
Allelopathic Effect of Neem (*Azadirachta indica*) Leaf Extract on Seed Germination and Seedling Growth of Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

Cotton (*Gossypium hirsutum* L.) is a globally significant crop grown primarily for its fibre. The present investigation was undertaken to study the allelopathic effect of *Azadirachta indica* (Neem) leaf extract on extract on in-vivo seed germination and early seedling growth in cotton. Different concentrations of neem leaf extract viz., 5%, 10%, 15%, 20% and 25% were applied to cotton seeds and seedlings grown in soil, and their effects were compared with control. The results revealed that neem leaf extract significantly influenced seed germination and seedling vigour. The highest seed germination percentage (79.2%) was recorded at 10%, 20% and 25% neem extract, followed by 70.8% germination at 5%, as compared to 54.2% in control. Seedling growth parameters also showed variation with concentration. The maximum seedling height (12.9 cm) and improved root growth were observed at 5% neem extract, indicating a stimulatory effect at lower concentrations. However, higher concentration (25%) showed reduced seedling height (10.5 cm), suggesting an inhibitory effect at elevated doses.

The study clearly indicates that low concentrations of neem leaf extract (5–15%) enhance seed germination and seedling growth, while higher concentrations adversely affect growth. Thus, neem leaf extract exhibits concentration-dependent allelopathic effects on cotton seedlings. The findings suggest that neem leaf extract at lower concentrations can be effectively used as an eco-friendly growth-promoting agent in cotton cultivation.

KEYWORDS:- Allelopathy; *Azadirachta indica*; Neem leaf extract; *Gossypium hirsutum*; Seed germination; Seedling growth; In-vivo study; Eco-friendly growth promoter.

INTRODUCTION

Cotton (*Gossypium* spp.) is one of the most important fibre crops globally and also serves as a source of edible oil and protein. The genus *Gossypium* (family Malvaceae) comprises about 52 species, of which four are cultivated. *Gossypium hirsutum* and *G. barbadense* are autotetraploid species ($2n = 52$), while *G. arboreum* and *G. herbaceum* are diploid ($2n = 26$). In India, cotton is grown across diverse agro-climatic regions, with *G. hirsutum* occupying nearly 99% of the cultivated area due to its high adaptability and yield potential.

The introduction of Bt cotton significantly improved productivity by providing resistance against the bollworm *Helicoverpa armigera*. However, the emergence of pest resistance and increasing dependence on chemical insecticides have raised concerns regarding environmental safety and sustainability. Continuous use of synthetic pesticides has also led to ecological imbalance and increased production costs.

Neem (*Azadirachta indica* A. Juss.) is a well-known medicinal tree possessing bioactive compounds such as azadirachtins, which exhibit strong insecticidal properties. Neem-based biopesticides are biodegradable, eco-friendly, and safe to non-target organisms, making them suitable alternatives to chemical pesticides.

This study investigates the influence of aqueous leaf extracts of *Azadirachta indica* at varying concentrations on plant growth and pest control in non-Bt cotton, with emphasis on the role of neem-based biopesticides in sustainable cotton production.

MATERIAL AND METHOD

Collection of Plant Material

Leaves of *Azadirachta indica* were picked from the PGTD. Of Botany RTMNU. Nagpur

Preparation of aqueous extract.

The leaves were washed thoroughly with tap water and shade dried for one week and crushed with the help of pestle and mortar into fine powder.

This powder was used for aqueous extract of leaves.

Method of Extraction

Method of Extraction and In Vivo Seed Germination

Fifty grams (50g) of dried powder of *Azadirachta indica* were added to 300 ml of boiling distilled water in a 500 ml conical flask and kept on a rotary shaker for 2 hours. The extract was passed through muslin cloth and then centrifuged at 3000 rpm for 15 minutes, after which the resulting pellets were collected and kept at room temperature.

