2R, G₂ : Fe & Zn 2019-4R, G₃ : Fe & Zn 2019-6R, G₄ : Fe & Zn 2019-7R, G₅ : Fe & Zn 2019-10R, G₆ : Fe & Zn 2019-12R, G₇ : Fe & Zn 2019-16R, G₈ : Fe & Zn 2019-21R, G₉ : Fe & Zn 2019-22R, G₁₀: Fe & Zn 2019-26R, G₁₁: DHANASHAKTHI, G₁₂: ICTP 8203, G₁₃: VPMH-7

Table.6 Effect of seed polymerization with micronutrients on seedling vigour index-II of resultant seeds of biofortified genotypes of pearl millet

G/T	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	T ₁₁	Mean
G ₁	5649	5904	6225	5875	5905	5784	6213	7614	6946	7958	7356	5852	6440
G ₂	6067	5614	6372	5891	6346	6342	6255	5975	6247	6064	6536	6059	6147
G ₃	5721	6213	5895	6666	6362	5653	6116	6571	6683	7785	7208	5545	6368
G ₄	5802	6113	6692	5732	6241	6095	6305	7659	6938	7936	7376	5825	6559
G ₅	5800	6433	6572	6099	6514	6963	6016	7342	7368	7872	7380	7013	6781
G ₆	5511	6134	6068	6300	5920	6002	6022	6889	6711	7909	6905	5919	6357
G ₇	7056	7017	7693	6650	6815	7341	7326	7724	7848	8126	7965	6428	7332
G ₈	5978	6154	6736	6205	6558	5796	6962	7679	7092	7881	7816	6014	6739
G ₉	5740	6632	5915	5877	6208	5806	6241	7120	6903	7554	7825	5656	6456
G ₁₀	5901	6875	7220	7842	7712	7722	7616	7897	7713	8197	8002	6604	7442
G ₁₁	6360	6427	6578	6349	7224	5813	7751	7427	7785	7899	7899	6645	7013
G ₁₂	6895	6993	7660	6349	7039	7190	6855	7665	7575	7831	7350	6603	7167
G ₁₃	6389	7170	7859	7646	7746	6934	7668	7924	7932	8343	8043	7168	7569
Mean	6067	6437	6730	6422	6661	6418	6719	7345	7211	7797	7512	6256	
For comparing the means of	S.Em ±	CD at 1 %											
T	64.40	236.04											
G	67.03	245.68											
T X G	232.20	NS											

Note: NS-Non significant

LEGEND: Treatments (T) T₀ : Control, T₁ : ZnSO₄ @ 2g per kg of seed, T₂ : ZnSO₄ @ 4g per kg of seed, T₃ : FeSO₄ @ 2g per kg of seed, T₄ : FeSO₄ @ 4g per kg of seed, T₅ : Boron @ 2g per kg of seed, T₆ : Boron @ 4g per kg of seed, T₇ : ZnSO₄ + FeSO₄ (each @ 2g / kg of seed), T₈ : ZnSO₄ + FeSO₄ (each @ 4g / kg of seed), T₉ : ZnSO₄ + FeSO₄ + Boron (each @ 2g / kg of seed), T₁₀ : ZnSO₄ + FeSO₄ + Boron (each @ 4g / kg of seed), T₁₁ : Only polymer
Genotypes (G): G₁: Fe & Zn 2019-2R, G₂ : Fe & Zn 2019-4R, G₃ : Fe & Zn 2019-6R, G₄ : Fe & Zn 2019-7R, G₅ : Fe & Zn 2019-10R, G₆ : Fe & Zn 2019-12R, G₇ : Fe & Zn 2019-16R, G₈ : Fe & Zn 2019-21R, G₉ : Fe & Zn 2019-22R, G₁₀: Fe & Zn 2019-26R, G₁₁: DHANASHAKTHI, G₁₂: ICTP 8203, G₁₃: VPMH-7

The increased shoot and root length might be due to seeds with higher test weight shall have higher germination potential and seedling growth, this intern might have increased the metabolic activity of indole acetic acid and auxin (Basaria Begam and Krishnasamy, (2003), the increased seedling vigour index might be due to higher root and shoot length and higher germination percentage. Similar results were reported by Harish Babu *et al.*, (2005), Sherin Susan *et al.*, (2005), Vinodkumar *et al.*, (2013), Handiganoor *et al.*, (2018).

The seed yield varied significantly among the different biofortified genotypes of pearl millet, The increased seed yield was recorded in G₁₃[VPMH-7] (2667 kg/ha) fallowed by G₁₀[Fe & Zn 2019-26R] (2609 kg/ha) and G₇[Fe & Zn 2019-16R] (2517 kg/ha) While, the seed yield recorded in G₂[Fe & Zn 2019-4R] (1933 kg/ha).

