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Effect of slow release fertilizer on soil-chemical properties and yield of cotton in vertisols

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ABSTRACT

A field experiment was investigated during the Kharif season of 2025–26 at the Department of Soil Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, to assess the impacts of slow release fertilizer on soil-chemical properties and yield of cotton in black-cotton soils of Maharashtra State. The experiment was laid out in randomized block design with seven treatments and three replications. The treatments comprised absolute control, 100% RDF through straight fertilizer, 100% RDF through straight fertilizer + FYM @ 5 t ha⁻¹, 100% RDN through SnRF + 100% P and K through straight fertilizer, 75% RDN through SnRF + 100% P and K through straight fertilizer, 50% RDN through SnRF and 100% P and K through straight fertilizer, 25% RDN through SnRF + 100% P and K through straight fertilizer. The results revealed that application of slow release fertilizer with straight fertilizer significantly influenced soil-chemical properties like EC, organic carbon, available N, available P, available K content in post-harvest soil of cotton. A slight increase in soil pH was noticed which was non-significant. The seed cotton yield and cotton stalk yield was recorded significantly highest over absolute control. Thus, it is suggested that addition of slow release fertilizer with straight fertilizer in soil not only increases yield of cotton but also improved soil-chemical properties of post-harvest soil of cotton.

Keywords: Cotton, Slow release fertilizer, FYM, RDF, Soil-chemical properties, Yield of cotton

Introduction

Cotton (*Gossypium* sp.), one of the world's oldest cultivated crops, plays a crucial role in global textile industry (Shahrajabian *et al.*, 2020) [1]. It is one of the most important commercial crops grown in India which is locally called as kapus belong to malvaceae family. Cotton was derived from Arabic word “qutun”, belongs to *Gossypium* genus, which was also derived from the Arabic word “goz”, meaning a soft substance (Gledhil, 2008) [2]. Cotton fibre is the backbone of textile and other industries. Due to its economic importance in India, cotton is called as “White Gold”.

Cotton is a natural, soft, fluffy staple fibre that grows in a boll around the seeds of the cotton plants and cotton fibre is most often spun into yarn or thread and used to make a soft, breathable and durable textile (Rathore, 2010) [3].

Cotton fibre is one of the most widely used and economically valuable textile fibres in the world, prized for its versatility, comfort, and breathability and this fibre is almost pure cellulose and may contain small amounts of polysaccharides, waxes, proteins, fats, water soluble substances, ash (Winnie, 2025).

India ranks first in the world in terms of cotton acreage, with about 114.47 lakh hectares area under cotton cultivation, i.e. around 37 per cent of the global cotton-growing area. Approximately 67 per cent of cotton production in India is obtained from rainfed areas, while 33 per cent is produced under irrigated conditions. In terms of productivity, India is on 40th rank with yield of 437 kg/ha, making India one of the major producers, consumers and exporters of cotton globally. Maharashtra accounts for the largest area under cotton cultivation in the country, covering about 41.23 lakh hectares, with an average productivity of 304 kg ha⁻¹ (COCPC, 2025).

Sustaining cotton productivity is a major challenge due to declining soil fertility, nutrient imbalance and deterioration of soil health under intensive cultivation system. The excessive use of fertilizers give rise to environmental problems viz. groundwater pollution by nitrate and algal blooms in rivers (Torres *et al.* 2020).

To overcome this problem, slow-release fertilizers (SRFs) are gaining lots of interest because of their ability to release nutrients at a rate that plants can absorb effectively. Slow release fertilizer is a fertilizer which releases nutrients over a period of time. These slow release fertilizers help to improve the use efficiency of chemical fertilizer and it improves N uptake efficiency and crop yield (Zhijie *et al.*, 2001; Shaviv, 2001) [5, 4].

Biochar is a soil amendment and pyrogenic black carbon that has attracted increased attention in political, academic and scientific arenas. Biochar behave as a slow release nitrogenous fertilizers which delay the re

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lease of N and can promote microbial activity, boost soil nitrification and minimize denitrification by shifting microbial populations towards nitrifying bacteria compared with urea alone (Liao *et al.*, 2020) [6].

Material and Methods

The two year field experiment was conducted during *kharif* 2024-2025 and 2025-26 at Research farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India. The city of Akola is positioned at an altitude of 307.4 meters above sea level, located between 22°41' N latitude and 77°02' E longitude. Its climate can be classified as subtropical, characterized by three distinct seasons: summer, monsoon and winter.

