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Research Paper

Larvicidal and Repellent Activity of Ethanolic Extracts of *Datura innoxia* and *Datura stramonium* Against White Grub LarvaeVaibhav Late¹, Shubham Ambhore², Nitin Kadam¹, Nitin Kalyankar², Kishor Dhadage³¹Jijamata College of Science and Arts, Bhende Tal. Newasa Dist. Ahilyanagar, MS²Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar, MS³Pravara Medical Trust Art's, Commerce and Science College, Shevgaon, MS**Abstract**

White grub larvae are destructive soil pests causing severe damage to sugarcane and other root crops. Overreliance on synthetic insecticides has resulted in environmental contamination, pest resistance, and health concerns. The present study evaluates the bio-insecticidal efficacy of ethanolic extracts of *Datura innoxia* (White Datura) and *Datura stramonium* (Black Datura) against white grub larvae. Plant leaves were shade-dried, oven-dried at 60°C for 48 hours, powdered, and extracted using 70% ethanol. The extracts were filtered, centrifuged, and tested using a direct-spray bioassay on white grub larvae. Mortality and behavioural changes were recorded at 24 and 48 hours. UV–Visible spectroscopic analysis confirmed the presence of bioactive compounds. Preliminary results indicated strong repellent and larvicidal effects, with 100% mortality observed within 24 hours in treated groups, while control larvae remained healthy. Black Datura extract showed comparatively higher efficacy. The study suggests that *Datura* extracts can serve as eco-friendly botanical pesticides, though further standardization and field trials are required.

Keywords: White grub, *Datura innoxia*, *Datura stramonium*, Tropane alkaloids, Botanical pesticide, UV–Vis spectroscopy

Introduction-

White grubs (Coleopteran larvae, mainly belonging to the family Scarabaeidae) are among the most destructive soil-dwelling pests affecting agricultural crops worldwide. In India and other tropical countries, white grub infestation is particularly severe in sugarcane, groundnut, maize, potato, and various vegetable crops. The larvae feed voraciously on underground plant parts, especially roots, leading to poor nutrient uptake, wilting, stunted growth, lodging, and significant yield losses. Reports indicate that heavy infestation may result in 30–80% crop loss depending on the crop stage and pest density (Ritcher, 1966; Chandel, 2021). In sugarcane ecosystems, species such as *Holotrichia* spp. are recognized as major soil pests that cause chronic damage to ratoon and newly planted crops. Because white

grubs remain concealed in soil for most of their life cycle, their management is challenging. Conventional control strategies rely primarily on synthetic chemical insecticides including organophosphates, carbamates, and neonicotinoids. Although effective, prolonged and indiscriminate use of chemical insecticides has led to serious drawbacks such as pesticide resistance, soil and groundwater contamination, bioaccumulation, toxicity to non-target organisms, and health hazards to farmers (Pimentel, 2005; Aktar et al., 2009). These limitations highlight the urgent need for environmentally safe and sustainable alternatives.

Botanical pesticides have emerged as promising tools in integrated pest management (IPM) programs. Plant-derived secondary metabolites such as alkaloids, terpenoids, flavonoids, phenolics, and tannins possess insecticidal, antifeedant, repellent, and growth-regulating properties (Isman, 2006; Pavela, 2016). Botanical extracts are generally biodegradable, eco-friendly, and less harmful to beneficial organisms compared to synthetic chemicals. Among medicinal and toxic plants, species of the genus *Datura* (family Solanaceae) have attracted attention for their high levels of bioactive tropane alkaloids. *Datura innoxia* (White Datura) and *Datura stramonium* (Black Datura) are widely distributed weeds in tropical and subtropical regions. These plants contain potent tropane alkaloids, such as atropine, scopolamine, and hyoscyamine, which interfere with cholinergic neurotransmission by blocking acetylcholine receptors (Griffin and Lin, 2000). In insects, disruption of neurotransmission leads to paralysis, feeding inhibition, behavioral abnormalities, and mortality.

