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Evaluate the effect of essential oils on plant growth parameters of sunflower

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Abstract
The experiment was laid out during the *kharif* season 2022 conducted at the Departmental field (Department of Plant Pathology) of SHUATS, Prayagraj, sunflowers were treated with Mentha oil (0.7%), Fennel oil (0.7%), Cumin oil (0.7%), Lemongrass oil (0.7%), Eucalyptus oil (0.7%), Trichoderma viride (10 grams), and treated with Mancozeb (0.2%). It was found that Mentha oil (0.7%) was the most effective treatment among those examined. and recorded maximum plant height (37.6 cm). There were seven treatments and three replication and the experiment was conducted in a Randomized Block Design.

Keywords: Essential oils, bio agent, sunflower, plant height parameters

Introduction
Worldwide, sunflower (*Helianthus annuus* L.) is a significant oilseed crop. It is a member of the Asteraceae family, which has 200 genera, 65 species of Helianthus among them. It is endemic to North Eastern America and is believed to have been domesticated by endemic Americans about 3000 B.C. Although the wild sunflower is a native of North America, it happened in Russia that the crop was first commercialized. Due to their relatively short growth season, these huge plants are grown all over the world. A sunflower is an annual plant that grows at a height of 3 to 12 feet. It has rough, hairy stems, broad leaves that are coarsely serrated, and round flower heads that are 3 to 6 inches across in wild specimens and sometimes a foot or more in cultivation. The flower-heads are made up of several tiny tubular flowers compactly packed on a flat disk; the long, strap-shaped corollas of the flowers in the outer row create the composite flower's rays. In reality, each inflorescence, or head, of a sunflower is made up of two different kinds of blooms. Individual ray flowers are what resemble golden petals around the head's edge (Luqueño *et al*., 2014) [1].

The sunflower, or *Helianthus annuus* L., is a significant and rapidly expanding vegetable oilseed crop that is indigenous to Mexico and the southern United States. It is ranked fourth in the world, behind soybean, rapeseed, and peanut. The Greek words "Helios" (sun) and "Anthos" (flower) refer to the Sun, Gurumukhi, or Sooryakanthi, which are members of the Asteraceae family. The name refers only to a plant whose blossom faces directly toward the light and resembles the sun's yellow rays as it passes. Next to food grains, oilseed crops play a significant role in the Indian economy.

In addition to being a vital component of the human diet, oil is used as a raw material to make a variety of goods, including lubricants and flavor enhancers. India first planted sunflower in 1969 as an addition to its conventional oilseed crops in an effort to fill the nation's ongoing need for edible oil. Russian cultivars from the USSR and Canada were introduced in 1972–1973, marking the beginning of the commercial cultivation of sunflower in India. The crop is currently widely used due to its advantageous characteristics, which include short growth season, insensitivity to photoperiod, adaptability to a variety of soil and climate conditions, resistance to drought, increased seed to plant balance, and top quality edible oil (45–50%) (Shekhawat and Shivay, 2008) [6]. The introduction of this crop in India, productivity has remained low in comparison to global average productivity, despite the fact that the area under this crop has risen significantly. Achieving optimal resource use efficiency (RUE) is a prerequisite for a sustainable industrial system (Hawkesford, 2012) [7].

With 0.90 million hectares of cultivation, 0.62 million tons of output, and an average yield of 696 kg/ha, India is the world's greatest sunflower producer. The states of Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, Bihar, Punjab, Haryana, and Uttar Pradesh are significant producers of sunflowers in the nation. Andhra Pradesh and Maharashtra both come after Karnatka in terms of area and production of sunflower. Karnataka hols 1st position. (Waghe *et al*., 2015) [2].

India is one of the world's biggest importers of edible oils and a significant producer and consumer of oilseeds and their derivatives, having become so in the late 1990s. Because of the rise in per capita income and level of life, there has also been a substantial increase in the domestic demand for vegetable oils and fats. The sunflower, a significant oilseed crop, is a member of the Asteraceae family's genus Helianthus. Its superior edible oil has led to its widespread adoption and acceptance. Sunflower seeds have high oil content, between 35 and 50 percent. Since Russian varieties like Peredovick (EC 68414) and Armavirskii (EC 68415) were introduced to India in the 1960s, sunflower has become a significant commercial oilseed crop. It is grown in many different climatic and geographic regions because of its wider adaptability, responsiveness to additional inputs, and neutrality to day length. The traditional sunflower-growing states in India include Karnataka, Andhra Pradesh, Maharashtra, and Tamil Nadu, with Karnataka leading the nation in production. But recently, sunflower has migrated to the nation's north, where output is quite high. The area used to raise sunflowers in India is trending downward (Nimbrayan *et al*., 2020) [3].

