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A study on the root borer pest (*Cosmopolites sordidus*) affecting banana cultivation and its cosmopolitan distribution in the Bihar region

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Abstract
The present study investigates the root borer pest (*Cosmopolites sordidus*) and its impact on banana cultivation in the Bihar region. The root borer pest is a significant threat to the banana industry worldwide, causing extensive economic losses. This research aims to analyze the cosmopolitan distribution of the root borer pest and explore its prevalence, damage potential, and management strategies in Bihar.

The findings, based on several research papers, surveys, and field visits, reveal that *Cosmopolites sordidus* is widely distributed in the Bihar region, affecting banana plantations of both small-scale and large-scale farmers. The pest infestation was observed to cause substantial damage to the roots, leading to stunted growth, reduced yield, and increased susceptibility to other diseases. Farmers reported limited awareness of effective management practices and faced difficulties in implementing control measures due to financial constraints and a lack of technical knowledge.

Based on the study results, integrated pest management (IPM) approaches were recommended for sustainable management of the root borer pest. These strategies include cultural practices, such as crop rotation and sanitation, biological control methods, and the judicious use of chemical pesticides.

The outcomes of this study contribute to our understanding of the root borer pest's cosmopolitan distribution in the Bihar region and its detrimental impact on banana cultivation. The proposed management strategies serve as valuable guidelines for banana farmers, agricultural extension services, and policymakers to mitigate the damage caused by *Cosmopolites sordidus* and ensure sustainable banana production in the region.

Keywords: Root borer pest, banana cultivation, infested soil

Introduction
Banana cultivation plays a significant role in the agricultural landscape of Bihar, a state located in eastern India. The state's favorable climatic conditions and fertile soil make it an ideal region for banana production. This article provides a concise overview of banana cultivation in the Bihar region, highlighting its importance for the region's economy and food security, along with the effects of the root borer pest (*Cosmopolites sordidus)* on banana cultivation and its cosmopolitan distribution in the region.

Farmers in Bihar cultivate various banana varieties, including Cavendish, Robusta, Grand Naine, and local varieties suited to the region's climate and soil conditions. Prior to planting, the land is prepared by plowing, leveling, and incorporating organic matter. Banana plants are propagated through suckers or tissue-culture plantlets and are usually planted during the onset of the monsoon season. Regular irrigation, nutrient management, weed control, and pest and disease management are essential cultural practices followed by farmers to ensure healthy plant growth and maximize yields. Bananas are typically harvested when they reach maturity, indicated by a change in peel color. Bunches are carefully cut from the plant and transported for further processing or market sale.

Banana cultivation has emerged as a significant source of income for farmers in Bihar. The state's favorable agro-climatic conditions facilitate high productivity and favorable market opportunities, contributing to the economic well-being of farmers. Banana cultivation supports a vast workforce, providing employment opportunities for both skilled and unskilled laborers.

From planting to harvesting and post-harvest activities, banana farming creates jobs along the entire value chain. Bananas are a staple crop in Bihar, serving as a vital food source for both rural and urban populations. They are rich in essential nutrients, vitamins, and minerals, and their availability contributes to improved food security and nutrition in the region. Bihar's banana production surplus has opened avenues for exporting the fruit to neighboring states and even internationally. This presents opportunities for increased income generation and boosts the state's overall agricultural exports. Continued support and investment in this sector can further enhance the socio-economic well-being of farmers and contribute to the overall agricultural development of the region.

Banana cultivation is an essential agricultural activity in the Bihar region, contributing significantly to the economy and providing livelihoods to numerous farmers. However, the cultivation of bananas in this region is faced with various challenges, including the detrimental impact of root borer pests. Root borers are a type of insect pest that infests the roots of banana plants, causing substantial damage to their growth and overall productivity.