Previous studies have demonstrated insecticidal and repellent activities of *Datura* extracts against various agricultural pests including mosquitoes, storage pests, and lepidopteran larvae (Pavela, 2016). The insecticidal potential is not limited to alkaloids alone; flavonoids, terpenoids, tannins, and phenolic compounds present in *Datura* species contribute synergistically to toxicity and repellency (Ullah et al., 2022). Terpenoids, being volatile in nature, may act as fumigants or repellents, while phenolics and tannins interfere with digestion and growth regulation in herbivorous insects. Despite documented insecticidal properties of *Datura* species, few studies have examined their efficacy against soil-dwelling pests, such as white grub larvae. Given the concealed habitat and persistent nature of white grubs, botanical extracts with contact and repellent properties may provide an effective, eco-friendly alternative. Therefore, the present study investigates the larvicidal and repellent efficacy of ethanolic extracts of *Datura innoxia* and *Datura stramonium* against white grub larvae, with the aim of exploring their potential as sustainable botanical pesticides for agricultural pest management.

Material and Methods-

The plant material is collected from barren land. The experiment was conducted in the Departmental Laboratory under laboratory conditions. White grub larvae were collected from an infested sugarcane field located in the Aurangabad region, Maharashtra, India. Fresh, healthy leaves of *Datura innoxia* (White Datura) and *Datura stramonium* (Black Datura) were collected from locally available wild populations. The collected specimens were washed thoroughly under running tap water to remove dust and adherent soil particles, then rinsed with distilled water. The plant material was shade-dried at room temperature for 5–7 days and subsequently oven-dried at 60°C for 48 hours to remove residual moisture. The dried leaves were pulverized into fine powder using a mechanical grinder and stored in airtight containers at room temperature until extraction.



Oven dry 60 degrees for 48 hrs



Powder form of Sample

Ethanol extraction with 70% ethanol was used to efficiently extract both polar and moderately nonpolar phytochemicals. Taken 3 g of powdered White Datura leaves and 3 g of powdered Black Datura leaves were weighed separately. Each sample was soaked in 100 mL of 70% ethanol in a conical flask. The mixture was kept at room temperature for 48 hours to leach secondary metabolites, with occasional shaking to enhance extraction efficiency. After extraction, the mixture was filtered through a double-layered muslin cloth, then through a Whatman No. 1 filter paper. The filtrate was centrifuged at 5000 rpm for 10 minutes to remove suspended particulate matter. The supernatant was carefully collected and stored in sterile spray bottles at 4°C until further use.

White grub larvae (Coleopteran larvae, family Scarabaeidae) were collected manually from infested sugarcane fields by digging the soil around the root zone. Healthy and active

larvae of uniform size were selected for the experiment. The larvae were temporarily maintained in plastic containers containing moist soil under laboratory conditions ($27 \pm 2^\circ\text{C}$ temperature and 60–70% relative humidity) prior to bioassay.



A preliminary larvicidal bioassay was conducted to evaluate the insecticidal efficacy of the plant extracts. Five healthy larvae were selected from each treatment group. Treatments included: White Datura extract, Black Datura extract, and Control (70% ethanol only). Each treatment was performed under identical laboratory conditions. The ethanolic extract was applied by directly spraying onto the dorsal surface of the larvae using a hand sprayer to ensure uniform exposure. The control group received an equal volume of 70% ethanol without plant extract. The larvae were observed at 24 and 48 hours post-treatment. The following parameters were recorded: Mortality rate, Behavioral changes (sluggish movement, reduced activity, paralysis), and Visible morphological abnormalities. Mortality was confirmed when larvae showed no movement upon gentle probing.