It is the fourth-largest oil-seed crop in the world; the dried stalk is used as fuel and the seeds are eaten. It was utilized in ancient rites and is already employed as an attractive plant. There have also been reports of medical applications for respiratory ailments. Furthermore, this plant's components are utilized to make textile dyes, body paint, and other decorations. In addition to being used for cooking, sunflower oil is also utilized in the production of margarine and shortening. Paints and cosmetics are made in the business using sunflower oil. The roasted seeds could be used to make a sort of coffee. The seed cake left over after oil is extracted is fed to cattle in some nations. The hulls were used in the Soviet Union to cultivate yeast, make ethyl alcohol, and line plywood. Additionally, fuel has been made from the dried stems. The stems can be composted and added back to the soil as fertilizer because they contain potassium and phosphorus. Given its high nutritional content and absence of antinutritional elements, sunflower meal presents a viable source of protein for human consumption (Luqueño *et al*., 2014) [1].

Materials and Methods

The experiment took place in the *kharif* season of 2022 at the Department of Plant Pathology at Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS). Prayagraj is a city in southern Uttar Pradesh that is situated at a junction of the Ganga and the Yamuna along with the Saraswati river. Its coordinates are 25.45°N 81.84°E. The humid subtropical climate that is typical of north-central Indian cities is what Prayagraj experiences. Three distinct seasons are experienced in Prayagraj: warm, humid monsoon; mild, dry winter; and hot, dry summer. Maximum temperatures throughout the summer months of April through June range from 40 °C (104 °F) to 45 °C (113 °F). The monsoon season lasts from early July to September. Plotting was done in the chosen field area in accordance with the layout plan. The chosen field was excavated, cleared of weeds, thoroughly cleansed, and the dirt thoroughly ground up before the entire area was split up into smaller portions. The sunflower variety used in the experiment was the Surya S3. Every procedure was carried out in accordance with standard agronomic procedures. Plants were spaced 25 cm apart from one another, and rows were separated by 60 cm. After the seeds were sown, a light irrigation was carried out. Prior to and following seeding, the field received light irrigation. On alternate days, the field received regular nighttime irrigation. To minimize crop-weed competition and ensure optimal crop growth, weeding was done on schedule, every seven days, or once a week.

Essential oils have been studied for their potential effects on plant growth and development, including on crops like sunflowers. Here's an evaluation of the potential effects:

1. **Stimulation of Growth:** Some essential oils have been found to stimulate plant growth by enhancing nutrient uptake, promoting root development, and increasing photosynthesis. Certain constituents of essential oils, such as terpenes and phenolic compounds, may act as growth promoters by enhancing hormone production or signaling pathways in plants.
2. **Antimicrobial Properties:** Many essential oils possess antimicrobial properties due to their high concentrations of compounds like terpenoids. By controlling pathogens in the soil or on plant surfaces, essential oils may indirectly support plant growth by reducing the risk of disease and allowing plants to allocate more resources to growth rather than defense.
3. **Allelopathic Effects:** Some essential oils have allelopathic properties, meaning they release chemicals that inhibit the growth of competing plants or weeds. While this can be advantageous in weed control, it may also affect neighboring sunflowers if not applied carefully, potentially leading to reduced growth or yield.
4. **Stress Alleviation:** Essential oils are known to have stress-alleviating effects on plants. They can mitigate the negative impacts of abiotic stresses such as drought, salinity, or extreme temperatures by enhancing antioxidant activity and regulating stress-responsive genes. By reducing stress, essential oils may indirectly promote better growth and yield in sunflowers.
5. **Insect Repellent:** Some essential oils have insect-repellent properties, which can protect sunflowers from pest damage. By deterring pests or interfering with their feeding behavior, essential oils can prevent stunted growth or yield loss caused by insect infestations.
6. **Phytotoxicity:** On the flip side, high concentrations of certain essential oils can be phytotoxic, causing damage to plant tissues and inhibiting growth. Care must be taken to determine appropriate concentrations and application methods to avoid negative effects on sunflowers.
7. **Soil Health:** Essential oils can also influence soil health by affecting microbial communities and nutrient cycling processes. By promoting beneficial soil microorganisms or inhibiting harmful ones, essential oils may indirectly improve nutrient availability and uptake, thus supporting sunflower growth.

Overall, while essential oils have the potential to positively influence various aspects of sunflower growth, their effectiveness can vary depending on factors such as oil composition, concentration, application method, and environmental conditions. Further research is needed to better understand the specific effects of different essential oils on sunflower growth parameters and to optimize their use in agricultural practices.