The seed quality parameters varied significantly among different biofortified genotypes of pearl millet, The increased seedling vigour index-I (3437) and seedling vigour index-II (7568) observed in G₁₃[VPMH-7]. The increased seedling vigour index-I and seedling vigour index-II mainly attributed higher seed germination percentage, seedling legth and Seedling dry weight were recorded in G₁₃[VPMH-7] (93.26, 37.14 cm and 81.12 g respectively) fallowed by G₁₀[Fe & Zn 2019-26R] (92.53, 35.92 cm and 80.30 g respectively) and G₇[Fe & Zn 2019-16R] (91.69, 35.29 cm and 79.99 g respectively) While, the lower germination percentage, shoot length, root length and seedling dry weight recorded in G₂[Fe & Zn 2019-4R] (86.70, 31.64 cm and 70.99 g respectively).

The seed yield per hectare was not significantly influenced by the seed polymerization with micronutrients in bio fortified genotypes of pearl millet. The higher

seed yield per hactare of 27.54 percent over control. The maximum seed yield (2855 kg/ha) was recorded in G₁₃ [VPMH-7] and seed polymerization with ZnSO₄ + FeSO₄ + boron @ 2 g per kg of seed followed by G₁₀ [Fe & Zn 2019-26R] seed polymerization with ZnSO₄ + FeSO₄ + boron @ 2 g per kg of seed (2819kg/ha) and the seeds of G₇ [Fe & Zn 2019-16R] seed polymerization with ZnSO₄ + FeSO₄ + boron @ 2 g per kg of seed (2813 kg/ha) While, the minimum seed yield was noticed in G₂ [Fe & Zn 2019-4R] control without seed polymerization (1668 kg/ha) The increase in seed yield as a result of seed polymerization with micronutrients might be attributed to the role played by micronutrients in activating dehydrogenase and other enzymes. These micronutrients are also necessary for the biosynthesis of IAA, the growth regulator, which is essential for normal enlargement of cells. It is also a constituent of amino acids, from which protein and enzymes are synthesized. Similar results obtained by Shakuntala *et al.*, (2012) in sunflower, Shinde *et al.*, (2018) in pigeon pea and Handiganoor *et al.*, (2018) in pigeon pea.

Seed quality parameters did not differed significantly due to interaction of seed polymerization with a micronutrients with different bio-fortified genotypes of pearl millet. The increased seedling vigour index-I (3907) and seedling vigour index-II (8342) was observed in G₁₃ [VPMH-7] and seed polymerized with ZnSO₄ + FeSO₄ + boron each @ 2g per kg of seed. However numerically higher seedling vigour index-I and seedling vigour index-II was mainly attributed to higher germination percentage, seedling length and seedling dry weight were recorded in G₁₃ [VPMH-7] seed polymerized with ZnSO₄ + FeSO₄ + boron each @ 2g per kg of seeds (97.13 %, 39.20 cm and 85.99 g respectively) followed by G₁₀ [Fe & Zn 2019-26R] seed polymerized with ZnSO₄ + FeSO₄

+ boron each @ 2g per kg of seeds, (96.63 %, 38.20 cm and 84.83 g respectively), G7 [Fe & Zn 2019-16R] seed polymerized with ZnSO₄ + FeSO₄ + boron each @ 2g per kg of seeds (96.47%, 38.38 cm and 84.23 g respectively),. While, the lower seed quality parameters was seen in G₂ [Fe & Zn 2019-4R] control with no seed polymerization (84.13%, 28.10 cm and 72.12 g respectively). This is having positive relation to seed development which is reflected through the size and test weight of seed and the micronutrients present in it. This is in turn dependent on efficient synthesis, accumulation of food metabolites such as protein, carbohydrates and their translocation from source to the developing seed at greater ease, The increased shoot and root length might be due to seeds with higher test weight shall have higher germination potential and seedling growth, this intern might have increased the metabolic activity of indole acetic acid and auxin (Basaria Begam and Krishnasamy, 2003) through micronutrients and its translocation leading to early germination, cell division and elongation leading to increase in root and shoot length. Similar results were reported by Srimathi *et al.*, (2007), Shinde *et al.*, (2017).

The increase in seedling dry weight was due to better seedling length and also greater vigour reflected in early stage and higher percentage of germination of seeds that had reached autotrophic stage well in advance than others. Increase in dry weight might further be enhanced due to enhanced lipid utilisation through glyoxalate cycle, a primitive metabolic pathway thereby, facilitating the conversion of acetate into nucleic acid (Sherin Susan *et al.*, 2005), Handiganoor *et al.*, (2018), so As a result of improved germination percentage, seedling length and seedling dry weight due to imposed treatments the seedling vigour index I and II differed significantly.

