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Effect of micro nutrient seed treatment on germination and growth of *Bt* cotton in vertisol

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Abstract
The present investigation pertaining to studies on effect of seed treatments on growth, yield and quality and soil nutrient dynamics of *Bt* cotton in vertisol was carried out during the year 2017-2018 at Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vasantrao Naik Marathwada Krishi vidyapeeth, Parbhani. The field experiment was undertaken in a Randomized Block Design with nine treatments and three replication to find out the effect of various seed treatments on growth and yield of *Bt* cotton in vertisol. The nutrient seed dressing treatments are T_1 - Absolute control, T_2 - 100% NPK +Zinc Sulphate ($ZnSo_4$), T_3 -100 % N P K + Zn EDTA, T_4 -100% NPK + Borax (B), T_5-100% NPK + Manganese Sulphate ($MnSo_4$), T_6 -100% NPK +Sodium Molybdate (NaMo), T_7-100% NPK + Cupper Nitrate ($CuNo_3$), T_8-100% NPK +Ferrous Sulphate ($FeSo_4$), T_9 - 100% NPK +FeEDTA seed application. The nutrient seed dressing treatment T_3-100 % N P K + Zn EDTA seed application to *Bt* cotton found to be effective in improving germination and growth attributing characters like, plant height, number of leaves, leaf area and root density.

Keywords: Seed treatments, NPK, Micronutrients, germination, Growth, *Bt* cotton

Introduction
Cotton (*Gossypium* spp. L) is one of the most important commercial cash crop and important fiber crop of global significance cultivated in more than seventy countries. It is an important raw material of economy in terms of both employment generation and foreign exchange and hence it is known as 'White gold' or 'friendly fiber and king of fiber'. The cotton plant belongs to the genus *Gossypium* of the family *Malvaceae.* Cotton is one of the principal crops of India, and plays a vital role in the country's economic growth by providing substantial employment and making significant contributions to export earnings. It was the superiority of Indian cotton fabrics famed as "Web of woven mind" which attracted European countries to seek new trade routes to India.

Cotton, the white gold enjoys premier position among commercial crops in India. It is an important raw material supplying about 65 per cent requirement of the Indian textile industry. The Indian textile industry occupies a significant place in the country's economy with over 1500 mills, four million handlooms, 1.7 million power looms and thousands of garments hosiery and processing units, providing employment directly or indirectly to about 35 million people (Ashok *et al.*, 2004) [2].

Strategies for improving the growth and development of crop species have been investigated for many years. Rapid germination and emergence are essential for successful crop establishment, for which seed priming could play an important role. The essential mineral elements which are required in higher concentrations by the plant have major role in determining the growth and development of cotton often produces more vegetative growth, than needed for maximum boll production and yield especially when climatic condition favour vegetative growth, these by directing the nutrients and photo assimilates towards vegetative growth rather than reproductive growth.

Material and Methods
A field experiment was conducted during *kharif* 2017, with *Bt* cotton (*Gossypium hirsutum*) used as a test crop, on the farm of department of Soil Science and Agricultural Chemistry at College of Agriculture, VNMKV, Parbhani.

The initial soil pH was 8.12, EC-0.10 dSm^{-1}, Organic Carbon- 6.70 g kg^{-1}, Calcium carbonate - 48 g kg^{-1}, available nitrogen-112 kg ha^{-1}, Phosphorus -13.46 kg ha^{-1}, Potassium- 575 kg ha^{-1}.

The initial micronutrient status was DTPA Copper- 4.37 mg kg^{-1}, Mangnease-12.04 mg kg^{-1}, Zinc-0.57 mg kg^{-1} and Ferrous-2.62 mg kg^{-1}. The soil was clayey in texture, moderately alkaline in reaction, medium in available nitrogen, phosphorus and sufficient in available potassium and low in sulphur and iron.

The field experiment was carried out on *Bt* cotton (*Gossypium hirsutum*) in kharif season during year 2017-18. After completion of preparatory tillage operations, the experiment was laid out in randomized block design comprising (09) treatments and replicated (03) times.