During the summer months, from March to May, Akola experiences hot and dry weather. The monsoon season lasts from June to October, bringing warm and rainy conditions. The winter season, from November to February, is characterized by dry and mild cold weather. The experimental soil was a deep, clayey black soil (Vertisol).

The experiment comprised seven nutrient management treatments, viz., Absolute control (T_1), 100% RDF through straight fertilizer (T_2), 100% RDF through straight fertilizer + FYM @ 5 t ha⁻¹ (T_3), 100% RDN through SnRF + 100% P and K through straight fertilizer (T_4), 75% RDN through SnRF + 100% P and K through straight fertilizer (T_5), 50% RDN through SnRF + 100% P and K through straight fertilizer (T_6), 25% RDN through SnRF + 100% P and K through straight fertilizer (T_7). The treatments were replicated three times in a Randomized Block Design (RBD), resulting in a total of 27 experimental plots. The seed rate of cotton is 3 kg ha⁻¹ with variety Ajit-155 at a spacing 90 x 45 cm. The recommended dose of fertilizer was 90:45:45 kg N: P₂O₅: K₂O kg ha⁻¹ and FYM @ 5 t ha⁻¹ was applied before sowing in the treatment T_3 . Half N, Full P and Full dose of K were applied as basal doses, while remaining nitrogen was applied 30 days after sowing (DAS). Full nitrogen will be applied to cotton through SnRF at the time of sowing according to treatment. The initial characteristics of soil are enlisted below: Soil pH (8.09), EC (0.23 dS m⁻¹), organic carbon (4.53 g kg⁻¹), available N (181 kg ha⁻¹), available P (15.0 kg ha⁻¹) and available K (399.5 kg ha⁻¹).

Soil samples were collected from each experimental plot before sowing and after harvest of crop. The collected samples were air dried, gently crushed, passed through a 2-mm sieve and used for the determination of soil chemical properties.

The analysis of soil-chemical properties was carried out by the methods namely, soil pH was measured by using glass electrode pH meter in a 1:2.5 ratio of soil water suspension (Jackson, 1973), EC by conductivity meter (Jackson, 1973), organic carbon by wet-oxidation method (Walkley and Black, 1931), available N by alkaline permanganate method (Subbiah and Asija, 1956), available P by Olsen's method NaHCO₃ (0.5 M and pH - 8.5) using a spectrophotometer (Olsen and Watanabe, 1954) and available K by neutral normal ammonium acetate method using flame photometer (Jackson, 1973). Seed cotton yield was harvested from each net plot at appropriate picking intervals. The produce obtained from each plot was weighed separately and the yield was expressed in q ha⁻¹.

The recorded data on soil-chemical properties and yield of cotton were statistically analyzed using analysis of variance (ANOVA) appropriate for Randomized Block Design with seven treatments and three replication as described by Gomez, 1984. The appropriate stan-

dard error of mean (S.E m) and the critical difference (C.D.) were calculated at 5% level of probability.

Results and Discussion

a. Soil-chemical properties

Soil-chemical properties was significantly influenced by the slow-release fertilizer treatments.

Soil pH

Soil pH was found non-significant but it can be numerically vary among various treatments. The highest soil pH (8.13) was recorded in treatment T_3 (100% RDF through straight fertilizer + FYM @ 5 t ha⁻¹). The slow release fertilizer treatments T_4 , T_5 , T_6 and T_7 recorded comparable highest than control treatment. The lowest soil pH (8.08) was recorded in treatment T_1 (absolute control). The decrease in soil pH due to application of balanced fertilizer with FYM was confirmed by the findings by Chan *et al.* (2008) [7], Shenbagavali and Mahimairaja (2012) [8] and Abujabhah *et al.* (2016).