Results

The observation of plant height represented in table 1 and figure 1 was taken at 30 DAS, 45 DAS, 60 DAS show that significant increase in plant height was observed in T_1 plot which was treated with Mentha (*Mentha piperita*) and the seed tratment was done with Trichoderma viride. The growth of Plant height parameter of different days after sowing are as follows -

The sunflower plant was measured to the following height (cm) at the end of 30 days after sowing (DAS) as indicated in table - 1 and figure - 1. The plant height significantly decreased when (Treatment - 3) Cumin oil was applied at 0.7% (25 cm), (Treatment - 5) Eucalyptus oil was applied at 0.7% (27.8 cm), (Treatment - 2) Fennel oil was applied at 0.7% (28.3 cm), (Treatment - 4) Lemongrass oil was applied at 0.7% (29.11 cm) and (Treatment - 1) Mentha oil was applied at 0.7% (32.9 cm) compared to (Treatment - 6) Mancozeb and (Treatment - 0) untreated control (22.3 cm). As a whole, all treatments were found to be significant compared to the untreated control (T_0). However, there were no significant differences among the treatments (T_3, T_5), (T_5, T_2, T_4), and (T_2, T_4).

The sunflower plant was measured to the following height (cm) at the end of 45 days after sowing (DAS) as indicated in table - 1 and figure – 1. The plant height significantly decreased in (Treatment – 3) Cumin oil was applied at 0.7% (27.3 cm), followed by (Treatment – 5) Eucalyptus oil was applied at 0.7% (29.3 cm), (Treatment – 2) Fennel oil was applied at 0.7% (29.7 cm), (Treatment – 4) Lemongrass oil was applied at 0.7% (31.1 cm) and (Treatment – 1) Mentha oil was applied at 0.7% (34.3 cm) compared to (Treatment – 6) Mancozeb was applied at 0.2% (37.5 cm) and (Treatment - 0) untreated control (23.6 cm). As a whole, all the treatments were found to be significant compared to the untreated check (T_0). However, there were no significant differences among the treatments (T_3, T_5, T_2), (T_5, T_2, T_4) and (T_2, T_4).

The sunflower plant was measured to the following height (cm) at the end of 60 days after sowing (DAS) as indicated in table - 1 and figure – 1. The plant height significantly decreased in (Treatment – 3) Cumin oil was applied at 0.7% (30 cm), followed by (Treatment – 5) Eucalyptus oil was applied at 0.7% (32.8 cm), (Treatment – 2) Fennel oil was applied at 0.7% (33.5 cm), (Treatment – 4) Lemongrass oil was applied at 0.7% (34.5 cm) and (Treatment – 1) Mentha oil was applied at 0.7% (37.6 cm) when compared to (Treatment – 6) Mancozeb was applied at 0.2% (40.4 cm) and (Treatment - 0) untreated check (25 cm). As a whole, all the treatments were found to be significant compared to the untreated check (T_0). However, there were no significant differences among the treatments (T_3, T_5, T_2), (T_5, T_2, T_4), and (T_2, T_4).

Table. 1: Tabular Representation of the treatments impact on sunflower plant height (cm) at 30 DAS, 45 DAS, and 60 DAS.

S. No	Treatments	Plant Height (cm)		
		30 DAS	45 DAS	60 DAS
T_0	Control (untreated check)	22.3	23.6	24.9
T_1	Treat the seeds with *Trichoderma viride* at a rate of 10 g/kg + *Mentha piperita* at a rate of 0.7% (7 ml)	32.9	34.3	37.6
T_2	Treat the seeds with *Trichoderma viride* at the rate of 10 g/kg seed + *Foeniculum vulgare* at the rate of 0.7% (7 ml)	28.3	29.7	33
T_3	Treat the seeds with *Trichoderma viride* at the rate of 10 g/kg seed + *Cuminum cyminum* at the rate of 0.7% (7 ml)	25	27.3	30
T_4	Treat the seeds with *Trichoderma viride* at the rate of 10 g/kg seed + Lemongrass at the rate of 0.7% (7 ml)	29.1	31.1	34.5
T_5	Treat the seeds with *Trichoderma viride* at the rate of 10 g/kg seed + *Eucalyptus globules* at the rate of 0.7% (7 ml)	27.8	29.3	32.8
T_6	Treated check-Mancozeb at the rate of 0.2%	35.9	37.5	40.4
F. test		S	S	S
S.Ed. (±)		1.18	1.32	1.50
CD (5%)		2.5	2.8	3.2