Treatments details

Nine treatments were formulated to evaluate the studies on effect of seed treatments on growth, yield and quality and soil nutrient dynamics of *Bt* cotton in vertisol. Details of treatment are as follows

T_1: Ac	Absolute control 100% NPK	
T_2: RZn	100% NPK + Zinc Sulphate ($ZnSO_4$)	3 g / kg seed
T3: RZnE	100% NPK + Zn EDTA	3 g / kg seed
T_4: RB	100% NPK+ Borax (B)	3 g / kg seed
T_5: RMn	100% NPK+ Manganese Sulphate ($MnSO_4$)	3 g / kg seed
T_6: RMo	100% NPK+ Sodium Molybdate (NaMo)	4 g / kg seed
T_7: RCu	100% NPK+ Cupper Nitrate ($CuNO_3$)	3 g / kg seed
T_8: RFe	100% NPK + Ferrous Sulphate ($FeSO_4$)	3 g / kg seed
T_9: RFeE	100% NPK + Fe EDTA	3 g / kg seed

Treatment evaluation/Details of observations recorded

Germination (%)

The germination percentage was counted after emergence of cotton crop 5-6 days after sowing in each plot.

Plant height (cm)

The plant height was measured from base of the plant to the tip of fully opened leaf on the main shoot and the mean plant height was expressed in centimetres. It was recorded at an interval of 30 days with effect of days after sowing (DAS), 60 days, 90 days up to 120 days of sowing of crop growth.

Number of leaves/ plant

Number of leaves $plant^{-1}$ was counted during critical growth stages. (30, 60, 90 and 120 DAS)

Leaf area

Leaf area was calculated by using Leaf area meter in the laboratory at four critical growth stages. (30, 60, 90 and 120 DAS)

Root density

Root density was measured by Root density Meter or water displacement method. The formula for root density is Weight/Volume. Root density is calculated at four critical growth stages. (30, 60, 90 and 120 DAS)

Statistical analysis

The results obtained were statistically analyzed and appropriately interpreted as per the method described in "Statistical Methods for Agricultural Workers" by Panse and Sukhatme, (1985). Appropriate Standard Error (S.E.) and critical differences (C.D.) at 5% level were worked out for treatment comparison.

Results and Discussion

Effect of micronutrient seed dressing treatment on germination percentage and growth attributes

Germination percentage

The results of germination % of *Bt* cotton are depicted in the table 1 showed that mean number of germination %. Germination is the important parameter of *Bt* cotton. Seed treatment with micronutrients has the potential to meet crop micronutrient requirements and improve seedling emergence.

The highest germination percentage was recorded in the treatment T_3 i.e. 100% NPK+3 gm Zn EDTA seed application i.e. 99.63 % and rest of the treatments are at par with each other. The results were in conformation with the result reported by Farooq *et al.*, (2012) [4].

Table 1: Effect of various nutrient seed dressing treatments with micronutrients on Germination (%) of *Bt* cotton

Treatment code	Treatments	Germination %
T_1Ac	Absolute control 100% NPK	95.83
T_2R Zn	100% NPK +Zinc Sulphate ($ZnSo_4$)	98.15
T_3RZnE	100% NPK+Zn EDTA	99.63
T_4RB	100% NPK + Borax (B)	97.22
T_5RMn	100% NPK+ Manganese Sulphate ($MnSo_4$)	97.22
T_6RMo	100% NPK +Sodium Molybdate (NaMo)	97.68
T_7RCu	100% NPK +Cupper Nitrate ($CuNo_3$)	96.76
T_8RFe	100% NPK +Ferrous Sulphate ($FeSo_4$)	98.15
T_9RFeE	100% NPK +FeEDTA	98.61
Grand mean		97.63
S E (m)		1.524
C D at 5 %		4.587

Plant height (cm)

Data in respect of plant height (cm) as influenced by various seed dressing treatment with micronutrients during the year of experimentation are presented in Table 2 which indicated that mean plant height of cotton was favorably influenced significantly due to various seed dressing treatment with

micronutrients at 30, 60, 90 and 120 DAS.