For in vivo seed germination, seeds were sown in sterilized soil. The pots were irrigated with different concentrations of the extract (5%, 10%, 15%, 20%, and 25%), while control pots received distilled water. Germination percentage was recorded at regular intervals.

RESULTS

In-Vivo Seed Germination

The effect of different concentrations of neem extract on in-vivo seed germination is presented in Table No. 1. The results clearly indicate that neem extract had a positive influence on seed germination when compared to the control.

In the control treatment, only 54.2% seed germination was recorded. Application of neem extract significantly increased germination percentage. The highest seed germination (79.2%) was observed at 10%, 20%, and 25% neem extract concentrations, indicating a strong stimulatory effect at these levels. This was followed by 5% neem extract, which showed 70.8% germination.

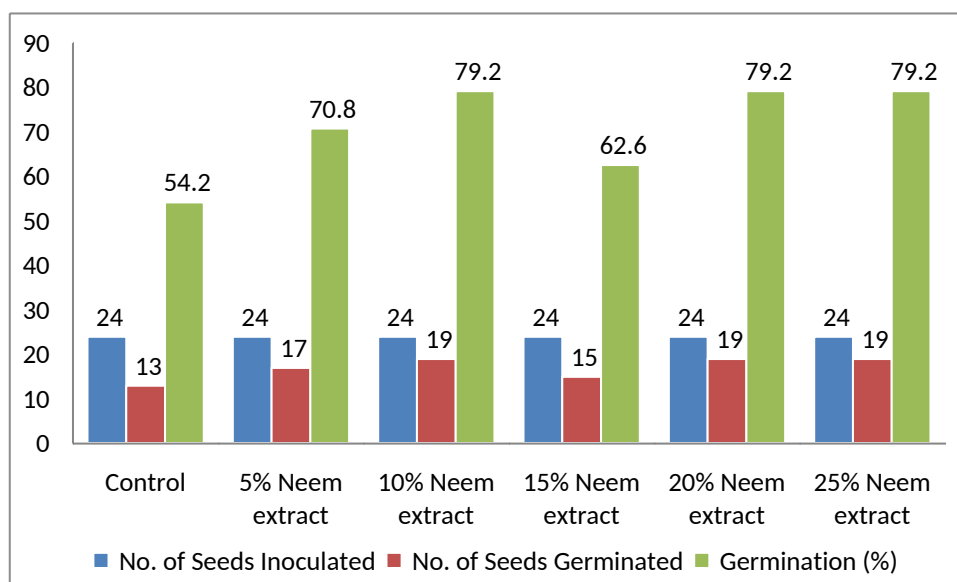
However, at 15% neem extract, germination decreased slightly to 62.6%, suggesting that moderate concentrations may exert a comparatively lesser effect on germination than higher concentrations.

Overall, the study reveals that incorporation of neem extract into the soil enhanced seed germination, with optimum results observed at 10–25% concentrations. The improved germination may be attributed to the presence of bioactive compounds in neem that stimulate seed metabolic activity and improve soil micro-environment.

Table 1. Effect of Neem Extract on Seed Germination Percentage

Treatment	No. of Seeds Inoculated	No. of Seeds Germinated	Germination (%)
Control	24	13	54.2
5% Neem extract	24	17	70.8
10% Neem extract	24	19	79.2
15% Neem extract	24	15	62.6
20% Neem extract	24	19	79.2
25% Neem extract	24	19	79.2

Graph: -Effect of Aqueous Neem Extract at Different Concentrations on Seed



Germination Performance

Photographs of Seed germination response under different concentrations of neem (*Azadirachta indica*) extract (Control, 5%, 10%, 15%, 20% and 25%).







