# “A Review on Nano Chitosan and Bio capsules on Growth Yield and Quality of Strawberry”

**Abstract:-**

The properties of utilizing biocapsules with accommodating microorganisms and eco-accommodating and acceptable nano chitosan were the subject of the exploration. Higher growth limits, increased fruit yields, and greater fruit excellence, including flavor and nutritional value, suggest that strawberry plants performed better. It might be doable to make a more viable and capable strawberry development system by utilizing biocapsules and nano chitosan, and the mix of nano chitosan and bio containers with gainful microorganisms can offer a reasonable and further developed development framework for strawberries, with beneficial outcomes on development, yield, and organic product quality.

**Keywords**: - Nano Chitosan, Bio capsules, Strawberry growth, Yield.

## Introduction

Strawberry (*Fragaria ananassa*Duch) is a soft fruit crop which belongs to the family Rosaceae and genus Fragaria. The fleshy fruit of strawberry is classified as an aggregate fruit. In nature, all strawberry cultivars are octoploid (n=56) and belong to the Rosaceaefamily. It is a short-day plant, started in France and the two American diploids Fragaria × chiloensisand Fragaria × virginiana are considered as its begetters (Hancock *et al.*,1991). The Rosaceae family is represented by approximately half of the grown strawberries (n=56). Initially from France, it drops from two American diploids, *Fragaria chiloensis* and *Fragaria virginiana*. Strawberry cultivation used to primarily take place in regions with temperate climates. Be that as it may, even in heat and humidity with higher elevations, it tends to be filled in subtropical circumstances. Runners less than a year old are the ones who spread it. As a result, substance composts combined with natural fertilizers ought to be utilized appropriately as sources of vitamins and minerals. This will increase the productivity of supplement use without adversely affecting the health of the soil (Verma *et al.*,2020). Rhizopus sp. and the fungus Botrytis cinerea frequently end the strawberry fruit (*Fragariaananassa*) storage life due to fungal infections. (Maas,1981).Straightforwardly after collection, strawberries are put away at temperatures as low as one degree Celsius and high stickiness, which is the most widely recognized technique

for keeping them new and taking a look at rot. Alternative methods of preservation have been investigated because it is difficult to effectively control the temperature while strawberries are being transported and stored. Because of their ability to endure raised CO levels, strawberries are shipped in bed packs under high COZ circumstances (Ghaouth*et al.*,1991). However, (Kazzaz *et al.*,1983) have high CO* controls, and off-flavor advancement might result from deferred CO1 openness (Woodward and Trimming, 1972).

The use of nanotechnology techniques in material science and biomass conversion technology used in the agriculture sector is fundamental in the production of food and fuels (Salachna*et al.*,2021).Developingnanotechnologies has the possible to suggestively progress agricultural manufacture and sustainability. Norio Taniguchi, a professor at the Tokyo University of Science, coined the term "nanotechnology" in 1974 (Khan & Rizvi, 2014). Additions from nano manures are approved on a case-by-case basis, forestalling unfortunate contact with soil, water, and microorganisms. The plant's structure rapidlycaptivates the enhancements. As shown by (Rosa *et al.*,2010).Thesefeatures may improve crop nutrient productivity. Strawberries are now substantial nearly 75 countries. China, the US, Canada, France, Italy, the Joined Domain, Bulgaria, Poland, Southern and Eastern Africa, New Zealand, Australia, and Japan are the important strawberry non-industrial countries. The critical groups of progress in India are Nainital (a region) and Dehradun in Uttar Pradesh, Mahabaleshwar (Maharashtra), the Kashmir Valley, Bangalore, and Kalimpong (West Bengal), all of which have a complete area of 0.21 thousand ha and harvest 1.61 thousand MT (Pramanick*et al.*,2013).In accumulation, it makes available a potent source of vitamin A (60 IU per 100 g of usable portion) in place of pure L-ascorbic acid. According to Wange and Kzlogoz (1998), calcium petite's complex gelatin content (0.55%) makes it an exceptional element for jam-making. Strawberries have arisen as a fundamental food thing for a huge number of characters overall because of their slight flavor and indulgence of nutrients and minerals (Sahana *et al.*,2020). In addition to anthocyanin, carotenoids, flavonoids, nutrients, flavonoids, and phenolic compounds (Giampieri*et al.*, 2017).