Plant height is a simple indicator that allows assessment of cotton development. Effect of various seed dressing treatment with micronutrients found to be beneficial in improvement of height of cotton plant. Among the various treatments, treatment T_3 i.e. 100% NPK + 3 gm Zn EDTA kg^{-1} seed application was significantly superior over Absolute Control and rest of the treatments at 30 days after sowing. The treatment T_3 i.e. 100% NPK+3 gm Zn EDTA seed application was significantly superior over absolute control and rest of the treatments except T_2, T_4, T_6, T_8 and T_9 at 60 days after sowing. At 90 DAS treatment T_3 i.e. 100% NPK+3 gm Zn EDTA seed application was significantly superior over Absolute control and at par with the rest of the all treatments i.e. T_2, T_4, T_5, T_6, T_7, T_8 and T_9. Significantly higher plant height due to the treatment T_3 i.e. 100% NPK+ z3 gm Zn EDTA seed application was significantly superior over Absolute control and rest of the all treatments except T_2 and T_9 at 120 DAS. It recorded highest height i.e. 161.20 cm. The mean plant height was progressively increased with the age of crop and attained maximum 139.71 cm at 120 DAS.

Table 2: Effect of various nutrient seed dressing treatments with micronutrients on plant height (cm) at various growth stages of *Bt* cotton.

Treatment code	Treatments	Plant height (cm)			
		At 30 days	At 60 days	At 90 days	At harvesting
T1Ac	Absolute control 100% NPK	51.87	86.87	105.93	127.80
T2R Zn	100% NPK +Zinc Sulphate (ZnSo4)	55.80	103.47	125.20	152.60
T3RZnE	100% NPK+Zn EDTA	65.47	108.53	143	161.20
T4RB	100% NPK + Borax (B)	53.53	91.67	122.27	131.87
T5RMn	100% NPK + Manganese Sulphate (MnSo4)	53.20	91.13	118.13	129.27
T6RMo	100% NPK +Sodium Molybdate (NaMo)	54.80	94.07	122.70	134.80
T7RCu	100% NPK +Cupper Nitrate (CuNo3)	53.20	89.33	117.93	128.60
T8RFe	100% NPK +Ferrous Sulphate (FeSo4)	55.53	103.27	124.07	135.20
T9RFeE	100% NPK +FeEDTA	56.87	104.05	129.07	156.07
Grand mean		55.58	96.93	123.07	139.71
S E		2.189	5.676	5.35	5.311
C.D at 5%		6.59	17.08	16.13	15.98

It was noticed that application of seed dressing treatment 100% NPK+3 gm Zn EDTA seed application recorded higher plant height at all growth stages over rest of the micronutrient seed dressing treatments. Similar results were also reported by Sathiyamurthy and Dhansekaran. (2014).

Number of leaves per plant

The number of leaves $plant^{-1}$ is one of the growth parameter related to physiological development of the crop. The leaves count was taken at 30 DAS, 60 DAS, 90 DAS and 120 DAS of *Bt* cotton and the data are presented in the Table 3.

Table 3: Effect of various nutrient seed dressing treatments with micronutrients on number of leaves at various growth stages of *Bt* cotton

Treatment code	Treatments	Number of leaves			
		At 30 days	At 60 days	At 90 days	At harvesting
T_1Ac	Absolute control 100% NPK	35.00	92.13	104.67	104.33
T_2R Zn	100% NPK +Zinc Sulphate ($ZnSo_4$)	49.20	124.47	157.67	165.33
T_3RZnE	100% NPK+Zn EDTA	49.47	132	171.73	174.53
T_4RB	100% NPK + Borax (B)	45.67	110.67	147.20	124.80
T_5RMn	100% NPK+ Manganese Sulphate ($MnSo_4$)	41.33	110.67	123.87	124.60
T_6RMo	100% NPK +Sodium Molybdate (NaMo)	37.20	104.33	119.67	113.20
T_7RCu	100% NPK +Cupper Nitrate ($CuNo_3$)	41.00	106.40	123.73	117.00
T_8RFe	100% NPK +Ferrous Sulphate ($FeSo_4$)	46.53	113.67	149.33	126.93
T_9RFeE	100% NPK +FeEDTA	49.33	124.73	160	169
Grand mean		43.86	113.23	139.76	135.53
S E (m)		4.31	8.98	10.42	15.41
C D at 5%		12.99	27.05	31.83	46.41

