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Seed Yield Enhancement Techniques in Fodder Maize (*Zea mays* L.)

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ABSTRACT: A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, during *kharif* 2014, to evaluate seed yield enhancement techniques in fodder maize (cv. African Tall). The experiment was laid out in simple RCBD with 10 treatments replicated thrice. The results of the investigation revealed that highest field emergence, minimum days to 50 per cent tasseling, 50 per cent silking and days to maturity was recorded in seeds primed with KH_2PO_4 (2%) + polymer coating @ 3 ml per kg of seed (95.38%, 64.33, 70.33 and 117.00, respectively). Among different seed yield enhancement techniques, seed treatment with zinc sulphate ($ZnSO_4$) @ 2 g per kg of seed + polymer coating @ 3 ml per kg of seed + soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha recorded significantly highest plant height at harvest (297.80 cm), dry matter production at harvest (244.27 g) and maximum yield parameters *viz.*, maximum cob length (19.15 cm), cob girth (16.10 cm), number of seeds per row (36.22), number of seeds per cob (482.00), cob weight (171.37 g), seed yield per ha (34.54 q) and test weight (33.04 g).

Key words: Enhancement techniques, Fodder maize, KH_2PO_4, Polymer coating, $ZnSO_4$

INTRODUCTION

In the world agricultural economy, maize (*Zea mays* L.) is one of the important crops as it has higher yield potential than any other cereals and many a times it is referred as "miracle crop" or the "queen" of cereals. Maize is grown both as food for man and feed for animal. Major growing states are Karnataka, Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar, Andhra Pradesh, Gujarat and Maharashtra. The livestock industry depends mainly on the quality forage availability in any country since feeds alone accounts for more than half of the total cost of animal production. The quality green forage productivity is the only way to reduce this cost and increase the returns. This could be achieved through adoption of improved fodder production technologies, especially use of improved varieties and supply of good quality seeds for fodder cultivation.

Seed is the most important input in the fodder crop production programme. Since most of the fodder crops are harvested for green fodder at flowering stage or before seed maturity, their seed production still assumes greater importance. Seed rate in forage crops is high but the seed multiplication ratio is low compared to grain crops and as the forage crops are basically bred for higher biomass production, there exists a large gap between seed production and the requirement. Seed production of maize crop is influenced largely by several agronomic and management factors, like micronutrient application, seed priming and spraying of growth regulators. In maize seed production, micro nutrients are known to be potential inputs to enhance seed crop productivity.

The successful establishment of crop mainly depends upon good quality seed. To provide higher quality seeds, scientists have developed new technologies called "Seed Enhancement Techniques". The main objective of these techniques is to optimize the application of seed treatment products by improving the quality of seeds.

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Among the micronutrients, boron (B) and zinc (Zn) play a key role in pollination and seed set process; so that their deficiency can cause decrease in seed formation and subsequent yield reduction. [1] expressed that B is involved in carbohydrate metabolism and it is essentially necessary for protein synthesis, pollen germination and seed and cell wall formation. Similarly Zn supply is considered as an important factor in reproduction process. According to [2] formation of male and female reproductive organs and pollination process are disturbed in Zn deficiency which may be attributed to the reduction of Indol acetic acid (IAA) synthesis.

It is reported that seed priming is one of the most important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions [3, 4 & 5].

There is an important relationship between source and sink in plant physiology. The fact that source or sink can limit the yield is a challenging subject to plant physiologists. One of the effective factors that can control the size of sink and source are plant growth regulators. So, by using plant growth regulators we can increase seed yield and quality. Hence studies were taken with an objective of "Seed yield enhancement techniques in fodder maize (*Zea mays* L.)." at Main Agriculture Research Station, Dharwad.