Chitosan is the N-acetyl subsidiary of chitin developed by N-deactivation. Chitosan is broadly used in the food and bioengineering industries to encapsulate active food ingredients, immobilize enzymes, transport controlled drug delivery, and boost plant growth in agriculture. Chitosan also works as an antimicrobial and a resistance elicitor. Chitosan has captivating belongings like biodegradability, biocompatibility, bioactivity, nontoxicity, and polyatomic nature (Divya and Jisha, 2017). It is a fruit of the temperate zone, so it needs temperatures

below 26 degrees Celsius to begin flowering (Jackson *et al.,* 2011). However, it tends to be filled in subtropical environments and at high heights in tropical locales (Chattopadhyay, 2013). As of now, strawberries are occupied in a great many climatic zones because of their genotypic variety. The US is the major creating nation, accounting for 30% of the world accumulation, whereas India, is being industrialized in a space of 1000 hectares with a yearly making of 5000 metric tons (Pramanick*et al.,* 2013).

In the subtropical area, strawberry plants do much improved with good nutrition and a controlled source of nutrients and can produce more. Nano mixed foliar sprays with nano fertilizer that syndicate macro and microelements like iron (Fe), copper (Cu), manganese (Mn), and zinc (Zn) are better for production in the field, more durable, and less mobile than traditional sprays. Foliar nano composts furthermore lower soil useful full scale and miniature designed component poisonousness (Abbasifar*et al.,* 2020). The foliar use of nano chitosan improved natural product yield, as well as further emergent organic product quality credits, for example, sugar content and cell strengthening limit. These findingsmention that nanochitosan may absolutely affect both the amount and nature of strawberry making. The application of nano chitosan in strawberry cultivation has been the subject of abundant studies. (Ghahremaninejad*et al.*, 2020)

Demonstrated the effectiveness of encapsulated micronutrients in improving nutrient uptake efficiency and subsequently enhancing strawberry growth. This approach is particularly promising for optimizing the nutrient supply to the plant and reducing environmental impacts associated with excessive fertilizer application.In addition to nano chitosan, bio capsules have gained attention as a novel approach to enhance nutrient delivery and stress management in strawberry plants. Research by (Singh *et al.,* 2021)recently, illicit fertilizer, pesticides, and biological monitoring findings have created environmental contamination in strawberry agriculture (Zargar *et al.*, 2017). Chemical fertilizers increase crop productivity, but they also introduce harmful residues that harm humans, degrade sustainability, and pollute water (Mamun *et al.*, 2021).Increasing strawberry cultivation is therefore virtually a formidable challenge (Aziz *et al.*, 2021).

Despite its broad antimicrobial activity against fungal pathogens, nano chitosan's bulk size restricts its solubility, affecting its properties. Chitosan nanoparticles have a lot more potential than their bulk counterparts because their size can change several properties. Here must similarly remained disquiets raised regarding adverse belongings on environmental

health due to these materials' unique features, such as their greater outward area and higher reactivity. Researchers at the Indian Gathering of Rural Exploration (ICAR) have as of late fostered a technique for bundling bio-composts into minute cases. This kills the requirement for ranchers to convey the sacks of biofertilizers. It comprises a transporter medium wealthy in live microorganisms, particularly bacillus, and pseudomonas. It either increases the biological availability of soil nutrients when applied to seed, soil, or living plants. ICAR, Kozhikode (Indian Institute of Spices Research). Biocapsules, nanomicro, and nanomacro fertilizers, on the other hand, have received relatively little research attention. In light of the preceding information, the experiment titled "Effect of Nano-chitosan, Nano-micronutrients, and Biocapsules on Strawberry (Fragaria ananassa) cv. yield and qualitative attribute "Winter dawn" was planned and implemented.

This study means to add to the current group of information by researching the joined impacts of nano chitosan and bio containers on the development, yield, and nature of strawberry plants (Kashyap *et al.,* 2015). We hope to provide valuable insights for sustainable and high-quality strawberry production, which is of significance not only to the agricultural industry but also to consumers who enjoy this delectable fruit, by evaluating the most recent advancements in nanotechnology and their potential benefits for strawberry cultivation.

