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Impact of coated fertilizer on growth and quality parameter of Bt cotton

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Abstract

A field trial was conducted during the Kharif season of 2020-21 at the Research Farm, Department of Soil Science and Agricultural Chemistry, VNMKV, Parbhani, to evaluate the impact of coated fertilizers on growth and quality parameters of Bt cotton (*Gossypium hirsutum* L.). Coated fertilizers, formulated for controlled and gradual nutrient release, were compared with conventional straight and non-coated fertilizers. The experiment comprised nine treatments, including control, full recommended dose of fertilizer (RDF), and reduced RDF levels applied through both coated and non-coated fertilizer grades. Results revealed that coated fertilizers significantly enhanced plant growth, including plant height, number of monopodial and sympodial branches, and SPAD values. Treatment T₃, which received full RDF (120:60:60 kg NPK ha⁻¹) through a coated fertilizer blend enriched with macro- and micronutrients (N:P₂O₅:K₂O:S:Mg:Zn:B - 11:23:10:4:1.9:0.4:0.2), recorded the highest plant height (132.69 cm), monopodial branches (4.18), sympodial branches (23.86), and SPAD values. T₃ also achieved superior fiber quality, with the highest ginning percentage (40.80%), lint index (5.93), staple length (26.60 mm), and seed index (8.60 g). Even with reduced RDF levels, treatments T₅ and T₇ (75% and 50% RDF through coated fertilizers, respectively) outperformed their non-coated counterparts in both growth and quality parameters. This underscores the efficiency of coated fertilizers in improving nutrient use efficiency and sustaining cotton productivity with reduced inputs.

Keywords: Bt cotton, Coated fertilizers, Growth parameters, Ginning percentage

1. Introduction

Cotton, often referred to as the 'king of apparel fibers,' is a major cash crop that contributes significantly to the raw material needs of the textile industry and plays a vital role in the global economic and social landscape (Anonymous, 2010 [4]; Hosamani *et al.*, 2013) [13]. It is primarily cultivated for its fiber, which is used in textile manufacturing, thread production, and oil extraction from cottonseed (Deshmukh *et al.*, 2013) [9]. *Gossypium hirsutum* L., a key fiber-producing species, is cultivated widely across India under both rainfed and irrigated conditions. During the 2016-17 season, it covered approximately 118.72 lakh hectares, yielding 30.15 lakh bales with an average productivity of 432 kg ha⁻¹ (Anonymous 2017) [3].

In India, Maharashtra is important cotton growing states occupying cotton acreage of about 43.50 and 42.50 lakh hectares with average lint yield of 238 and 285 kg ha⁻¹ during 2017-18 and 2018-19, respectively. While, production of cotton was 60.09 and 71.30 lakh bales in 2017-18 and 2018-19 (Anonymous, 2019) [2].

According to Slafer and Savin (2018) [19], nitrogen (N) application must be carefully managed in alignment with the crop's specific requirements. Nitrate, a common form of nitrogen, is stored in the vacuoles of plant cells and undergoes reduction to nitrite in the cytoplasm through the activity of nitrate reductase. This process is closely linked with chlorophyll, which plays a vital role in photosynthesis. When nitrogen is readily available in the soil and coincides with the crop's demand, two essential factors must be considered (Lin *et al.*, 2017) [14]. Mismanagement of nitrogen fertilizers can lead to issues like crop lodging and reduced economic returns. Pleijel *et al.* (2019) [18] highlighted that the principle of diminishing returns-recognized for over half a century-illustrates that increasing fertilizer inputs does not necessarily translate to higher yields.

Utilizing slow-release nitrogen fertilizers can enhance nitrogen use efficiency (NUE). A significant concern in nitrogen application is the use of forms other than nitrate, which may not optimally support plant growth and development. Furthermore, nitrogen losses pose major environmental threats, with agriculture accounting for nearly half of all ammonia emissions into the atmosphere (Conijn *et al.*, 2018) [8]. Ammonia volatilization from urea-based fertilizers can range between 0-65%, depending on soil and environmental conditions (Bowles *et al.*, 2018 [7]; Bishop & Manning, 2010) [6]. Nitrate contamination of water sources is also a serious health risk for both humans and animals. Excessive nitrogen application beyond crop demand can result in reduced NUE and greater nitrogen loss to the environment. This inefficiency remains a long-standing concern in agriculture (Dobermann, 2005) [10]. Controlled-release fertilizers (CRFs) offer a promising alternative to conventional compound fertilizers (CCFs) by improving nitrogen uptake and reducing environmental losses. However, their adoption among growers remains limited due to higher costs and unfamiliarity with their performance (Medina *et al.*, 2008) [15].