MATERIALS AND METHODS

A field experiment was carried out at the Main Agricultural Research Station during *kharif* 2014 to evaluate the different seed yield enhancement techniques in fodder maize (cv. African Tall). The experiment was laid out in randomized complete block design with ten treatments *viz.*, (T_1) Control, (T_2) Seed treatment with zinc sulphate ($ZnSO_4$) @ 2 g per kg of seed + polymer coating @ 3 ml per kg of seed + soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha, (T_3) Seed treatment with granoboro @ 1 g per kg of seed + polymer coating @ 3 ml of seed per kg + soil application of granoboro @ 10 kg per ha, (T_4) Soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha + foliar application of 2% zinc sulphate ($ZnSO_4$) @ flowering stage, (T_5) Soil application of granoboro @ 10 kg per ha + foliar application of 1% borax @ flowering stage, (T_6) T_4+T_5, (T_7) Seed priming with $CaCl_2$ @ 2% + polymer coating @ 3 ml of seed per kg , (T_8) Seed priming with KH_2PO_4 @ 1% + polymer coating @ 3 ml of seed per kg, (T_9) Foliar spray of 10 ppm brassinosteriod @ flowering stage and (T_{10}) Foliar spray of 100 ppm tryptophan @ flowering stage and replicated thrice. The seeds of fodder maize (Cv. African Tall) collected from the ARS, Arabhavi. The seeds were subjected to different seed enhancement techniques and sown in the field for the further evaluation. Dharwad is located in 15º 26′ North latitude, 75º 27′ East longitude with an altitude of 678 m above mean sea level. Observations on field emergence (%), growth parameters like plant height at harvest (cm), dry matter production at harvest (g), flowering parameters like days to 50 per cent flowering, days to maturity and yield parameters like cob length (cm), cob girth (cm), number of seeds per row, number of seeds per cob, cob weight (g), seed yield (q/ha) and test weight (g). The five tagged plants from the net plot were used to record the above observations. The data recorded were subjected to the statistical analysis as per [6].

RESULTS AND DISCUSSION

The field emergence percentage was significantly influenced by the seed yield enhancement techniques. Significantly highest field emergence was recorded in the seeds primed with KH_2PO_4 (1%) + polymer coating @ 3 ml per kg of seed (T_8) (95.38%) emerged faster which was on par with the seeds primed with $CaCl_2$ (2%) + polymer coating @ 3 ml per kg of seed (T_7) (94.23%) (Table 1). The faster emergence might be due to the pre-sowing soaking of seed, which might have resulted in modification of the physiological and biochemical nature of seed so as to trigger the characters that are favourable for drought resistance and also it helps in imbibing enough quantity of water resulting in quick initiation of germination process [7].

Significantly highest plant height at harvest (297.80 cm) and dry matter production at harvest (244.27 g) noticed in seed treatment with zinc sulphate ($ZnSO_4$) @ 2 g per kg of seed + polymer coating @ 3 ml per kg of seed + soil application

of zinc sulphate ($ZnSO_4$) @ 10 kg per ha (T_2) (Table 2). Increase in plant height due to polymer coating and micronutrient mixture might be attributed to the effect of nutrients present in the coating materials, which could improve the growth resulting in higher plant height or due to enhanced seedling establishment and possibly due to activation of metabolic activity of seed . The activation of metabolic activity of seed could also be due to hydrophilic polymer coating present in the coating material, which might improve the rate of water uptake by the seed leading to early germination and better seedling establishment, which might also help in better plant height. Increase in plant height due to application of zinc sulphate as a seed treatment coupled with polymer coating might have helped in increase in plant height prolonging the effect of zinc sulphate by slow release and improved plant height results in higher dry matter production at harvest. Similar results are observed by [8] in maize and [7] in fodder sorghum.

The days required to attain 50 per cent flowering and days to maturity was reduced with different seed yield enhancement techniques. Seeds primed with KH_2PO_4 (1%) + polymer coating @ 3 ml per kg of seed (T_8) induced tasseling early by 3.30 days and the same treatments induced the early silking by 3 days over untreated control (Table 1). The advantages of increased rate of emergence could be correlated with early flowering and early harvest, observed in the present study. Similar observations in advancement of flowering also reported by [9] seeds primed with KH_2PO_4 @ 0.5 per cent in case of bhindi, cluster bean, chilli and tomato.

The plots having treatment seed treatment with zinc sulphate ($ZnSO_4$) @ 2 g per kg of seed + polymer coating @ 3 ml per kg of seed + soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha (T_2) showed significantly highest cob length, cob girth, , number of seeds per row, cob weight, number of seeds per cob, seed yield per hectare and test weight (19.15 cm, 16.10 cm, 36.22, 171.37 g, 482, 34.54 q/ha and 33.04 g , respectively) (Table 2). The increase in yield might be due to more number of seeds per cob and higher seed weight. The yield increase could be attributed to the presence of nutrients and polymer coating in

Table 1. Effect of different seed yield enhancement techniques on field emergence (%) and flowering parameters in fodder maize cv. African Tall

Treatments	Field emergence (%)	50% Tasseling	50% silking	Days to maturity
T_1	83.80(66.24)*	67.67	75.00	120.67
T_2	93.38(75.06)	65.00	72.00	118.33
T_3	91.47(72.99)	66.00	73.00	118.67
T_4	89.90(71.44)	65.33	72.33	119.33
T_5	89.47(71.03)	65.67	72.33	119.67
T_6	90.23(71.75)	65.00	72.00	118.67
T_7	94.23(76.07)	64.67	70.67	117.67
T_8	95.38(77.56)	64.33	70.33	117.00
T_9	85.07(67.24)	66.33	73.00	118.67
T_{10}	83.94(66.35)	67.33	73.33	119.67
Mean	89.64	65.77	72.43	118.83
SEm±	0.51	0.29	0.29	0.53
CD (0.05)	1.52	0.87	0.86	1.57