I'm not aware of any specific information regarding the application of biocapsules and nano chitosan to strawberries as of my most recent knowledge update in September 2021. However, I can provide some general insights into how strawberry cultivation may be affected by these technologies:-

**1.** Bio capsules: - Biocapsules are naturally tiny, decomposable vessels that are made to exactly and controlled deliver nutrients, pesticides, or other components to plants. With regards to strawberries, biocapsules could be used to deliver additions, improve innovative elements, or even useful microorganisms bit by bit after particular time (Lokesh *et al.,* 2020). The effects of biocapsules on strawberry plants could include:

Controlled Release of Nutrients: -Biocapsules can give a dependable accumulation of important complements to strawberry plants, probably additional developing development and natural product formation. Impact on the environment: Nutrient runoff's influence on the environment and over-fertilization can both be concentrated by controlled production systems. Disease and Pest Control: Biopesticides or beneficial microbes could be released into biocapsules to aid in defensible pest and disease control.

Enhanced Productivity: - Fruit quality, including flavor, color, and shelf life, could be enhanced through the controlled release of certain compounds (Yousuf *et al.*, 2018).

**2.** Nano Chitosan: - Chitosan is a polymer that separates in the body and is produced using shellfish chitin. The expression "nano chitosan" alludes to minuscule chitosan particles. When applied to strawberries, nano chitosan may have a couple of potential effects:

Infection Block: As indicated by (Naggar *et al.*, 2022) nano chitosan may upgrade the plant's regular protections, making it more impervious to normal strawberry illnesses like fine buildup and Botrytis cinerea. Expanded Time span of usability of Natural product: Strawberries can be covered with coatings made of chitosan to forestall deterioration and rot and increment their timeframe of realistic usability.

Expanded Take-up of Supplements (Khan *et al.*, 2019):- Nano chitosan could chip away at the ingestion of central enhancements, perhaps inciting extended regular item creation.

Biological Benefits: - Chitosan is considered an eco-obliging decision in cultivating due to its biodegradability and non-unsafe nature (Hassan *et al.*, 2107).

**Effect of Nano Chitosan:** - A changed type of chitosan, nano chitosan is a biopolymer produced using chitin tracked down in shellfish shells. It has acquired consideration in view of its possible applications in agribusiness, for example, helping strawberry development, yield, and quality. Coming up next are a few potential impacts of nano chitosan on strawberries.

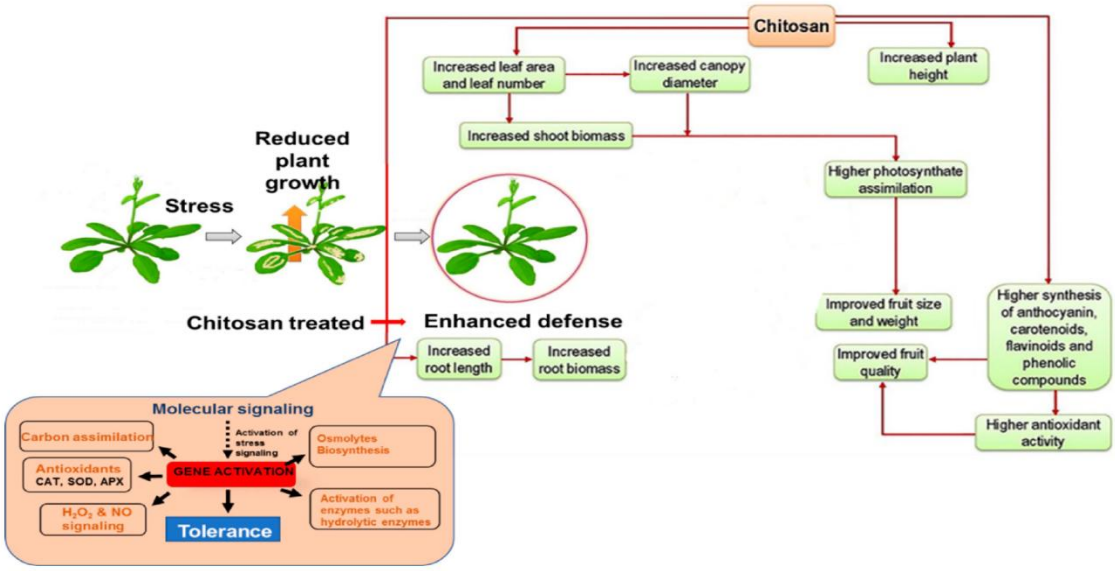


Fig.1- Diagram representing chitosan mediated plant growth regulation
Source – Chakraborty *et al.*,2020

1. Disease Resistance: Strawberry plants can be safeguarded from anthracnose and dark shape (Botrytis cinerea) on account of nano chitosan's feasible use as a typical fungicide and bactericide. It keeps microorganisms away from approaching the plant by going most likely as a restriction of well-being on its clear.