DISCUSSION

Allelopathy refers to a natural ecological process in which plants and other organisms interact through chemical substances, and this mechanism can be utilized for eco-friendly control of weeds, insect pests, and plant diseases in agriculture (Farooq et al., 2011). Although chemical pesticides are widely used in agriculture, their indiscriminate and prolonged application has resulted in serious environmental and health concerns, including soil and water contamination, air pollution, and adverse effects on non-target organisms (Aktar et al., 2009; Damalas & Eleftherohorinos, 2011). Residues of synthetic pesticides in water bodies used for human and livestock consumption further aggravate ecological risks (Snelder et al., 2008).

In the present investigation, in-vivo experiments were conducted to evaluate the effect of different concentrations of neem (*Azadirachta indica* A. Juss.) extract on seed germination, seedling vigour, and its pesticidal potential against *Helicoverpa armigera*. Neem is well known for its rich array of bioactive compounds such as azadirachtin, salannin, and nimbin, which possess growth-regulating as well as insecticidal properties (Isman, 2006).

The in-vivo seed germination studies revealed that neem extract significantly influenced germination percentage in a concentration-dependent manner. Higher germination percentages were recorded at 10%, 20%, and 25% neem extract, while the control showed comparatively lower germination. This clearly indicates that neem extract, when applied at appropriate concentrations, can enhance seed germination under natural growing conditions. However, a reduction in germination was observed at 15% concentration, suggesting that

certain intermediate concentrations may exert a mild inhibitory effect. Such biphasic responses are typical of allelopathic interactions, where low concentrations stimulate growth while higher or specific intermediate concentrations inhibit it.

Similar in-vivo responses have been reported by Fathima et al. (2015), who observed both stimulatory and inhibitory effects of aqueous neem extracts on seed germination and growth parameters of *Phaseolus vulgaris*. Their findings demonstrated improved performance at lower concentrations, while increased concentrations resulted in reduced germination and growth. The present results are in close agreement with these observations.

In contrast, Vaithiyanathan et al. (2014) reported a reduction in seed germination and biochemical constituents of *Abelmoschus esculentus* treated with neem extracts, with maximum germination observed in the control. Such variations in response may be attributed to differences in plant species, concentration of extract, method of application, and environmental conditions prevailing during in-vivo experimentation.

The present study further attempted to assess the pesticidal efficacy of neem extract against *Helicoverpa armigera* larvae under in-vivo conditions. Although neem is well documented as an effective biopesticide against lepidopteran pests (Schmutterer, 1990; Isman, 2006), the results of the present experiment were inconclusive. This may be due to the migration of larvae to nearby plants after release, which made it difficult to accurately assess larval mortality and feeding inhibition. Hence, more controlled in-vivo studies with proper containment, increased replication, and standardized exposure methods are required to conclusively establish the insecticidal potential of neem extract against *H. armigera*.

Overall, the in-vivo findings of the present study confirm that neem extract exhibits a dose-dependent effect, acting as a growth promoter at certain concentrations while showing inhibitory effects at others. These observations support earlier reports that allelochemicals present in neem influence plant growth and pest interactions in a concentration-specific manner (Rice, 1984; Farooq et al., 2011).

CONCLUSION

The present study investigated the effect of different concentrations of neem (*Azadirachta indica* A. Juss.) leaf extract on the growth of cotton seedlings under in-vivo

conditions. Five concentrations of neem leaf extract (5%, 10%, 15%, 20%, and 25%) were applied along with water. The results demonstrated a clear concentration-dependent response.

Application of lower concentrations (5%–15%) significantly enhanced seedling growth, with maximum seedling height (12.9 cm) recorded at 5% concentration. While shoot length remained relatively uniform across treatments, root length showed marked improvement at 5%–15% neem extract, indicating enhanced seedling vigour. In contrast, the highest concentration (25%) reduced seedling elongation, suggesting an inhibitory effect at elevated doses.

These findings indicate that lower concentrations of neem leaf extract favour cotton seedling growth, whereas higher concentrations adversely affect development. The study highlights the potential use of neem leaf extract as a natural growth-promoting agent under in-vivo conditions. The experiment will be repeated to validate these findings under similar environmental conditions.

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