Electrical conductivity

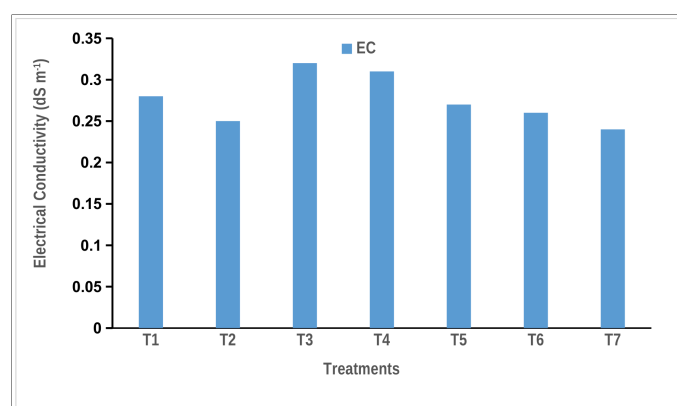


Figure 1. Effect of SnRF on EC of post-harvest soil of cotton

The data on soil EC after harvest of cotton depicted in Fig. 1, respectively. Application of SnRF show significant impacts on electrical conductivity of post-harvest soil of cotton crop. The highest EC (0.32 dS m⁻¹) was observed under 100% RDF through straight fertilizer + FYM @ 5 t ha⁻¹ which is at par with 100% RDN through SnRF + 100% P and K through straight fertilizer. The lowest EC (0.23 dS m⁻¹) was recorded in control. Similar results observed by Nigussie *et al.* (2012) [9], Ullah *et al.* (2022) [10] and Suradkar *et al.* (2023) [11].

Soil organic carbon

Effect of slow release fertilizer on soil organic carbon content was found significant which is illustrated in Fig. 2 respectively. The significantly highest value of soil organic carbon (5.48 g kg⁻¹) was observed under 100% RDF through straight fertilizer + FYM @ 5 t ha⁻¹, was statistically at par with 100% RDN through SnRF + 100% P and K through straight fertilizer. The lowest soil organic carbon (4.54 g kg⁻¹) was recorded in absolute control. Hati *et al.*, (2007) [12] stated that the balanced application of inorganic fertilizer and organic amendments greatly influenced the accumulation of organic matter in soil. Similar results recorded by many researchers, Meena *et al.* (2018) [13], Kaur *et al.* (2019) [14], Das and Ghosh (2023) and Q.S. Xu *et al.* (2026) [15].

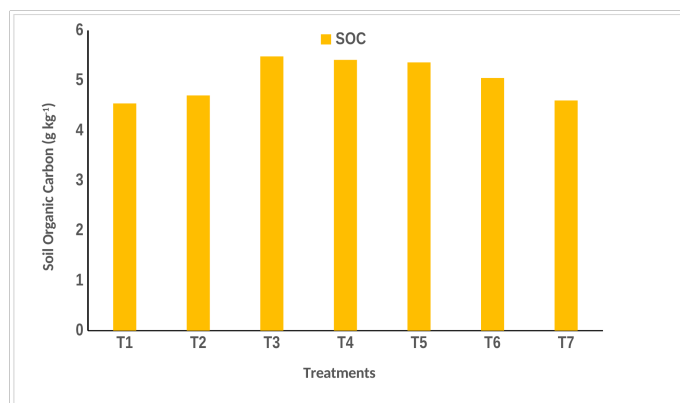


Figure 2. Effect of SnRF on soil organic carbon of post-harvest soil of cotton

Soil available N

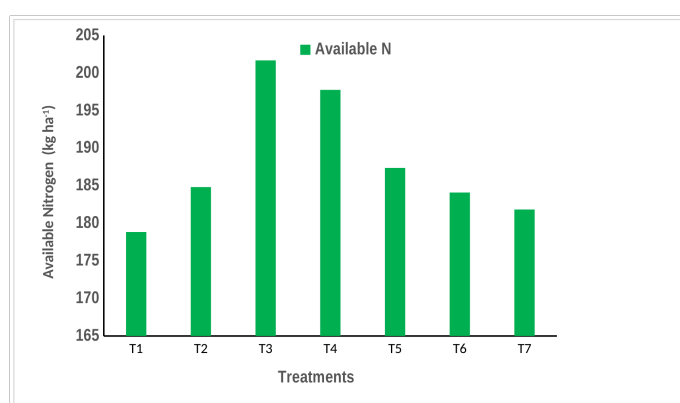


Figure 3. Effect of SnRF on soil available N of post-harvest soil of cotton

The data illustrated in Fig. 3, shows effect of slow release fertilizer on soil available N of post-harvest soil of cotton found significant. The significantly highest value of soil available N ($201.67 \text{ kg ha}^{-1}$) was observed in treatment T₃ (100% RDF through straight fertilizer + FYM @ 5 t ha^{-1}), statistically at par with T₄ (100% RDN through SnRF + 100% P and K through straight fertilizer). However, lowest soil available N ($178.83 \text{ kg ha}^{-1}$) was recorded in treatment T₁ (control). The available N value was found highest due to combined application of balanced fertilizer with FYM enhanced the soil fertility, regulating nitrogen leaching, and improving microbial properties (Sehra *et al.*, 2020) [16]. Similar results observed by Nayak *et al.* (2014) [17] and Gaddi *et al.* (2020) [18].