2. Materials and Methods

A field trial was conducted during the *Kharif* season of 2020-21 at the Experimental Research Farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiments on cotton were conducted to study the “Studies on Efficacy of Coated Fertilizer on Soil Properties, Yield and Quality of Bt Cotton”. The soil of experimental site was black soil dominant in Montmorillonite mineral which is inherently rich in lime, iron and magnesium (Gajbe *et al.*, 1976) [11]. The soil was alkaline in reaction (pH 8.28), low in salt content (0.20 dS m⁻¹) with high calcium carbonate content (10 g kg⁻¹). The organic carbon status of the soil was medium (6.6 g ha⁻¹). The soil available nitrogen was low (172.48 kg ha⁻¹), available phosphorus was medium (9.11 kg ha⁻¹), available potassium was very high (705.6 kg ha⁻¹) and available sulphur was medium (20.55 mg kg⁻¹). The experiment was carried out in Randomized Block Design (RBD) with ten treatments and three replications. A set of nine treatments viz. T₁-Absolute control, T₂- Recommended dose of fertilizer (Through straight fertilizer) T₃-RDF through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2), T₄-RDF through non coated fertilizer grade (N: P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2), T₅-25% reduction to RDF with coated fertilizer grade, T₆-25% reduction to RDF with non-coated fertilizer, T₇-50% reduction to RDF with coated fertilizer, T₈-50% reduction to RDF with non-coated fertilizer, T₉-RDF through straight/complete fertilizers + individual secondary and Micronutrients as per treatment second for basal dose only. Certified seed of cotton (Ajeet 155 BG II) were sown in *Kharif* by dibbling two seeds per hill. The main stem height in centimetres was measured from the ground level to the base of the last fully opened leaf at the apex of five selected plants per net plot at 30, 60, and 90 days after sowing and at harvest, and the average was calculated. The number of monopodial branches was recorded at 30 and 60 days after sowing by counting them on five selected plants from each net plot, and the average per plant was calculated by dividing the total count by five. Similarly, the number of sympodial (fruiting) branches was recorded at 60, 90, and 120 days after sowing and at harvest

from five observational plants, and the average was obtained by dividing the total number by five. Chlorophyll content was measured using a SPAD chlorophyll meter by selecting the three healthiest leaves per plant from five plants in each net plot. Observations were taken at 20, 40, 60, 80, and 100 days after sowing, and the average values were calculated.

Ginning percentage was calculated by dividing the weight of lint by the weight of seed cotton and expressing the result as a percentage. The produce from each plant was bulked separately, and a representative sample of 200 g was collected from each treatment. This sample was ginned using a machine, and the weights of lint and seed cotton were recorded.

The ginning % was estimated using the formula below.

$$\text{Ginning (\%)} = \frac{\text{Weight of lint (g)}}{\text{Weight of total seed cotton}} \times 100$$

Eed index was calculated by weighing 100 seeds of each plot per replication and averaged. The weight of lint (g) obtained from 100 individual seed from each plot was considered as lint index.

Lint index was calculated by using following formula.

$$L.I = \frac{\text{Weight of 100 seed} \times \text{Ginning \%}}{100 - \text{Ginning}}$$

The lint present on seed was combed keeping it on seed as it is and halo length was read at point on three radicle lines marked on standard halo disk in mm and mean halo length was estimated. The data were analyzed by statistical method as suggested by Panse and Sukhatme (1985) [17].

3. Result and Discussion

3.1 Growth Parameters of Bt cotton.

3.1.1 Plant height

The application of coated fertilizers significantly enhanced the nutrient availability throughout the cotton growth period, creating a more favorable environment for optimal root development. This, in turn, contributed to an increase in plant height and an overall improvement in crop growth dynamics. The consistent and gradual release of nutrients ensured by the coating technology supported sustained vegetative growth and vigor. The data on plant height of cotton at various growth stages influenced by coated fertilizer during the year of experimentation are presented in Table 1. It revealed that Significantly maximum height was recorded in treatment (T₃), receiving RDF (120:60:60 Kg NPK ha⁻¹) through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 1:23:10:4:1.9:0.4:0.2) followed by (T₅), (T₇). However, minimum plant height was recorded in (T₁) i.e., Absolute control at all stages. Our results are similar to findings of Noor *et al.* (2017) [16], they found that the application of complete recommended dose of through polymer-coated DAP raised wheat plant height by 13.4% over control and by 4.1 above DAP that wasn't coated. In comparison to the control treatment using various rates of polymer coated DAP increased plant height.

