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Effect of seed dressing on growth, quality and yield of *kharif* sorghum (*Sorghum bicolor* L. Monech)

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Abstract
A field experiment was conducted to know the effect of seed dressing treatments on nutrient dynamics and uptake of *kharif* sorghum (Sorghum bicolor L. Monech) at, Research farm Dept. of Soil Science & Agricultural Chemistry, VNMKV Agricultural University, Parbhani, Maharashtra during 2017. The experiment consists of nine treatments with three replications in randomized block design. The results revealed that seed dressing with RDF + Zn EDTA @ 3 g per kg of seed recorded significantly higher fresh weight (448.73 gm, 954.50 gm, 676.60 gm), plant height (70.70 cm, 144.26 cm, 144.26 cm), leaf area (538.12, 777.71, 773.90 sq. cm /plant), dry root density (2.68, 2.12, 1.96 g/cm^3), dry matter (65.15 gm, 176.41 gm, 163.02 gm) at grand growth flowering and at harvest stage. Also seed dressing with RDF + Zn EDTA @ 3 g per kg of seed recorded significantly higher seed yield (20.22 q ha^{-1}), fodder yield (53.03 q ha^{-1}) and biological yield (73.25 q ha^{-1}). In grain quality the results revealed that, the significantly higher test weight (3.91 gm 100 seeds^{-1}) recorded seed dressing with Zn EDTA @ 3 g per kg of seed.

Keywords: sorghum, micronutrient, seed dressing, seed priming, seed treatment

Introduction

Sorghum (*Sorghum bicolor* (L) Moench) belongs to family Graminae and the word sorghum is derived from latin word ‘Sargo’ means ‘rising above’ i.e., growing taller than the other crops in field. Sorghum grain contains 10 to 12 per cent protein, 3 per cent fat, and 70 per cent carbohydrates. The major sorghum producing countries of the world are India, USA, South Africa, China, Nigeria, Sudan and Argentina. In India, the average area of *kharif* sorghum is 2268.8 ha. The average production of *kharif* sorghum is 1816 tonne and average productivity of *kharif* sorghum is 850 kg ha^{-1} (Agristat, Indiastat.com 2014-2015) [15]. At present, Maharashtra is largest producer of sorghum, and the state has total area of 680.0 (000) ha in *kharif.* The average productivity of sorghum in *kharif* is 1014 kg ha^{-1} and the average production of sorghum in *kharif* is 585.0 (000) ton (Agristat, Indiastat. com 2014-2015) [16]. In the last two decades, the nature and composition of utilization of sorghum grain has undergone a change from staple food to industrial uses such as livestock and poultry feed, potable alcohol, starch and ethanol production (Rao *et al*., 2010) [23]. Seed may be treated with micronutrients either by soaking in nutrient solution for a specific duration (seed priming) or by coating with micronutrients. In seed priming, seeds are partially hydrated to allow metabolic events changes to occur without actual germination and re-dries (near to their original weight) to permits to routine handling (Bradford 1986) [5], such seed germinate faster than priming (nutrients priming), if micronutrients are used as osmotica (Imran *et al*., 2004; singh 2007) [14, 26]. Primed seeds usually have better and more synchronized germination (Farooq *et al*., 2009) [10] owing simply to less imbibition time (Brock-lehurst and Dearman, 2008; McDonald, 2000; Taylor *et al*., 1998) [6, 19] and build-up of germination-enhancing metabolites (Basra *et al*., 2005; Farooq *et al*., 2006) [9, 4]. In seed coating, materials that influence the seed or soil at the seed soil interface are applied to the seed coat. Seed coating generally refers to the application of finely-ground solids or liquids containing dissolved or suspended solids to form, a more or less continuous layer covering the natural seed coat ; it includes pelleting and many other seed treatments (Scott,1989), seed pelleting involves the addition of inert material to modify seed shape and size for precision planting.

While in seed coating, useful materials like micro-organisms, plant growth regulators, nutrients and other chemicals adheres around the seed by the use of some sticky material. However, both of these terms are being used interchangeably.