Soil available P

The data related to effect of slow release fertilizer on soil available P depicted in Fig. 4, respectively.

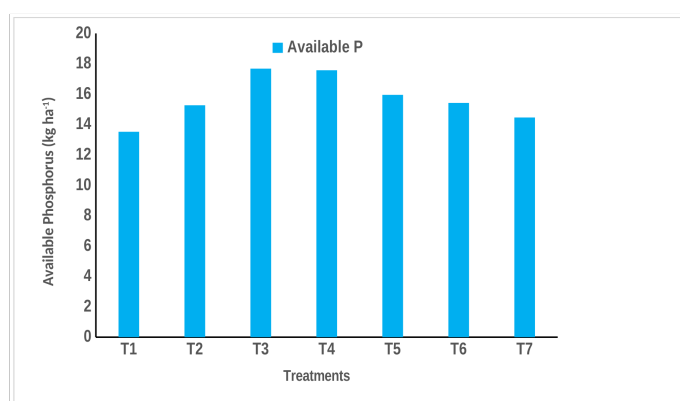


Figure 4. Effect of SnRF on soil available P of post-harvest soil of cotton

The effect of SnRF on soil available P found significant. The significantly highest value of available P (17.68 kg ha^{-1}) observed under treatment T₃ (100% RDF through straight fertilizer + FYM @ 5 t ha^{-1}), statistically at par with T₄ (100% RDN through SnRF + 100% P and K through straight fertilizer). However, lowest soil available P (13.52 kg ha^{-1}) was recorded in treatment T₁ (control). Similar results observed by, Hussain *et al.* (2012) [19] and Soltys *et al.* (2020) [20].

Soil available K

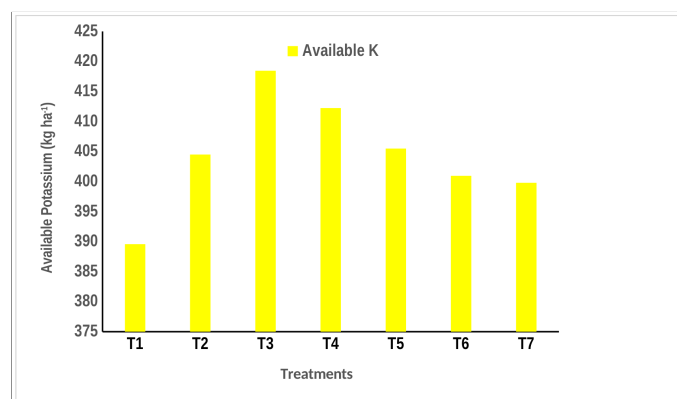


Figure 5. Effect of SnRF on soil available K of post-harvest soil of cotton

The data related to effect of slow release fertilizer on soil available K of post-harvest soil of cotton crop shown in Fig. 5, respectively. The effect of slow release fertilizer on soil available K was significant. The result revealed that, the highest soil available K was found under 100% RDF through straight fertilizer + FYM @ 5 t ha^{-1} ($418.45 \text{ kg ha}^{-1}$) which was statistically at par with 100% RDN through SnRF + 100% P and K through straight fertilizer. However, the lowest ($389.57 \text{ kg ha}^{-1}$) was recorded under absolute control. Similar results found by Elangovan *et al.* (2014) [21].

b. Effect of slow release fertilizer on yield of cotton

Seed cotton yield

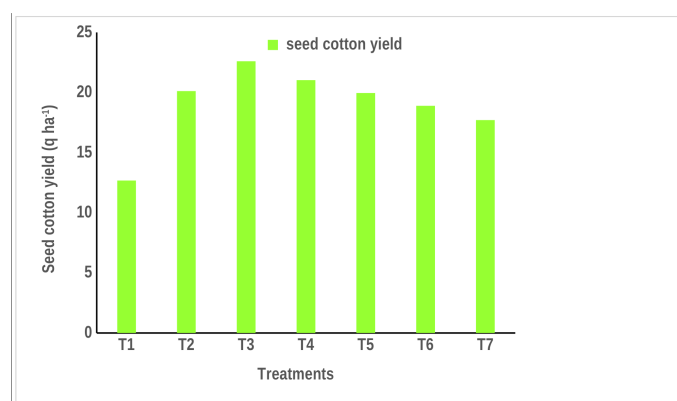


Figure 6. Effect of SnRF on seed cotton yield

As shown in Fig. 6, the application of SnRF with straight fertilizer significantly increase seed cotton yield. The maximum value for seed cotton yield (22.60 q ha^{-1}) was recorded under 100% RDF through straight fertilizer + FYM @ 5 t ha^{-1} , which was found statistically at par with 100% RDN through SnRF + 100% P and K through straight fertilizer. The minimum value (12.67 q ha^{-1}) for seed cotton yield was recorded in control. The combined application of balanced fertilizer with organic sources increases yield of cotton due to might be attributed to slowly releases nutrient in the soil through mineralization of organic sources which might have facilitated better crop growth