2. Increased Absorption of Supplements: Strawberry plants may be able to retain more essential additions thanks to nano chitosan. Fruit quality, production, and growth may all get improved (Fig.1).

3. Increased Efficiency: In the wake of utilizing nano chitosan, strawberries might increase in assortment, flavor, and medical advantages. By diminishing post-collect decay, strawberries might have the option to keep up with their cleanness for a more drawn-out timeframe.

4. Adaptability to Stress: It has been discovered that nano chitosan helps a plant resist salt and the dry season. Strawberry plants may gain from this in adverse conditions.

5. Pesticide Use Reduction: The improvement of strawberries with nano chitosan could make it less crucial to utilize planned pesticides. In addition to not affecting the ecosystem, this may also reduce manufacturing costs.

6. Economic Expansion: Extra-made sickness checks, better improvement take-up, and push obstructions can initiate higher strawberry yields. Farmers can anticipate producing more natural products for each unit of land or plant.

7. Filling in a down-to-earth way: Nano chitosan is an actual that is ok for the environment and can be utilized in regular and pragmatic development frameworks.

**Bio-capsule result:-**

There is still a wide range of products and knowledge that are mentioned to as "bio capsules." bio cases" might refer to changed items or ideas in horticulture and related fields (Martins *et al.*, 2022). Numerous possible results are as follows:

1. Cases of bio fertilizer: Alive or slow-discharge bio fertilizersvolumeis alluded to as bio capsules. These containers coverhelpful microorganisms or additions designed to progress soil maturity and plant growth. Strawberry plants can have more admittance by using bio fertilizer containers.

2. Bio pesticide Cases: Bio cases may likewise allude to embodied types of appreciated bugs, nematodes, or microorganisms used in strawberry cultivation for natural nuisance regulator. To combat specific pests, these containers gradually statement beneficial organisms into the environment.

3. Cases for Biodegradable Equipment: For sowing seeds or seedlings, a few groups are developing biodegradable cases. These cases might contain development-supporting additions or defensive components, like strawberries.

4. Cases with Controlled Supplement Delivery: In controlled-release agriculture, nutrients are regularly released to plants through capsules. Specific additionsupplies for various harvests, including strawberries, can be added to these cases.

5. Biotechnology or Genetic Planning: The encapsulation of genetically adaptedmaterials or organisms for crop development research or biotechnology applications might be mentioned to as bio capsules.

**Effects of Nano Chitosan and Bio-Capsule:-**

The use of biocapsules (Fig.2) and nano chitosan (Fig.3) in strawberry farming may have numerous helpful things for the plants and the crop as a whole (Rise*het al.*, 2022)


Fig. 2- Bio- capsule

Fig 3- Nano chitosan

1. **Integration of biocapsules and nano chitosan with organic fertilizers:** Investigating the potential synergy of combining biocapsules and nano chitosan with organic fertilizers will be useful. Organic fertilizers can enhance soil and provide nutrients to plants, while biocapsules and nano-chitosan can improve nutrient uptake and disease resistance.
2. **Testing different application methods:** It will be valuable to investigate different methods of using bio-capsules and nano-chitosan in strawberry plants. This can include foliar application, root drench or incorporation into the soil during planting. By comparing the effectiveness of different application methods, farmers can determine the most efficient and practical methods for their specific farming practices.
3. **Long-term evaluation:** Long-term evaluation of biocapsules and nano-chitosan in strawberry cultivation is needed. This can include monitoring soil health, crop yield

and quality over multiple growing seasons. Long-term studies provide a comprehensive understanding of the sustainability and effectiveness of these technologies.