Material and Methods

A field experiment was conducted during *kharif* 2016-2017 at Sorghum research Station, College of Agriculture, VNMKV, Parbhani to investigate the effect of seed dressing treatments on growth, quality and seed yield of *kharif* sorghum (*Sorghum bicolor* L. Monech) PVK-801. The experiment was laid out in RBD with three replication the experiment consisted of 9 treatments *viz.*, seed dressing with T_1- RDF only (control), T_2- RDF + 3 g $ZnSO_4$ kg^{-1}, T_3- RDF + 3 g Zn EDTA kg^{-1}, T_4- RDF + 3 g $Na_2B_4O_7.10H_2O$ kg^{-1}, T_5- RDF + 3 g $MnSO_4$ kg^{-1}, T_6- RDF + 4 g Na_2MoO_4 kg^{-1}, T_7- RDF + 3 g $CuNO_3$ kg^{-1}, T_8- RDF + 3 g $FeSO_4$ kg^{-1}, T_9- RDF + 3 g Fe EDTA kg^{-1}. The observation recorded on plant height, fresh weight, leaf area, dry root density, dry matter at grand growth (45 DAS), flowering (70 DAS) and at harvest stage (135 DAS). The yield attributing parameters viz., seed yield, fodder yield, total biomass were recorded at harvest stage. The data collected from the above observation were analysed statistically by the procedure prescribed by Panse and Sukhatme (1967).

Result and Discussion

Table 1: Fresh weight (gm) of *kharif* sorghum as influenced by different nutrient seed dressing treatments of micronutrients

Treatment No	Treatments	Grand growth (45 DAS)	Flowering (70 DAS)	At harvest (135 DAS)
T_1	RDF only (control)	285.40	685.40	474.73
T_2	RDF + 3g $ZnSO_4$ kg^{-1}	397.42	857.50	582.80
T_3	RDF + 3g Zn EDTA kg^{-1}	448.73	954.50	676.60
T_4	RDF + 3g $Na_2B_4O_7.10H_2O$ kg^{-1}	376.63	756.81	603.73
T_5	RDF + 3g $MnSO_4$ kg^{-1}	287.33	799.13	523.40
T_6	RDF + 4g Na_2MoO_4 kg^{-1}	324.90	942.00	534.20
T_7	RDF + 3g $CuNO_3$ kg^{-1}	310.93	833.83	545.26
T_8	RDF + 3g $FeSO_4$ kg^{-1}	353.23	896.43	595.40
T_9	RDF + 3g Fe EDTA kg^{-1}	399.00	909.60	642.46
SE ±		53.82	58.40	71.15
CD at 5%		N.S	N.S	N.S
Grand mean		353.73	848.35	575.40

Fresh weight

Effect of various nutrient seed dressing treatments with micronutrients proved to be beneficial for improving the fresh weight of *kharif* sorghum (Table 1.). Among the different nutrient seed dressing treatments, the application of 3 g Zn EDTA salt per kg of sorghum seed found to be significantly superior over control (only RDF) at grand growth (45 DAS), flowering (70 DAS) and at harvest stage (135 DAS) of the crop and it was found to be at par with treatment T_9 at grand growth (45 DAS), flowering (70 DAS) and at harvesting stage (135 DAS). The second best seed treatment produced maximum fresh weight of sorghum receiving 3 g Fe EDTA chelate per kg of sorghum seed (T_9).

From the above data, it is clearly observed that, the treatment treating seed with Zn EDTA and Fe EDTA was found to be better over application of only RDF. This improvement in yield attributes to the immediate and early availability of soil deficient nutrient to the crop. Further it was noted that, the nutrient like Zn has synergetic effect on availability of nitrogen. Basra *et al.* (2003) [3] reported that, the improvement was noticed in biometric parameters due to nutrient seed dressing in various crops.