To confirm the presence of bioactive phytochemicals, the ethanolic extracts were analyzed by UV–Visible spectroscopy. The extract was scanned in the wavelength range of 300–700 nm. Absorption peaks were recorded and interpreted based on characteristic wavelengths of plant secondary metabolites. Observed Spectral Regions- 300–400 nm: Presence of aromatic compounds, alkaloids, flavonoids, and phenolic compounds, 466–502 nm: Possible flavonoids or carotenoid-like compounds, 531–559 nm: Chlorophyll degradation products or xanthophylls, 601–660 nm: Strong peak at 660 nm corresponding to chlorophyll a in ethanol extract. Control mortality was recorded and compared with the

treatment groups. Since this was a preliminary study with a limited sample size, descriptive statistics were used.

Result and Discussion-

The ethanolic extracts of *Datura innoxia* and *Datura stramonium* demonstrated pronounced larvicidal activity against white grub larvae under laboratory conditions. Within a few hours of exposure, treated larvae exhibited marked behavioral abnormalities, including reduced motility and sluggishness. After 24 h of treatment, 100% mortality was recorded in both treatment groups, whereas no mortality was observed in the control group treated with ethanol alone. The rapid mortality indicates strong contact toxicity of the extracts. The higher apparent efficacy of *D. stramonium* compared to *D. innoxia* may be attributed to quantitative and qualitative differences in alkaloid composition. Previous phytochemical studies have reported that *D. stramonium* often contains higher concentrations of tropane alkaloids such as atropine and scopolamine compared to related species (Griffin and Lin, 2000).

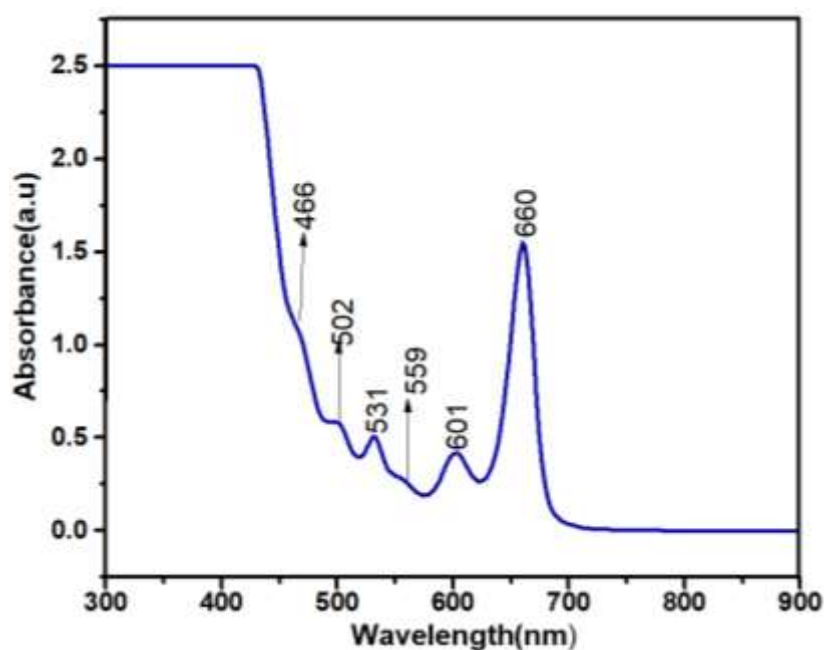


After 24 Hrs death of white grub larvae

The observed mortality aligns with earlier reports indicating insecticidal activity of *Datura* species against lepidopteran larvae, mosquitoes, and stored grain pests (Kumar et al., 2013; Pavela, 2016). Botanical insecticides derived from alkaloid-rich plants are known to produce rapid neurotoxic effects leading to paralysis and death. The behavioral and Toxicological Symptoms are prior to death, larvae exhibited, Sluggish and uncoordinated movement, the reduced responsiveness to stimuli, Gradual paralysis, Darkening of body surface in certain individuals.