Effects of Root Borer Pest on Banana Cultivation

Stunted Growth: Root borer pests, particularly the larvae, tunnel through the roots of banana plants, impairing their ability to absorb nutrients and water effectively. This results in stunted growth, leading to reduced plant vigor and diminished yields. Pale green, withering and floppy foliage may be the first symptoms in infested banana plants Feeding holes or excrement may be observed first on the older leaf sheaths or on the lower parts of the stems. The larvae bore tunnels in stems and roots, sometimes across their entire length. In severely infected tissues, rotting occurs through fungal decay, visible as a block discoloration. The feeding damage and the colonization by opportunistic pathogens interfere with water and nutrient transport, causing leaves to dry up and die prematurely. Young plants fail to develop, and older ones show stunted growth. In severe cases, affected plants can be blown over during adverse weather. The size and number of bunches have also considerably decreased. The damage to the crop is caused by the insect *Cosmopolites sordidus* and its larvae. Adults are dark brown to gray blocks with shining armor. They are most commonly found at the base of the plant, associated with crop residues, or in leaf sheaths. They are nocturnal and survive without feeding for several months. Females lay white, oval eggs in bojes on crop residues in soil or hidden in the least sheaths. Egg development does not occur below 12 °C. After hatching, young larvae bore tunnels in the roots or stem tissues, weakening the plants and sometimes causing them to fall over. Opportunistic pathogens use the wounds caused by the root borer to infect the plant The spread of the pest from one plantation to another occurs mainly via infested planting material

Weakened Plant Health: The continuous feeding activity of root borers weakens the overall health of banana plants. As the roots suffer damage, the plants become more susceptible to other diseases, pests, and environmental stressors, exacerbating the negative impact on cultivation. Nutrient Deprivation: The root borer larvae tunnel through the roots of banana plants, causing damage to the vascular system. This damage disrupts the plant's ability to absorb water and essential nutrients from the soil, leading to nutrient deprivation and stunted growth. The burrowing activity of root borer larvae creates tunnels within the root system, resulting in damaged or severed root segments. As a consequence, the plant's capacity to uptake water efficiently is compromised. Insufficient water uptake affects the plant's overall health and growth. The damage caused by root borer pests weakens the root system of banana plants, making them more susceptible to lodging and uprooting during strong winds or heavy rainfall. This vulnerability further hampers the plant's growth and productivity.

Reduced Yield and Increased Production Costs: Infestations of root borer pests can significantly reduce the yield of banana crops. The compromised root system affects the plant's ability to uptake nutrients, leading to fewer and smaller fruit bunches. Farmers experience substantial economic losses due to diminished yields and decreased market value. Controlling and managing root borer pests requires additional measures, including the application of pesticides and regular monitoring. These measures increase the production costs for farmers, further affecting their profitability and sustainability. As a result of decreased yields and increased production costs, banana farmers in the Bihar region experience a decline in their income. The financial strain can have long-term consequences, impacting the livelihoods of farming communities and the overall agricultural sector.

Signs of Root Borer Infestation: Affected banana plants exhibit limited vertical and lateral growth. The overall size of the plant remains small compared to its healthy counterparts of the same age. The leaves of infested plants may turn yellow or display chlorotic patterns due to nutrient deficiencies caused by impaired root function. Infested plants may show signs of wilting, even when soil moisture levels are adequate. As the root borer larvae disrupt water uptake, the plant may not receive enough moisture, leading to leaf drying and eventual death. Upon careful examination, the roots of affected plants may reveal physical damage such as tunnels, feeding marks, or larval presence. Damaged roots are usually discolored, showing signs of decay or decay-causing pathogens.

Environmental Impact: The use of pesticides to control root borer pests can have adverse effects on the environment. Chemical residues may contaminate soil and water sources, leading to ecological imbalances and potential harm to non-target organisms.

Mitigation and Management Strategies

Implement preventive measures such as using healthy planting materials, maintaining proper hygiene in the plantation, and avoiding the introduction of infested soil or transplants. Adopt good agricultural practices, including regular weeding, appropriate irrigation, and balanced fertilization, to promote plant vigor and resilience. Encourage natural predators and parasitoids that feed on root borer larvae, such as certain nematodes and beneficial insects, by providing suitable habitats or using biological control agents. In severe infestations, chemical insecticides may be necessary.

Root borers belong to the family Cerambycidae and are commonly known as longhorn beetles. They are large,

cylindrical beetles with long antennae. The larvae of root borers are the most damaging stage, as they bore into the roots of banana plants, causing significant harm. The adults, while they can chew on the leaves, do not cause as much damage as the larvae.

Identifying Root Borer Infestation: Early detection of root borer infestations is essential for effective control. Here are some signs that can indicate the presence of root borers in banana plants:

1. Stunted Growth: Affected plants often exhibit stunted growth, with smaller leaves and overall diminished vigor.
2. Wilting and Leaf Yellowing: Infested plants may show signs of wilting and yellowing leaves as the damaged roots cannot adequately supply water and nutrients.
3. Entry Holes: Look for entry holes in the lower parts of the plant, close to the soil surface. These holes may have wood dust or frass around them, indicating larval activity.
4. Damage to Root System: Gently dig around the base of the plant and inspect the root system for larval tunnels, chewed roots, or signs of rotting.