Table 2: Plant height (cm) of *kharif* sorghum as influenced by different nutrient seed dressing treatments

Treatment No	Treatments	Grand growth (45DAS) (cm)	Flowering (70DAS) (cm)	At harvest (135DAS) (cm)
T_1	RDF only (control)	58.80	129.90	129.90
T_2	RDF + 3g $ZnSO_4$ kg^{-1}	64.93	140.83	140.43
T_3	RDF + 3g Zn EDTA kg^{-1}	70.70	144.26	144.26
T_4	RDF + 3g $Na_2B_4O_7.10H_2O$ kg^{-1}	64.80	134.63	134.63
T_5	RDF + 3g $MnSO_4$ kg^{-1}	67.06	130.06	130.06
T_6	RDF + 4g Na_2MoO_4 kg^{-1}	67.80	130.43	130.43
T_7	RDF + 3g $CuNO_3$ kg^{-1}	60.60	134.20	134.63
T_8	RDF + 3g $FeSO_4$ kg^{-1}	60.10	138.26	138.26
T_9	RDF + 3g Fe EDTA kg^{-1}	68.73	141.16	141.16
SE ±		3.57	5.00	4.98
CD at 5%		N.S	N.S	N.S
Grand mean		64.83	135.97	135.97

Periodic plant height

The plant height of *kharif* sorghum is presented in Table 2. It was observed that the plant height of sorghum at grand growth (45 DAS), flowering (70 DAS) and at harvesting stage (135 DAS) varied from 58.80 to 70.70 cm, 129.90 to 144.26 cm and 129.90 to 144.26 cm respectively. Effect of various nutrient seed dressing treatments with micronutrient observed to be beneficial in improving plant height of sorghum. Among the different nutrient seed dressing treatments, the application of 3 g Zn EDTA (T_3) salt per kg of sorghum seed found to be significantly superior over control (only RDF) at grand growth (45 DAS), flowering (70 DAS) and at harvest stage (135 DAS). The treatment T_9 found to be best treatment which recorded maximum plant height of sorghum due to application of 3 g Fe EDTA and it was found to be at par with the treatment T_6 i.e. 4 g Na_2MoO_4. This revealed from the data, the treating seed with Zn EDTA and Fe EDTA was found to be better over application of only RDF.

Increase in plant height might be due to cell elongation, cell enlargement and more chlorophyll synthesis resulting in better plant growth due to nutrient seed dressing treatment.

Table 3: Leaf area (sq. cm/ plant) of *kharif* sorghum as influenced by different nutrient seed dressing treatments

Treatment No	Treatments	Grand growth (45 DAS)	Flowerin (70 DAS)	At harvest (135 DAS)
T_1	RDF only (control)	444.45	672.26	668.44
T_2	RDF + 3g $ZnSO_4$ kg^{-1}	519.30	757.57	749.48
T_3	RDF + 3g Zn EDTA kg^{-1}	538.12	777.71	773.90
T_4	RDF + 3g $Na_2B_4O_7.10H_2O$ kg^{-1}	491.24	719.70	716.88
T_5	RDF + 3g $MnSO_4$ kg^{-1}	506.75	731.46	723.38
T_6	RDF + 4g Na_2MoO_4 kg^{-1}	492.40	741.14	741.12
T_7	RDF + 3g $CuNO_3$ kg^{-1}	499.23	745.74	732.45
T_8	RDF + 3g $FeSO_4$ kg^{-1}	521.25	749.48	743.58
T_9	RDF + 3g Fe EDTA kg^{-1}	535.44	767.08	760.33
SE ±		41.60	51.33	51.62
CD at 5%		N.S	N.S	N.S
Grand mean		505.46	740.24	734.39

Leaf area

The leaf area of *kharif* sorghum is presented in Table 3. It was noted that, the leaf area up to flowering stage found to be increased from 444.45 to 777.71 sq. cm and it was thereafter decreased. This might be due to census of crop.

The various treatments of nutrient seed are influenced due to various micronutrients seed dressing. In general, the seed dressing of 3 g Zn EDTA per kg of sorghum seed with RDF recorded maximum leaf area at grand growth (45 DAS) and flowering stage (70 DAS) after sowing followed by application of 3 g Fe EDTA per kg of sorghum seed. The said treatments could not showed statistically significant over other treatments at both the growth stages. The similar results were also noticed at harvest stage of the crop.

Thus from the above results, it can be inferred that, the nutrient seed dressing of various micronutrients could not reach to the level of significance, however there was numerical increase in leaf area to the tune of 21 per cent and 20 per cent due to Zn EDTA and Fe EDTA seed dressing respectively at grand growth stage (45 DAS) and further at flowering stage (70 DAS) the increase was 15 per cent and 14 per cent respectively. The increase in leaf area in various treatments may be attributed to the availability of micronutrients from germination of the sorghum itself. Further the balanced nutrition due to supply of micronutrients might have improved the growth attributed in general and leaf area in particular.