* Figures in the parenthesis indicate arcsine values. Treatments : T_1 - Control (RDF); T_2 - Seed treatment with zinc sulphate ($ZnSO_4$) @ 2 g per kg of seed + polymer coating @ 3 ml per kg of seed + soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha; T_3 – Seed treatment with granoboro @ 1 g per kg of seed + polymer coating @ 3 ml per kg of seed+ soil application of granoboro @ 10 kg per ha; T_4 – Soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha + foliar application of 2% zinc sulphate ($ZnSO_4$) @ flowering stage; T_5 – Soil application of granoboro @ 10 kg per ha + foliar application of 1% borax @ flowering stage; T_6 – T_4+T_5; T_7 – Seed priming with $CaCl_2$ @ 2% + polymer coating @ 3 ml per kg of seed; T_8 – Seed priming with KH_2PO_4 @ 1% + polymer coating @ 3 ml per kg of seed; T_9 – Foliar spray of 10 ppm brassinosteriod @ flowering stage; T_{10} – Foliar spray of 100 ppm tryptophan @ flowering stage

the coating treatment. Nutrients are the constituent of several dehydrogenase enzymes, an activator of other enzymes. Nutrients 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

Table 2. Effect of different seed yield enhancement techniques on growth parameters and yield parameters in fodder maize cv. African Tall

Treatments	Plant height at harvest (cm)	Dry matter production (g/plant)	Cob length (cm)	Cob girth (cm)	No. of seeds/ row	No. of seeds/ cob	Cob weight (g)	Seed yield (q/ha)	Test weight (g)
T_1	277.17	215.90	16.70	13.86	31.87	438.57	152.07	28.61	30.48
T_2	297.80	244.27	19.15	16.10	36.22	482.00	171.37	34.54	33.04
T_3	291.53	234.83	17.89	15.04	34.33	468.08	163.60	31.14	31.44
T_4	287.70	236.67	18.35	14.69	35.13	472.53	168.23	31.35	32.15
T_5	289.23	235.60	17.84	14.73	34.23	470.93	162.37	30.81	31.43
T_6	293.13	238.40	18.95	15.16	35.30	474.20	170.94	33.55	32.51
T_7	290.57	240.97	17.97	14.71	32.80	459.23	162.85	31.03	31.85
T_8	295.33	241.27	18.01	14.53	33.54	465.09	161.15	30.70	32.01
T_9	286.73	234.00	17.93	14.33	34.10	468.57	159.30	30.15	31.40
T_{10}	282.03	236.00	17.56	14.46	34.07	465.57	161.38	30.37	32.01
Mean	289.12	236.49	18.04	14.76	34.41	466.48	163.33	31.19	31.83
SEm±	1.83	1.41	0.37	0.19	0.49	3.45	1.23	0.59	0.276
CD (0.05)	5.44	4.32	1.10	0.57	1.46	10.24	3.66	1.74	1.073

Treatments : T_1 - Control (RDF); T_2 - Seed treatment with zinc sulphate ($ZnSO_4$) @ 2 g per kg of seed + polymer coating @ 3 ml per kg of seed + soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha; T_3 – Seed treatment with granoboro @ 1 g per kg of seed + polymer coating @ 3 ml per kg of seed+ soil application of granoboro @ 10 kg per ha; T_4 – Soil application of zinc sulphate ($ZnSO_4$) @ 10 kg per ha + foliar application of 2% zinc sulphate ($ZnSO_4$) @ flowering stage; T_5 – Soil application of granoboro @ 10 kg per ha + foliar application of 1% borax @ flowering stage; T_6 – T_4+T_5; T_7 – Seed priming with $CaCl_2$ @ 2% + polymer coating @ 3 ml per kg of seed; T_8 – Seed priming with KH_2PO_4 @ 1% + polymer coating @ 3 ml per kg of seed; T_9 – Foliar spray of 10 ppm brassinosteriod @ flowering stage; T_{10} – Foliar spray of 100 ppm tryptophan @ flowering stage

are synthesized. Polymer coating present in the coating material have also helped in higher rate of water uptake and resulted in the early germination with more seedling vigour and better stand establishment, which might ultimately lead to better growth and productivity of fodder maize. This is confirmation with the findings of [10] in maize.

Thus, Seed treatment with zinc sulphate (2 g per kg of seed) along with polymer coating (3 ml per kg of seed) and soil application of zinc sulphate (10 kg per ha) helps to enhance the crop growth and seed yield in fodder maize (cv. African Tall).

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