Pest Control Management Strategies: The following strategies are involved in root borer pest control in banana cultivation. Integrated Pest Management (IPM) practices that combine various pest control methods, such as cultural practices, biological control agents, and targeted pesticide applications, can help manage root borer populations effectively while minimizing environmental impact.

Cultural Control

- **Crop Rotation:** Implementing crop rotation practices can help break the life cycle of root borers. Avoid planting bananas in the same area for consecutive seasons. Rotating banana crops with non-host plants can disrupt the life cycle of root borer pests, reducing their population and impact on subsequent plantings.
- **Sanitation:** Remove and destroy infested plant debris, including fallen leaves, pseudostems, and root systems, to prevent larvae from hatching and continuing their life cycle.
- **Regular Monitoring:** Conducting regular field surveys and monitoring root borer pest populations helps in identifying early infestations and implementing timely control measures.
- **Soil Management:** Ensure proper drainage and avoid water logging, as it can create favorable conditions for root borers. Maintain healthy soil by adding organic matter and appropriate fertilizers to enhance the plant's resilience.
- **Improved Farming Practices:** Implementing good agricultural practices, such as proper irrigation, balanced fertilization, and maintaining healthy soil conditions, can enhance plant vigor and resilience, reducing the susceptibility to root borer attacks.
- Uproot and burn infested plants.
- Planting material should be trimmed to reduce the number of eggs and grubs.
- After harvesting the bunch, remove and destroy the pseudostem from ground level so as to avoid it serving as a breeding site for the pest.
- Avoid mattacking (leaving the plant after bunch harvest for recycling of nutrients) in weevil endemic areas.
- Prune the side suckers every month
- Use healthy and pest free suckers to check the incidence
- Do not dump infested materials into manure pit
- Apply mud slurry mixed with neem oil 5% on the pseudostem five months after planting in heavily infested areas to prevent oviposition

Biological Control

- **Entomopathogenic Nematodes:** Beneficial nematodes, such as *Heterorhabditis* spp. and *Steinernema* spp., can be applied to the soil. These nematodes parasitize the larvae, effectively reducing their population.
- **Predatory Insects:** Encourage the presence of natural predators such as ground beetles and ants, which feed on root borer larvae.

Chemical Control

- **Insecticides:** If infestation levels are severe, the use of chemical insecticides may be necessary. Consult with local agricultural extension services or experts to identify suitable insecticides and follow proper application techniques. Always adhere to safety guidelines and consider the potential environmental impact.
- **Trunk Injection:** For targeted control, trunk injection of insecticides can be performed. This method ensures the direct delivery of the chemical into the tree, minimizing environmental exposure.

Injection of monocrotophos in 4 mL (0.1% of 50 EC) each at 45 and 65 cm above the ground is the common practice prevailing among farmers. Azadirachta indica (neem) oil, crude extracts of Lantana camera, and Gliricidia Sepium are also common in the management of *pseudostem weevil* (Sivasubramanian *et al*., 2009). Though a number of plant species have been reported to possess insecticidal properties, the non-availability of sufficient quantities, cumbersome procedures in the extraction of active principles, and low extractability of the promising compounds are the prime impediments to their commercial exploitation. Isolation of phytochemicals from locally available plants by a simple extraction method is a practical solution to producing bulk quantities of biopesticide. Many crops at harvest leave large quantities of biomass, such as leaves, seeds, etc., as waste, and the insecticidal molecules, if any, in such biomass have to be explored for the large scale extraction of pesticidal molecules.

Larval stages of the pest, being clandestine in nature, are unable to be controlled with ease. Injecting synthetic pesticides into the pseudostem, fumigating, or swabbing with pesticide containing slurry (Padmanaban and Sathiamoorthy, 2001) [24] are often expensive and also pose a threat to man and the environment. A flawless understanding of the behavior of the pest is the underpinning factor in every pest management strategy.

Conclusively, The presence of root borer pests poses significant challenges to banana cultivation in the Bihar region. Root borers pose a significant threat to banana cultivation, affecting plant health and productivity. The detrimental effects on plant growth, yield reduction, increased production costs, and decreased farmer income

necessitate the implementation of integrated pest management strategies. By adopting sustainable and proactive approaches, farmers can mitigate the impact of root borer pests, safeguard their livelihoods, and ensure the long-term sustainability of banana cultivation in the region. Effective management of these pests is crucial to maintaining sustainable banana production. By implementing cultural control practices, encouraging biological control agents, and, if necessary, using appropriate insecticides, farmers can mitigate root borer infestations and protect their banana crops. Regular monitoring, early detection, and prompt action are key to successful root borer pest control management, leading to healthier plants, increased yields, and improved livelihoods for banana growers.