Table 4: Dry root density (g/cm^3) of *kharif* sorghum as influenced by different nutrient seed dressing treatments

Treatment No	Treatments	Grand growth (45 DAS)	Flowering (70 DAS)	At harvest (135 DAS)
T_1	RDF only (control)	1.92	1.62	1.49
T_2	RDF + 3g $ZnSO_4$ kg^{-1}	2.32	1.92	1.86
T_3	RDF + 3g Zn EDTA kg^{-1}	2.68	2.12	1.96
T_4	RDF + 3g $Na_2B_4O_7.10H_2O$ kg^{-1}	2.01	1.72	1.60
T_5	RDF + 3g $MnSO_4$ kg^{-1}	2.16	1.71	1.59
T_6	RDF + 4g Na_2MoO_4 kg^{-1}	2.40	1.71	1.57
T_7	RDF + 3g $CuNO_3$ kg^{-1}	2.21	1.65	1.57
T_8	RDF + 3g $FeSO_4$ kg^{-1}	2.32	1.92	1.72
T_9	RDF + 3g Fe EDTA kg^{-1}	2.47	2.08	1.87
SE ±		0.22	0.16	0.19
CD at 5%		N.S	N.S	N.S
Grand mean		2.28	1.83	1.69

Dry root density

The dry root density is presented in Table 4. The data on dry root density of *kharif* sorghum was influenced by different nutrient seed dresser treatments. Among the various treatments, T_3 (RDF + 3 g Zn EDTA per kg seed) recorded maximum dry root density to the extent of 2.68, 2.12 and 1.96 g cm^{-1} at grand growth stage (45 DAS), flowering stage (70 DAS) and at harvest stage (135 DAS). The application of Fe EDTA with RDF found to be the second best treatment in production of dry root density. 2.47, 2.08 and 1.87 g/cm^3) at grand growth stage (45 DAS), flowering stage (70 DAS) and at harvesting stage (135 DAS) respectively. The increase in dry root density due to application of nutrient seed dressing of various micronutrients was 30 to 37 per cent over only RDF, due to Zn EDTA and Fe EDTA seed dressing.

The results showed that, the dry root density of *kharif* sorghum was increased due to micronutrient seed dressing to the extent of 37 per cent against application of only RDF. Further it was also noted that, their was gradual decrease in dry root density from 2.28 to 1.83 to 1.69 g/cm^3 at grand growth, flowering and at harvest stage.

Table 5: Dry matter (gm) of *kharif* sorghum as influenced by different nutrient seed dressing treatments

Treatment No	Treatments	Grand growth (45DAS) (gm)	Flowering (70DAS) (gm)	At harvest (135DAS)(gm)
T_1	RDF only (control)	48.42	150.72	145.52
T_2	RDF + 3g $ZnSO_4$ kg^{-1}	61.90	164.72	155.26

T_3	RDF + 3g Zn EDTA kg^{-1}	65.15	176.41	163.02
T_4	RDF + 3g $Na_2B_4O_7.10H_2O$ kg^{-1}	53.17	159.53	153.00
T_5	RDF + 3g $MnSO_4$ kg^{-1}	57.02	160.13	154.53
T_6	RDF + 4g Na_2MoO_4 kg^{-1}	61.48	152.89	148.96
T_7	RDF + 3g $CuNO_3$ kg^{-1}	57.90	156.36	150.59
T_8	RDF + 3g $FeSO_4$ kg^{-1}	62.08	161.08	160.43
T_9	RDF + 3g Fe EDTA kg^{-1}	63.53	169.49	161.05
SE ±		5.88	9.61	5.52
CD at 5%		N.S	N.S	N.S
Grand mean		58.96	161.26	154.71

Dry matter yield

The dry matter yield of *kharif* sorghum is presented in Table 5. There was significant increase in sorghum dry matter production due to administration of various nutrient seed dressing treatments. The application of 3 g Zn EDTA per kg of seed proved to be the best seed treatments at all growth stages in dry matter production. Further the application of 3 g Fe EDTA per kg of seed stood second best seed treatment as a as the dry matter is concern. The lowest dry matter production was recorded in treatment T_1, where sorghum crop received only RDF. The treatments comprising Zn EDTA recorded 34 per cent increase at grand growth stage (45 DAS) 17 per cent increased at flowering stage (70 DAS) and 12 per cent increased at harvest stage (135 DAS) as compared to control. In general the total increase was 5 to 17 per cent.