(Parmar *et al.* 2018) [22]. This findings is in conformity by Cevheri, (2026) [23] and Singh *et al.* (2020) [24].

Cotton stalk yield

The data in Fig. 7 indicates that effect of slow release fertilizer are significantly increases cotton stalk yield.



Figure 7. Effect of SnRF on cotton stalk yield

. The significantly highest cotton stalk yield observed in treatment T₃ (100% RDF through straight fertilizer + FYM @ 5 t ha⁻¹) which was found statistically at par with treatment T₄ (100% RDN through SnRF + 100% P and K through straight fertilizer). The lowest cotton stalk yield was recorded in control. Similar results observed by many researchers such as Parmar *et al.* (2018) [22], Ahmed *et al.* (2014) and Babaria *et al.* (2010) [25].

Conclusion

Based on the present experiment, it can be concluded that application of 100% RDF through straight fertilizer along with FYM @ 5 t ha⁻¹ and 100% RDN through SnRF + 100% P and K through straight fertilizer found equally beneficial for soil-chemical properties and enhancing productivity of cotton.

References

- Shahrajabian MH, Sun W, Cheng Q. Considering White Gold, Cotton, for its Fiber, Seed Oil, Traditional and Modern Health Benefits. *Journal of Biological and Environmental Sciences*. 2020;14:25-39.
- Gledhill D. The Names of Plants. 4th ed. Cambridge: Cambridge University Press; 2008.
- Rathore KS. Cotton. In: Kempken F, Jung C, eds. *Genetic Modification of Plants and Biotechnology in Agriculture and Forestry*. 2010:64.
- Shaviv A. Advances in controlled-release fertilizers. *Advances in Agronomy*. 2001;71:1-49.
- Zhijie W, Jianmin Z. Present situation, trend and strategy of control-released fertilizer and slow-released fertilizer in China. *Rev. China Agricultural Science and Technology*. 2001;3:73-76.
- Liao J, Liu X, Hu A, Song H, Chen X, Zhang Z. Effects of biochar-based controlled release nitrogen fertilizer on nitrogen-use efficiency of oilseed rape (*Brassica napus* L.). *Scientific Reports*. 2020;10.
- Chan K, Van Zwieten L, Meszaros I, Downie A, Joseph S. Using poultry litter biochars as soil amendments. *Soil Research*. 2008;46(5):437-444.
- Shenbagavalli S, Mahimairaja S. Production and Characterization of Biochar from Different Biological Wastes. *International Journal of Plant, Animal Environmental Sciences*. 2012;2:197-201.
- Nigussie A, Kissi E, Engdaw M, Ambaw G. Effect of Biochar Application on Soil Properties and Nutrient Uptake of Lettuces (*Lactuca sativa*) Grown in Chromium Polluted Soils. *American-Eurasian Journal of Agricultural and Environmental Science*. 2012;12:369-376.
- Ullah I, Tariq M, Sharif MN. Comparative Effect of Organic and Inorganic Fertilizers on Improving Soil Fertility and Productivity of Different Legumes Under Alkaline Calcareous Soil. *Gesunde Pflanzen*. 2022;75:1-16.
- Suradkar RK, Kadu PP, Kadlag AD, Durgude AG, Surve US. Effect of zeolite application on physico-chemical properties of soil at grand growth stage and after harvest of preseasonal sugarcane grown on inceptisol. *The Pharma Innovation Journal*. 2023;12(8):705-710.
- Hati KM, Swarup A, Dwivedi AK, Misra AK, Bandyopadhyay KK. Changes in Soil Physical Properties and Organic Carbon Status at the Topsoil Horizon of a Vertisol of Central India after 28 Years of Continuous Cropping, Fertilization and Manuring. *Agriculture, Ecosystems & Environment*. 2007;119:127-134.
- Meena BL, Fagodiya Ram, kPrajapat, Kaledhonkar M, Sharma Parbodh, Meena Ram Swaroop, Mitran Tarik, Sihag Sandeep. *Legume Green Manuring: An Option for Soil Sustainability*. 2018.
- Kaur S, Dheri GS, Benbi D. Effect of long-term fertilization in maize-wheat cropping system on carbon mineralization in soil. *Carbon Management*. 2019;10:1-10.