Table 1: Effect of coated of fertilizer on plant height of Bt cotton.

Treatments	Height of plant (cm)			
	30 DAS	60 DAS	90 DAS	After harvest
T ₁ - Absolute control	17.17	37.81	72.30	115.05
T ₂ - Recommended dose of fertilizer (Through straight fertilizer)	18.92	40.56	78.48	120.66
T ₃ - RDF through coated fertilizer grade (N:P ₂ O ₅ :K ₂ O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2)	23.77	49.97	90.35	132.69
T ₄ - RDF through non-coated fertilizer grade (N:P ₂ O ₅ :K ₂ O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2)	17.40	43.61	82.74	125.33
T ₅ -25% reduction to RDF with coated fertilizer grade	19.81	47.00	85.97	129.90
T ₆ - 25% reduction to RDF with non-coated fertilizer	16.53	42.07	80.05	123.99
T ₇ - 50% reduction to RDF with coated fertilizer	17.17	43.12	81.49	124.25
T ₈ -50% reduction to RDF with non-coated fertilizer	19.63	38.72	77.58	121.01
T ₉ - RDF through straight/ complete fertilizers + individual secondary and micronutrients as per treatment second for basal dose only	19.70	41.63	81.72	121.84
SE m±	0.61	0.33	0.48	0.54
CD at 5 %	1.84	1.01	1.45	1.64
CV	5.64	1.38	1.04	0.77

3.1.2 Number of monopodial and sympodial branches plant⁻¹ of Bt cotton: In the present study, monopodials were not a key yield component, as their effect on seed cotton yield was non-significant. The data on monopodial and sympodial branches of cotton at various growth stages influenced by coated fertilizer during the year of experimentation are presented in Table 2. It revealed that the maximum monopodial and sympodial branches was recorded in treatment (T₃), receiving RDF (120:60:60 Kg

NPK ha⁻¹) through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2) followed by (T₅), (T₇). However, Minimum number of monopodial and sympodial branches was recorded in (T₁) *i.e.*, Absolute control at all stages. Our results are similar to Begum *et al.* (2015) [5], they noticed that, combined application of 25 kg N with 54 kg P per ha through inorganic fertilizers the results was the highest number of branches observed in crop.

Table 2: Effect of coated fertilizer on number of monopodial and sympodial branches plant⁻¹ of Bt cotton.

Treatments	Number of monopodial branches plant ⁻¹		Number of sympodial branches plant ⁻¹		
	30 DAS	60 DAS	30 DAS	60 DAS	90 DAS
T ₁ - Absolute control	1.57	2.43	4.15	12.62	14.43
T ₂ - Recommended dose of fertilizer (Through straight fertilizer)	2.61	3.00	5.25	13.41	17.95
T ₃ - RDF through coated fertilizer grade (N:P ₂ O ₅ :K ₂ O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2)	3.02	4.18	8.15	16.74	23.86
T ₄ - RDF through non-coated fertilizer grade (N:P ₂ O ₅ :K ₂ O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2)	2.75	3.67	7.90	15.05	19.89
T ₅ -25% reduction to RDF with coated fertilizer grade	2.83	3.88	8.00	16.02	21.40
T ₆ - 25% reduction to RDF with non-coated fertilizer	2.48	3.53	7.75	14.82	17.92
T ₇ - 50% reduction to RDF with coated fertilizer	2.67	3.56	7.70	15.23	18.91
T ₈ -50% reduction to RDF with non-coated fertilizer	2.42	3.37	7.54	13.55	16.92
T ₉ - RDF through straight/complete fertilizers + individual secondary and micronutrients as per treatment second for basal dose only	2.61	3.29	5.60	13.60	18.42
SE m±	0.15	0.06	0.16	0.65	0.52
CD at 5%	0.45	0.19	0.49	1.96	1.56
CV	10.36	3.30	4.12	7.80	4.80