These symptoms are consistent with neurophysiological disruption caused by tropane alkaloids. Atropine and scopolamine act as competitive antagonists of acetylcholine at

muscarinic receptors, thereby blocking cholinergic neurotransmission (Griffin and Lin, 2000). Although insect cholinergic systems differ from mammals, interference with acetylcholine-mediated signaling disrupts neuromuscular coordination and respiratory function, leading to paralysis and mortality. Similar neurotoxic symptoms have been reported in insects exposed to botanical alkaloids and plant-derived neurotoxins (Isman, 2006). The absence of mortality or abnormal behaviour in control larvae confirms that the ethanol solvent did not contribute to the toxicity, validating that the mortality was extract-induced. UV–Visible Spectral Analysis and Phytochemical Correlation shows that distinct absorption peaks in both extracts. UV Region (300–400 nm)- Strong absorption in this region indicates the presence of aromatic and conjugated molecules such as alkaloids, flavonoids, and phenolic compounds. Alkaloids typically show absorption maxima in the UV region due to their heterocyclic ring structures. Visible Region (466–660 nm)- 466–502 nm: Likely flavonoids or carotenoid-like compounds, 531–559 nm: Chlorophyll degradation products or xanthophylls, 660 nm: Characteristic chlorophyll a absorption peak



UV-Visible Spectroscopy

The detection of multiple phytochemical classes suggests synergistic action. According to Pavela (2016), botanical extracts often exert insecticidal activity through combined mechanisms including neurotoxicity, feeding deterrence, growth inhibition, and metabolic disruption. Flavonoids and phenolic compounds are known to interfere with digestive enzymes and nutrient assimilation in herbivorous insects, reducing growth and survival (Simmonds, 2003). Terpenoids, being volatile, may contribute to repellency by

affecting insect olfactory receptors. Tropane alkaloids block acetylcholine receptors, impairing synaptic transmission, Secondary metabolites reduce feeding behavior, Phenolics and tannins may inhibit digestive enzymes, Neurotoxicity may affect spiracular muscle coordination. Botanical insecticides are known to act on multiple target sites, reducing the likelihood of rapid resistance development compared to single-site synthetic insecticides (Isman, 2006).

Conventional chemical insecticides such as organophosphates and neonicotinoids target acetylcholinesterase or nicotinic acetylcholine receptors but are associated with environmental persistence and non-target toxicity (Aktar et al., 2009). In contrast, plant-derived compounds are biodegradable and often exhibit lower environmental persistence. The strong larvicidal activity observed in this study suggests that *Datura*-based formulations may serve as eco-friendly alternatives in integrated pest management (IPM) systems. White grub larvae are difficult to manage because of their subterranean habitat. The strong contact toxicity observed in this laboratory study indicates potential for soil application or root-zone treatment formulations. However, because *Datura* species are inherently toxic plants, careful dose standardization and environmental toxicity assessment are necessary before field-scale application.

Conclusion-

The present study demonstrates that ethanolic leaf extracts of *Datura innoxia* and *Datura stramonium* possess strong larvicidal and repellent activity against white grub larvae under laboratory conditions. Complete mortality (100%) was observed within 24 hours of exposure, while control larvae remained unaffected, confirming the efficacy of plant-derived bioactive compounds. Behavioral abnormalities such as sluggish movement, paralysis, and reduced responsiveness prior to mortality indicate neurotoxic action. UV-Visible spectroscopic analysis confirmed the presence of conjugated secondary metabolites, including tropane alkaloids, flavonoids, and phenolic compounds, which likely act synergistically to exert insecticidal effects. Among the two species tested, *Datura stramonium* exhibited comparatively higher potency, possibly due to differences in alkaloid concentration and phytochemical composition. The findings support the potential application of *Datura*-based botanical extracts as eco-friendly, biodegradable, and low-cost alternatives to synthetic chemical insecticides for the management of soil-dwelling pests such as white grubs. Such plant-based formulations could contribute to sustainable agriculture and integrated pest management (IPM) strategies.

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