It could be concluded that seed polymerization (5ml/kg of seed) of pearl millet seeds coupled with micronutrients viz., ZnSO₄ + FeSO₄ + Boron each at 2 g per kg of seed found to be better treatment to record higher seed yield and quality parameters in pearl millet.

References

- Abdul-Baki, A. A. and Anderson, J. D., 1973, Vigour determination in soybean seeds by multiple criteria. *Crop Sci.*, 13: 630-633.
- Anonymous. Guidelines for use of micronutrients, soil ameliorants and integrated nutrient management practices in National Food Security Mission States, 2011, 1-27.
- Anonymous. www.icmr.nic.in, 2014.
- Anonymous, 2020, Area production productivity of millets, Ministry of Agriculture and Farmers welfare, Directorate of Economics and Statistics, Govt. of India. (ON1151).
- Basaria Begum, J. and Krishnasamy, V., 2003, Effect of seed hardening and pelleting on seed germination and vigour in black gram. *Seed Res.*, 3(2): 194-199.
- Bharathi A, Srinivasan J. Seed quality enhancement- Principles and practices. Published by scientific publishers (India), 2010, 234-235.
- Dell B, Huang L. Physiological responses of plants to boron. *Plant Soil.* 1997; 193:103-120.
- Evans LE, Bhatt GW. A non-destructive technique for measuring seedling vigour in wheat. *Canadian J Plant Sci.* 1977; 57:983-985.
- Gomez KA, Gomez AA. Statistical procedures for agricultural research, 2nd edition, A Willey International Science Publication, New York (USA), 2010, 20-29.

- Handiganoor, M. G., Patil, S. B. and Vasudevan, S. N., 2018. effect of Seed coating polymer and micronutrients on stomatal conductance and resistance at different growth stages of pigeonpea. *Advances in Research*, 1-8.
- Harish Babu, B. N., Kempegowda, M. L., Kalappa, V. P. and Rudra Naik, V., 2005, Comparative evaluation of different pelleting materials on seed performance of French bean and green gram. *Karnataka J. Agric. Sci.*, 18(1): 32-35.
- Hirschi, K. D. (2009). Nutrient biofortification of food crops. *Ann. Rev. Nutr.* 29, 401–421. doi: 10.1146/annurev-nutr-080508-141143
- Johnson SE, Lauren JG, Welch RM, Duxbury JM. A comparison of the effects of micronutrient seed priming and soil fertilization on the mineral nutrition of chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), rice (*Oryza sativa*) and wheat (*Triticum aestivum*) in Nepal. *Exper. Agric.* 2005; 41:427-448.
- Kaleeswari RK, Rajeswari R. Prabhakaran. J. A handbook of soil fertility. Satish serial publishing house, 2013
- Shakuntala, N. M., Vasudevan, S. N., Shankergoud, I. and Rakesh Mathad, 2012, Polymer film coating for precision seeding in sunflower. *Agro-Informatics and Precision Agric.*, pp.339-340
- Sharma, J., Dhiman, K. C., Sharma, J. K. and Kumar, R., 2017. Effect of Seed Coating on Seed Yield and Related Parameters in Quality Protein Maize Hybrid Hqpm 1 (*Zea mays* L.). *Himachal J. Agric. Res.*, 43(1):68-72.
- Singh B, Natesan SKA, Singh BK, Usha K. Improving zinc efficiency of cereals under zinc deficiency. *Curr. Sci.* 2003; 88:36-14.
- Sherin Susan John, Bharati, Natesan, P. and Raja, K., 2005, Seed film coating technology for maximizing the growth and productivity of maize. *Karnataka. J. Agric. Sci.*, 18(2): 349-356.
- Shinde, P., Doddagoudar, S. R. and Vasudevan, S. N., 2017. Influence of seed polymer coating with micronutrients and foliar spray on seed yield of chickpea (*Cicer arietinum* L.). *Legume Research-An Inter. J.*, 40(4), pp.704-709.
- Srimathi, P., Kavitha, S. and Renugadevi, J., 2007, Influence of seed hardening and pelleting on seed yield and quality in green gram (*Vigna radiate*) cv. Co-6. *Indian. J. Agric. Res.*, 41(2): 122-126.
- Vinodkumar, B. S., Vyakarnahal, Dhananjaya. P., Yegappa Hipparagi and Asha, A. M., 2013, Effect of seed polymer coating on field performance and quality of pigeonpea (*Cajanus cajan* (L.) Millsp.). *Env. and Ecology.*, 31 (1) : 43 - 4 6.

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