It was found that the treatment T_3 i.e. 100% NPK + 3gm Zn EDTA seed application was significantly superior over Absolute control and at par with all treatments i.e. T_2, T_4, T_5, T_6, T_7, T_8 and T_9 at 30 days after sowing. The treatment T_3 i.e. 100% NPK+3 gm Zn EDTA seed application was significantly superior over absolute control at 60 days after sowing recorded maximum leaves i.e. 132 and at par with treatments i.e. T_2, T_4, T_5, T_7, T_8 and T_9. At 90 days after sowing the treatment T_3 i.e. 100% NPK+3 gm Zn EDTA seed application was significantly superior over Absolute control recorded maximum leaves i.e. 171.73 and at par with treatments i.e. T_2, T_4, T_8 and T_9. The treatment T_3 i.e. 100% NPK + 3 gm Zn EDTA seed application was significantly superior over Absolute control at 120 days after sowing recorded maximum leaves i.e. 174.53 and at par with treatments i.e. T_2 and T_9. It was shows that at 90 days after sowing the number of leaves have maximum grand mean i.e. 139.76 and thereafter at 120 days after sowing it decreases upto 135.53 grand mean due to falling of leaves. These results are in line with Faoooq *et al.* (2012).

Leaf area (sq.cm)

The result on leaf area as influenced by the effect of various seed treatments with micronutrients on leaf area of cotton plant at various growth stages are presented in the table 4. There was continuous buildup of a leaf area in *Bt* cotton with advancing growth stages.

The treatment T_3 i.e. 100% NPK + 3 gm Zn EDTA seed

application was significantly superior over Absolute control and at par with treatments i.e. T_2, T_7, T_8 and T_9 at 30 days after sowing. At 60 days after sowing the treatment T_3 i.e. 100% NPK+3 gm Zn EDTA seed application was showed maximum leaf area and at par with all treatments. The treatment T_3 i.e. 100% NPK + 3 gm Zn EDTA seed application at 90 days after sowing was significantly superior over Absolute control and rest of the treatments except T_2, T_8 and T_9. The maximum leaf area i.e. 135.47 sq.cm was recorded in the treatment T_3 i.e. 100% NPK + 3 gm Zn EDTA seed application was significantly superior over Absolute control and rest of the treatments except T_9, at 120 days after sowing. The highest leaf area was recorded with T_3 i.e. 100% NPK+3 gm Zn EDTA seed application at all stages of growth in *Bt* cotton during the year of experimentation.

The increase in leaf area plant^{-1} with increasing age of the plant with nutrient seed dressing with micronutrients observed in the present study was in the accordance with the findings reported by Rathod and Jadhao (2006) [6].

Table 4: Effect of various nutrient seed dressing treatments with micronutrients on leaf area at various growth stages of *Bt* cotton.