The result presented in above paragraph of dry matter production by sorghum crop revealed that, the seed dressing of various micronutrients in general and zinc and iron in particular found to be beneficial. This results are in accordance with the observations recorded by Satyabhama *et al*. (2005) in groundnut and also Asad and Rafique. (2000) [2]. The increase dry matter production may be attributed to the improvement in plant height, leaf area and root density of sorghum crop.

Table 6: Yield (q ha^{-1}) of *kharif* sorghum as influenced by different nutrient seed dressing treatments

Treatment No	Treatment	Grain yield (q ha^{-1})	Fodder yield (q ha^{-1})	Biological Yield (q ha^{-1})
T_1	RDF only (control)	10.97	43.92	54.89
T_2	RDF + 3 g $ZnSO_4$ kg^{-1}	19.88	51.22	71.11
T_3	RDF + 3 g Zn EDTA kg^{-1}	20.22	53.03	73.25
T_4	RDF + 3 g $Na_2B_4O_7.10H_2O$ kg^{-1}	14.40	47.21	61.40
T_5	RDF + 3 $MnSO_4$ kg^{-1}	18.17	48.58	66.75
T_6	RDF + 3 g Na_2MoO_4 kg^{-1}	17.14	47.50	64.25
T_7	RDF + 3 g $CuNO_3$ kg^{-1}	15.43	47.10	62.53
T_8	RDF+ 3 g $FeSO_4$ kg^{-1}	18.85	50.17	69.02
T_9	RDF + 3 Fe EDTA kg^{-1}	19.20	51.86	71.06
SE		0.58	0.85	1.15
CD at 5%		1.73	2.56	3.44
Grand Mean		17.14	48.95	66.06

Grain yield

The grain yield of *kharif* sorghum was significantly influenced due to different nutrient seed dressing treatments of micronutrients (Table 6) Application of RDF along with 3 g Zn EDTA i.e. (T_3) per kg seed to *kharif* sorghum significantly recorded highest grain yield (20.22 q ha^{-1}) followed by treatment T_2 (RDF + 3 g $ZnSO_4$) i.e. 19.88 q ha^{-1} and the third highest grain yield was recorded in treatment T_9 (RDF + 3 g Fe EDTA) i.e. 19.20 which is followed by treatment T_8 (RDF + 3 g $FeSO_4$). Higher grain yield recorded under micronutrient application could be attributed to early bloom and bold seeds. i.e. 1000 grain weight. Chalwade *et al*., (2005) [7] also recorded higher grain yield was obtained due to application of 100% RDF + sulphur, zinc and boron. This findings are similar with Farroq *et al*. (2012). In maize, priming in 1% $ZnSO_4$ solution substantially improved grain yield (Harris *et al*. 2007) [13]. Similar findings were also recorded by Yari *et al*. (2011) [28].

Fodder yield

The data pertaining to the effect of different nutrient seed dressing treatment of micronutrients on fodder yield of *kharif* sorghum (Table 6) indicated that, the fodder yield of *kharif* sorghum was significantly increased due to application of micronutrients. The highest fodder yield (53.03 q ha^{-1}) was obtained from treatment receiving 100% RDF + 3 g Zn EDTA kg^{-1} (T_3) and were found at par with treatment T_2 and T_9 which recorded 51.22 q ha^{-1} and 51.86 q ha^{-1}, yield respectively. The minimum fodder yield was recorded in treatment T_1 (43.92 q ha^{-1}). The findings are similar with Singh *et al*. (1985) [25], More *et al*. (1994) [21], Minhas *et al*. (1995) [20], Ammal *et al*. (1998) [1], Harris *et al*. (2001) [11] and Harris *et al*. (2004) [12].