3.2 Quality Parameters of Bt cotton

3.2.1 Ginning percentage

The data on ginning percentage as influenced by different treatment are given in Table 3. The result revealed that the ginning percentage varied in the range of 35.53 to 40.80. Significantly ginning percentage of cotton *i.e.*, 40.80 was recorded in treatment (T₃), receiving RDF (120:60:60 Kg NPK ha⁻¹) through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2) followed by (T₅), receiving 25% reduction to RDF (120:60:60 Kg NPK ha⁻¹) with coated fertilizer grade 40.50, (T₇), receiving 50% reduction to RDF (120:60:60 Kg NPK ha⁻¹) with coated fertilizer 39.00. However, minimum ginning percentage of cotton was recorded in (T₁) *i.e.*, Absolute control 35.53.

3.2.2 Lint index

The data on lint index as influenced by different treatment are given in Table 3 it revealed that the lint index varied in the range of 3.63 to 5.93. Significantly lint index of cotton *i.e.*, 5.93 was

recorded in treatment (T₃), receiving RDF (120:60:60 Kg NPK ha⁻¹) through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2) followed by (T₅), receiving 25% reduction to RDF (120:60:60 Kg NPK ha⁻¹) with coated fertilizer grade 5.29, (T₇), receiving 50% reduction to RDF (120:60:60 Kg NPK ha⁻¹) with coated fertilizer 5.26. However, minimum lint index of cotton was recorded in (T₁) *i.e.*, Absolute control 3.63. The data on lint index of cotton was found statistically non-significant. Fertilization with coated fertilizer doses and there application did not match the lint index significantly during study.

3.2.3 Staple length

The result shows that the staple length (mm) varied in the range of 25.40 to 26.60. Significantly staple length (mm) of cotton *i.e.*, 26.60 (mm) was recorded in treatment (T₃), receiving RDF (120:60:60 Kg NPK ha⁻¹) through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2) followed by (T₅), receiving 25% reduction to RDF (120:60:60 Kg NPK ha⁻¹)

with coated fertilizer grade 26.40 (mm), (T₇), receiving 50% reduction to RDF(120:60:60 Kg NPK ha⁻¹) with coated fertilizer 26.30 (mm). However, minimum lint index of cotton was recorded in (T₁) i.e., Absolute control 25.40 (mm). The data on staple length (mm) of cotton was found statistically non-significant. Fertilization with coated fertilizer doses and there application did not match the staple length significantly during study.

3.2.4 Seed index

The data on effect of coated fertilizer on seed index of cotton is presented in Table 4.13. It revealed that the on-seed index of cotton ranged from 6.87 to 8.60 (g). Significantly maximum

seed index of cotton i.e., 8.60 (g) was recorded in treatment (T₃), receiving RDF (120:60:60 Kg NPK ha⁻¹) through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2) followed by (T₅), receiving 25% reduction to RDF (120:60:60 Kg NPK ha⁻¹) with coated fertilizer grade 8.48 (g), (T₇), receiving 50% reduction to RDF(120:60:60 Kg NPK ha⁻¹) with coated fertilizer 8.23 (g). However, minimum seed index of cotton was recorded in (T₁) i.e., Absolute control 6.87 (g). Our results are related to findings of Ali *et al.* (2017), who reported that the application with 50% and 100% doses of polymer coated DAP increased the test weight of wheat by 2% and 16% respectively.

Table 3: Effect of coated fertilizer on ginning percentage, lint index, staple length of Bt cotton.

Treatments	Ginning %	Lint index	Staple length(mm)	Seed index of cotton (g)
T ₁ - Absolute control	35.53	3.63	25.40	6.87
T ₂ - Recommended dose of fertilizer (Through straight fertilizer)	36.30	4.36	25.60	7.80
T ₃ - RDF through coated fertilizer grade (N:P ₂ O ₅ :K ₂ O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2)	40.80	5.93	26.60	8.60
T ₄ - RDF through non-coated fertilizer grade (N:P ₂ O ₅ :K ₂ O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2)	38.40	4.87	25.90	7.95
T ₅ -25% reduction to RDF with coated fertilizer grade	40.50	5.29	26.40	8.48
T ₆ - 25% reduction to RDF with non-coated fertilizer	38.30	4.78	25.70	7.70
T ₇ - 50% reduction to RDF with coated fertilizer	39.00	5.26	26.30	8.23
T ₈ -50% reduction to RDF with non-coated fertilizer	36.20	4.29	26.00	7.54
T ₉ - RDF through straight/complete fertilizers + individual secondary and micronutrients as per treatment second for basal dose only	38.10	4.51	25.70	8.15
SE m±	0.23	0.60	0.25	0.23
CD at 5%	0.71	NS	NS	0.71
CV	1.08	22.10	1.70	5.24