Treatment code	Treatments	Leaf area (sq.cm)			
		At 30 days	At 60 days	At 90 days	At harvesting
T_1Ac	Absolute control 100% NPK	94.79	90.23	101.00	116.23
T_2R Zn	100% NPK +Zinc Sulphate ($ZnSo_4$)	114.35	100.33	112.93	130.10
T_3RZnE	100% NPK +Zn EDTA	120.09	109.78	126.93	135.47
T_4RB	100% NPK + Borax (B)	97.31	94.64	108.47	123.47
T_5RMn	100% NPK+ Manganese Sulphate ($MnSo_4$)	95.77	93.67	108.20	121.53
T_6RMo	100% NPK +Sodium Molybdate (NaMo)	99.89	94.58	110.67	125.60
T_7RCu	100% NPK +Cupper Nitrate ($CuNo_3$)	101.98	96.27	110.97	127.50
T_8RFe	100% NPK +Ferrous Sulphate ($FeSo_4$)	102.49	100.05	112.33	129.20
T_9RFeE	100% NPK +FeEDTA	117.57	106.93	123.27	133.20
Grand mean		104.92	98.50	112.75	126.93
S E		6.32	7.25	5.07	1.039
C D at 5 %		19.03	21.84	15.27	3.130

Root density (g cc^{-1})

Data in respect of mean number of root density plant^{-1} as influenced by various seed dressing treatment with micronutrients are presented in the table 5 which indicated that mean number of root density was influenced significantly due to100% NPK+3 gm Zn EDTA seed application at 30, 60, 90 and 120 DAS.

The grand mean varies from 0.47 to 0.84g cc^{-1}.Root density at 30 days was maximum in the treatment the T_3 i.e. 100% NPK+3 gm Zn EDTA seed application was at par with all treatments i.e. absolute control, T_2, T_4, T_5, T_6, T_7, T_8 and T_9. The T_3 i.e. 100% NPK+3 gm Zn EDTA seed application and T9 i.e. 100% NPK+3 gm Fe EDTA seed application i.e. 0.88 was at par with all treatments i.e. absolute control, T_2, T_4, T_5, T_6, T_7 and T_8, at 60 days after sowing.

Root density was maximum in the treatment the T_3 i.e. 100% NPK+3 gm Zn EDTA seed application,$T_9$100% NPK+3 gm Fe EDTA seed application and T_2 100 % NPK + $ZnSo_4$ i.e. 0.78 at 90 days after sowing was at par with all treatments i.e. absolute control, T_4, T_5, T_6, T_7 and T_8. At 120 days after sowing root density was recorded maximum i.e. 0.94 g cc^{-1}, the treatment T_3 i.e. 100% NPK+3 gm Zn EDTA seed application was significantly superior over absolute control and at par with T_2, T_5, T_6, T_8 and T_9. The availability of micronutrients increased due to seed treatment with micronutrients and increase in root density.

Table 5: Effect of various nutrient seed dressing treatments with micronutrients on root density (g cc^{-1}) at various growth stages of *Bt* cotton.

Treatment code	Treatments	Root density (g cc^{-1})			
		At 30 days	At 60 days	At 90 days	At harvesting
T_1Ac	Absolute control 100% NPK	0.40	0.69	0.68	0.66
T_2R Zn	100% NPK +Zinc Sulphate ($ZnSo_4$)	0.50	0.86	0.78	0.91
T_3RZnE	100% NPK+Zn EDTA	0.53	0.88	0.78	0.94
T_4RB	100% NPK + Borax (B)	0.44	0.69	0.69	0.75
T_5RMn	100% NPK+ Manganese Sulphate ($MnSo_4$)	0.48	0.76	0.76	0.88
T_6RMo	100% NPK +Sodium Molybdate (NaMo)	0.46	0.73	0.76	0.83
T_7RCu	100% NPK +Cupper Nitrate ($CuNo_3$)	0.45	0.70	0.71	0.80
T_8RFe	100% NPK +Ferrous Sulphate ($FeSo_4$)	0.48	0.76	0.77	0.90
T_9RFeE	100% NPK +FeEDTA	0.52	0.88	0.78	0.94
Grand mean		0.47	0.77	0.74	0.84
S E		0.066	0.072	0.072	0.039
C D at 5 %		0.201	0.217	0.219	0.119

Conclusion

The study concluded that, nutrient seed dressing treatment T_3 i.e. 100 % N P K + Zn EDTA seed application to *Bt* cotton found to be effective in improving germination and growth attributing characters like plant height, number of leaves, leaf area and root density.

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