Cosmopolitan distribution of root borer (*Cosmopolites sordidus)* pests in banana cultivation in the Bihar region

The term cosmopolitan distribution" refers to the wide geographic range in which a particular species or group of species is found. Root borer pests with a cosmopolitan distribution are capable of infesting crops across different regions and countries, including the Bihar region. This distribution pattern is often facilitated by various factors such as insect mobility, international trade, climate change, and human activities.

In Bihar, several root borer pest species exhibit cosmopolitan distribution patterns. These include, but are not limited to:

Asian corn borer (*Ostrinia furnacalis*): The Asian corn borer is a significant pest that affects various cereal crops, including maize, in the Bihar region. It has a wide distribution in Asia and has been reported in different countries across the world. The moth's ability to disperse over long distances contributes to its cosmopolitan distribution.

Sugarcane stalk borer (*Chilo infuscatellus*): This pest primarily affects sugarcane crops and is found in many regions worldwide. Its cosmopolitan distribution can be attributed to its ability to infest a wide range of grass species, including maize, sorghum, and rice, which are common crops in the Bihar region.

Rice stem borer (*Scirpophaga* spp.): The rice stem borer is a cosmopolitan pest that affects rice crops globally. It has a wide distribution in Asia and has been reported in several countries, including India. In Bihar, rice is a staple crop, making it susceptible to infestation by this pest.

Distribution

The banana root borer probably originated in Southeast Asia and Indonesia. It now has a cosmopolitan distribution and is found in all the banana-growing regions of the world: southern Asia, Africa, Macaronesia, Australia, South and Central America, the West Indies, and Mexico. In the United States, it is restricted to Monroe and Miami-Dade Counties in Florida. It is easily transported from one place to another in the larval stage, inside sections of the root or corm.

The first Florida infestation was found at Larkin (Dade County) in December 1917 and March 1918 in Manatee County, "this appearing to be the point where the insect had become established several years previously." (Newell 1921) [21]. If the species was eradicated, it was soon reintroduced and has probably been present since 1920. Newell (1921) [21] discussed the eradication program initiated after the first infestation was discovered and stated that "no infestations are known to occur in the state at present." Sleeper (1957) [22] recorded it from Marco, Flamingo, Ft. Myers, Opa Locka, Miami, Larkin, and Coconut Grove. The Florida State Collection of Arthropods contains the following additional records: Ormond, Palma Sola, Buckingham, Key West, Coral Gables, White City, Cutler, and Homestead.

The pest is found to prefer tropical climatic conditions with high humidity. As regards weevil density, Tamil Nadu is at the top among the other States (Palanichamy, 2011) [23]. The following is the first report on the pest incidence in different States of India. The banana *pseudostem weevil* was supposed to evolve in the regions/ spots where the banana was supposed to originate, i.e., from the south and south east of Asia. The origin of the tropical belt of Asia was documented by Padmanaban and Sathiamoorty (2001) [24], and Froggatt (1928) [10]. The following are the first reports of pest attacks in different countries. Reports by Shukla and Kumar 1970 [25], the BPW was listed as a major pest in Sikkim, Burma, Japan, and Myanmar in their respective first reports. The pest was reported in Java by Frroggatt (1928) [10], Hong Kong by Hoffman (1933) [26], Sri Lanka by Jepson (1935) [27], From all this, Mohammad *et al*. (2010) [28] concluded that Asia is cosmopolitan.

The cosmopolitan distribution of these root borer pests in the Bihar region poses a significant challenge for farmers and agricultural authorities. Effective management strategies need to be implemented to mitigate the damage caused by these pests. Integrated pest management practices that include cultural, biological, and chemical control methods can help minimize the impact of root borer pests on agricultural crops. Furthermore, increased surveillance and monitoring programs should be established to track the spread and occurrence of these cosmopolitan pests. This will aid in early detection and timely intervention, allowing farmers to take appropriate measures to protect their crops.

In conclusion, the cosmopolitan distribution of root borer pests in the Bihar region underscores the need for proactive pest management strategies. By adopting integrated approaches and promoting sustainable agricultural practices, farmers can reduce the impact of these pests and safeguard their crop yields. Collaboration between farmers, researchers, and agricultural authorities is crucial to effectively combating the challenges posed by cosmopolitan root borer pests in Bihar.

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