4. **Considering the environmental risk:** In the situation that biocapsules and nano-chitosan have the potential to reduce the environmental risk, it is evaluated that the potential negative for the ecosystem is very important. Environmental risk assessments must be conducted to ensure that these technologies do not harm non-target organisms or contaminate water resources.
5. **The possibility of economic evaluation and economic feasibility:** it will be useful to conduct analyzes for the possibility of evaluating and cost-effectiveness of bio-capsules and nano-chitosan in the commercial cultivation of strawberries. Farmers must understand the potential return on investment and determine whether the benefits outweigh the costs.
6. **Knowledge transfer and training of farmers:** To use biological capsules and nano-chitosan in strawberry cultivation, it is to provide education and training to farmers in their correct use and application. Knowledge transfer programs and on-farm demonstrations can help farmers understand the potential and learn how to integrate these technologies into their farming practices.
7. **Expanded Supplement Assimilation:**Nanochitosan redesigns the take-up of foremost improvements by strawberry plants, while bio receptacles release additions step by step. This dual approach makes sure that as many nutrients as possible are available, which helps the plants grow well and make more fruit.
8. **Adaptability to Stress:** Strawberry establishes that are more vigorous and complete to endure ecological stressors like saltiness and dry spells can profit from the expansion of bio cases and nano chitosan.
9. **Pesticide Use Reduction:** The synergistic things of nano chitosan and bio cases can help with increasing the prerequisite for designed pesticides, in this manner secondary reasonable and eco-obliging emerging practices.
10. **Profitable Growth:** The application of the two improvements can affect higher returns, resulting in more abundant strawberry yields, which can be achieved by adding strengthening illness resistance, additional intake, and stress flexibility.

11. **Increased Efficiency:** Organic products from improved plants have improved tone, flavor, and health benefits. Fruit of higher quality can be formed by combining biocapsules and nano chitosan, making it more appealing to consumers.
12. **Cases for Biodegradable Equipment:** Strawberry plants may benefit from the biocapsules' capability to biodegrade and deliver them with an ideal environment for their early growth and development, resulting in better formation.
13. **Viable Developing Practices:** Using both bio capsule and nano-chitosan follows biologically friendly and wieldy rural practices that can support reducing the usual influence of strawberry growth.

In general, more research and practical operation of bio-capsules and nano-chitosan in strawberry cultivation can improve the productivity, stability and quality of the fruit, which will benefit farmers and consumers.The combinedapplication of nano-chitosan and bio capsule in strawberry development can absolutely affect the increase of strawberry growth:-

**Growth:-**

1. Enhanced Nutrient Absorption: Strawberry plants absorb added of the essential nutrients nano-chitosan and Biocapsules may strongly release nutrients, further encouraging healthy plant growth:-

2. Improved Stress Flexibility: Both nano chitosan and bio containers can increase the plant's ability to endure natural stressors, like dry spell and saltiness, prompting improved and more influential plants.

3. RecyclableForming Cases: Bio cases, if environmental, can establish a good climate for the early growth of strawberry plants, guaranteeing a better foundation and starting development.

**Yield: -**

1. Prolonged Sickness Impediment: Nano chitosan protects against diseases that can lower yields by acting as a natural fungicide and bactericide.

2. Improved Access to Nutrients: Biocapsules and nano chitosan can be used together to increase nutrient accessibility, ensuing in improved fruit production and yields.

1. Quality ImprovedProduction: Strawberries from better plants are more colorful, flavorful, and nutritious. The application of both nano-chitosan and bio capsule can quick unrivaled biological product quality.

2. Reduced Higher Pesticides: The combinedsystem might reduce the condition for engineered pesticides, ensuring that the organic product is liberated- from pesticide accumulations and satisfies quality procedures.

3. Sustainability: Both nano chitosan and bio capsulesustenancepossible and harmless to the environment horticultural works on, adding to the growth of top caliber, capably developed strawberries.

**Conclusion**

Overall, the combined use of bio capsule and nano chitosan in strawberry production may have a significant and positive effect. Similar positive effect is seen in the experiment of Topno & devi,2022 that the combined application of Nano chitosan 120 ppm + Bio capsule 120 ppm resulted in highest growth, yield and quality of Chilli that are- plant height (63.73 cm), fruit yield per 200m2 (3.27q), T.S.S. (9.67 0 Brix) and ascorbic acid (143.96 mg/100 g).Likewise, Singh *et al.*,2023 concluded in his experiment that the application of N P K (RDF) + Nano chitosan 100 ppm (Soil drenching) + Bio capsule 500ppm + foliar application of ZnO and

FeO nano particles was found best and significantly most effective in terms of strawberry growth, flowering and fruiting attributes that are- plant height (14.86 cm), leaf per plant (19.48), flowers per plant (30.4), number of fruits per plant(25.57).These improvements advance wieldy cultivating practices, increase enhancement take-up, upgrade pressure flexibility, and upgrade sickness opposition. Subsequently, the plants are greater, the yields are higher, and the natural product quality is better. To get the most out of these benefits, it is necessary to adapt native regulations and guidelines for safe and responsible agricultural practices to specific strawberry varieties and growing conditions.

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