3.3 Soil Plant Analysis Development values

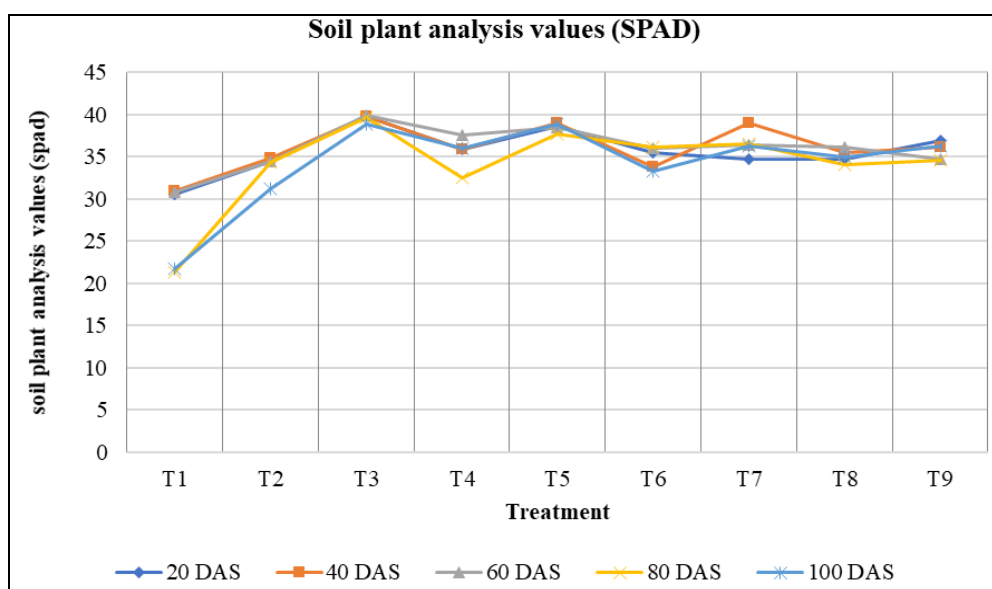


Fig 1: Effect of coated fertilizer on soil plant analysis development values (SPAD).

Nitrogen (N) is often the most limiting nutrient for crop productivity, and supplying enough N to meet crop demands is both costly and time-consuming. Therefore, monitoring the nitrogen status of crops is important, as it allows for timely management adjustments to optimize yield and quality. This is especially crucial for cotton (*Gossypium hirsutum* L.), as both nitrogen deficiency and excess can negatively affect the crop. There is relationship between SAPD values and N content in plant. The data on SPAD values of cotton at various growth stages influenced by coated fertilizer during the year of experimentation are represented in Fig 4.2 it noticed that

Significantly maximum SPAD values was recorded in treatment (T₃), receiving RDF (120:60:60 Kg NPK ha⁻¹) through coated fertilizer grade (N:P₂O₅:K₂O:S:Mg:Zn:B 11:23:10:4:1.9:0.4:0.2) followed by (T₅), (T₇). However, minimum SPAD values was recorded in (T₁) i.e., Absolute control at all stages. Our results are similar to findings of Geng *et al.* (2016) [12] who reported that the SPAD values were considerably affected by N and S fertilization. Under PCU fertilization treatment, the SPAD value was higher compared with urea treatment.

4. Conclusion

The application of coated fertilizers significantly improved the growth and quality parameters of Bt cotton. Among all treatments, T₃ (RDF through coated fertilizer grade) consistently recorded maximum plant height, number of branches, SPAD values, and superior quality traits such as ginning percentage, lint index, staple length, and seed index. This indicates that coated fertilizers enhance nutrient availability, promote sustained growth, and improve fiber quality in Bt cotton. Even at reduced RDF levels (T₅, T₇), coated fertilizers performed better than full-dose non-coated or straight fertilizers, highlighting their efficiency and potential for nutrient use optimization.

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