Total biomass/ Biological Yield

The different nutrient seed dressing treatment of micronutrient significantly influenced on total biomass (Table 6). Highest total biomass of *kharif* sorghum (73.25 q ha^{-1}) was obtained with the application of RDF + 3 g Zn EDTA kg^{-1} followed by treatment T_2 (RDF + 3 g $ZnSO_4$) and treatment T_9 (RDF + 3 g Fe EDTA kg^{-1}) recorded 71.11 q ha^{-1} and 71.06 q ha^{-1} total biomass respectively.

Among the different nutrient seed dressing treatment of micronutrient, the treatment T_8 (RDF + 3 g $FeSO_4$ kg^{-1}) recorded maximum total biomass production (69.02 q ha^{-1}). The minimum biomass production (54.89 q ha^{-1}) was observed in control (T_1).

Patil and Varade (2006) reported that, the graded levels of NPK increased significantly grain and fodder yield (total biomass yield) over control. NPK with Zn increased the yield significantly over 100% RDF alone. Jha and Chandel (1987) [17] also reported the same trend with Zn application. Similar results were also recorded by Yari *et al*. (2011) [28].

Table 7: Grain quality of *kharif* sorghum as influenced by different nutrient seed dressing treatments of micronutrients

Treatment No	Treatments	Test weight (gm 100 seeds^{-1})
T_1	RDF only (control)	2.52
T_2	RDF + 3g $ZnSO_4$ kg^{-1}	3.45
T_3	RDF + 3g Zn EDTA kg^{-1}	3.91
T_4	RDF + 3g B kg^{-1}	3.25
T_5	RDF + 3g $MnSO_4$ kg^{-1}	3.43
T_6	RDF + 4g Na_2MoO_4 kg^{-1}	3.22
T_7	RDF + 3g $CuNO_3$ kg^{-1}	3.35
T_8	RDF + 3g $FeSO_4$ kg^{-1}	3.43
T_9	RDF + 3g Fe EDTA kg^{-1}	3.46
SE ±		0.17
CD at 5%		0.52
Grand mean		3.33

Test weight (gm)

Data presented in Table 7. Indicated that, the test weight (gm per 100 seeds) was in the range from 2.52 to 3.91 and maximum test weight was observed in the treatment T_3 (RDF + 3 g Zn EDTA) i.e. 3.91 gm, which at par with treatment T_2 (RDF + 3 g $ZnSO_4$), T_8 (RDF + 3 g $FeSO_4$) and T_9 (RDF + 3 g Fe EDTA). The minimum test weight (2.52 gm.) was observed in treatment T_1 (Control). Similar findings were observed by Tripathi and Singh (1991) and Anuja *et al*. (2000).

Conclusion

As regards the growth and yield attributes, initial plant population (198.33) and final plant (182.33) population were found maximum in treatment T_3 (RDF + 3 g Zn EDTA kg^{-1}) and lowest in T_1 (control). Also the maximum fresh weight, plant height, leaf area, dry root density and dry matter yield observed in treatment T_3 (RDF + 3 g Zn EDTA kg^{-1}) and lowest in T_1 (control). The growth and yield attributes of *kharif* sorghum did not influenced significantly due to different nutrient seed dressing treatment. The yield of *kharif* sorghum significantly influenced by different nutrient seed dressing treatment of micronutrient. The maximum grain (20.22 q ha^{-1}), fodder yield (53.03 q ha^{-1}) and total biomass (73.25 q ha^{-1}) were recorded in treatment T_3 (RDF + 3 g Zn EDTA kg^{-1}) which was at par with treatment T_2 (RDF + 3 g $ZnSO_4$ kg^{-1}) and T_9 (RDF + 3 g Fe EDTA kg^{-1}) respectively. As regards the grain quality parameters, test weight were found maximum (3.91) in treatment T_3 (RDF + 3 g Zn EDTA kg^{-1}) which was at par with treatment T_2 (RDF + 3 g $ZnSO_4$ kg^{-1}), T_8 (RDF + 3 g $FeSO_4$ kg^{-1}) and T_9 (RDF + 3 g Fe EDTA kg^{-1}) respectively.

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