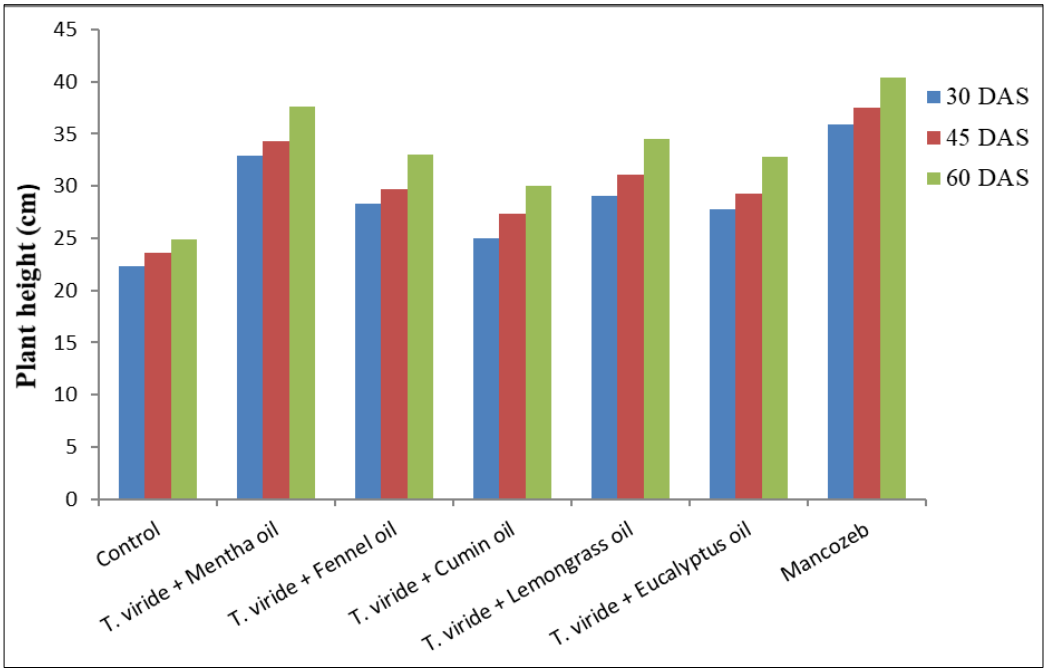

Fig 1: Graphical representation of the treatments imapact on sunflower plant height (cm) at 30 DAS, 45 DAS and 60 DAS.

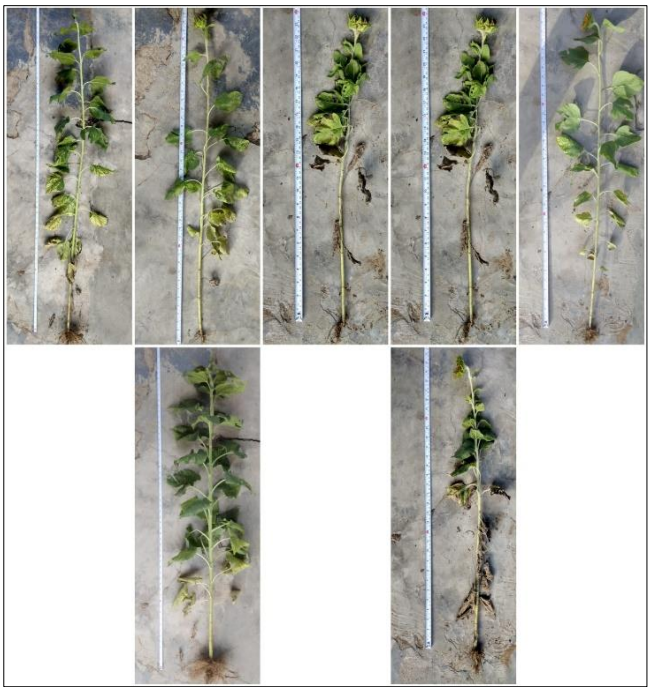

Fig 2: Image showing Sunflower plant height (cm) based on treatments

These results could be explained by the fact that *Trichoderma* species is a fast-growing fungus that suppresses pathogen growth through cellulose synthesis, antibiosis, competition, and other hydrolytic enzyme production. Additionally, by fostering plant resistance and encouraging plant growth, they can indirectly reduce infections. Mentha essential oil, for example, has According to the reports, menthol contains a hydroxyl group surrounding the phenolic ring, which disrupts the cytoplasmic membrane of microorganisms to operate as an effective antimicrobial agent. Plants that grew better as a result may have reached their maximum height (in centimeters).

Similar findings have been reported by Nakkeeran *et al.* (2018) [4]; Mafakheri and Mirghazanfari (2018) [5].

Conclusion

The current study's findings showed that applying 10 g of *Trichoderma viride* to seeds and 0.7% of mentha essential oil via foliar spraying resulted in maximum plant height (cm). The result of the current study is restricted to a single crop season (April 2022–June 2022) in Prayagraj, with agroclimatic conditions. Consequently, additional trials of this kind should be conducted in the future to validate the current findings.

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