- Xu Q, Yan Y, Wang H, Li S, Chi C, Kong Y, Tian W, Cao X, Zhu L, Li Q, Li J, Zhang J, Zhu C. Slow-release fertilizers applied in conjunction with manure enhanced soil quality and rice grain yield by regulating labile nutrient pools, soil enzyme activities, and soil structure. *Field Crops Research*. 2026;339.
- Sehra V, Thomas T, David A. Effect of Different Level of N P K and Biochar on Soil Physico-chemical Properties and Yield Attribute of Black Gram (*Vigna mungo* L.) var KPU 07-08. *International Journal of Current Microbiology and Applied Sciences*. 2020;9:2007-2015.
- Nayak R, Singh RK, Yadav SK. Status of organic carbon and total nitrogen under green manure and varying nitrogen levels in rice-wheat cropping system. *International Journal of Farm Sciences*. 2014;4(3):9-14.
- Gaddi AK, Basavanneppa M, Tevari P. Effects of long term use of organic and inorganic fertilizers on soil fertility and productivity under paddy- sesame cropping system. *Bangladesh Journal of Botany*. 2020;49:585-591.
- Hussain A, Ali A, Ijaz NR. Effect of Phosphorus With and Without Rhizobium Inoculation on Nitrogen and Phosphorus Concentration and Uptake by Mungbean (*Vigna radiata* L.). *Journal of Agricultural Research*. 2012;50(1).
- Soltys L, Myronyuk I, Tatarchuk T, Tsinurchyn V. Zeolite-based Composites as Slow Release Fertilizers (Review). *Physics and chemistry of solid state*. 2020;21:89-104.
- Elangovan R, Sekaran NC. Effect of biochar application on soil properties and quality parameters in cotton, Tamil Nadu. *Asian Journal of Soil Science*. 2014;9(1):1-10.
- Rm Parmar, Parmar KB, Jadeja Amardipsinh. Effect of integrated nutrient management on yield and yield attributing characters of Bt. Cotton (*Gossypium hirsutum* L.) under north -west agro climatic zone of Gujarat. *International Journal of Chemical Studies*. 2018;7(1):2362-2365.
- Cevheri CI. Farmyard manure improves the productivity and profitability of cotton (*Gossypium hirsutum* L.) under semi-arid conditions through integrated nutrient management. *Plant Biology*. 2026;26:10.
- Singh SP, Patel CR, Paikra KK. Integrated nutrient management: an effective approach for sustainable agriculture in Chhattisgarh: a review. *International Journal of Current Microbiology Applied Science*. 2020;9(5):1652-1662.

25. Babaria N, Kumari S, Rajani A, Sakarvadia H. Effect of balanced fertilization on yield, nutrient content and uptake in Bt cotton (*Gossypium hirsutum* L.) on south Saurashtra Region. Agriculture-Towards a New Paradigm of Sustainability (Mishra GC, Editor). Excellent Publishing House, New Delhi. 2010:238-244.
26. Abujabhah I, Bound S, Doyle R, Bowman J. Effects of biochar and compost amendments on soil physico-chemical properties and the total community within a temperate agricultural soil. Applied Soil Ecology. 2015;98:10.
27. Ahmed AUH, Ali R, Zamir SI, Mehmood N. Growth, yield and quality performance of cotton cultivar BH-160 (*Gossypium hirsutum* L.). The Journal of Animal and Plant Sciences. 2009;19(4):189-192.
28. Cotton Corporation of India. Annual Report 2024–25. Cotton Corporation of India, Ministry of Textiles, Government of India; 2025.
29. Das S, Ghosh G. Developing biochar-based slow-release N-P-K fertilizer for controlled nutrient release and its impact on soil health and yield. Biomass Conversion and Biorefinery. 2021;13:10.
30. Fan Qinguo. Chemical testing of textiles. Woodhead publishing; 2005.
31. Vélez-Torres I, Torres AM, Bernal-Galeano S, *et al.* Afrocolombian Struggles for Food, Land, and Culture: The Case of El Tiple. Environmental Engineering Science. n.d.;38(5):340-354.

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