Original Research Article

Documentation of Pest Incidence and Pesticide Application Patterns in Banana with Special Emphasis on the Management of *Odoiporus longicollis* (Olivier) (Coleoptera: Curculionidae) in Selected Districts of Kerala,India

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ABSTRACT

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| Banana (*Musa* spp.) is a major fruit crop extensively cultivated in tropical and subtropical regions. This study investigated pest occurrence, pesticide usage patterns, and control strategies in banana cultivation systems, focusing particularly on Odoiporus longicollis (Olivier), an economically significant pest species, across selected districts in Kerala and Tamil Nadu. Data were collected from 80 commercial banana farmers across eight major banana-growing districts through a structured questionnaire. The study identified *O. longicollis* as the most prevalent chewing pest (87.5%), followed by *Cosmopolites sordidus* (82.5%) and *Spodoptera litura* (21.25%). Dominant sucking pests included *Aleurodicus rugioperculatus* (23.75%), *Aleurodicus dispersus* (18.75%), and *Pentalonia nigronervosa* (15%). Additionally, the study documented Rhynchophorus ferrugineus infesting banana plantations, marking a potential host expansion of this pest. Among insecticides from different groups chlorpyrifos (27.5%) was the most commonly used insecticide. The use of restricted insecticides, including monocrotophos and carbofuran, was also documented. Spraying on pseudostem and leaf axils (63.75%) was the primary application method, followed by sucker treatment (50%). Biopesticides such as neem oil, *Pseudomonas fluorescens*, *Beauveria bassiana*, and entomopathogenic nematodes were adopted minimally. About 55% of farmers followed a one-month spray interval from 4 months after planting (MAP) to 8 MAP, with 26.25% reporting control failures. Only 12.5% of the respondents practiced insecticide rotation, indicating gaps in resistance management awareness. |

*Keywords: Pest incidence, insecticide usage pattern, Odoiporus longicollis, Kerala, Tamil Nadu, banana plantations, pest management strategies*

1. INTRODUCTION

Banana (*Musa* spp.) is an economically important fruit crop extensively cultivated in tropical and subtropical regions worldwide and ranks as the fourth most important food crop globally, following rice, wheat, and maize (Thangavelu and Mustaffa, 2012). In Kerala and Tamil Nadu, banana is cultivated over an area of 47,540 hectares and 113,860 hectares, respectively, with an annual production of 477,520 tonnes in Kerala and 4,719,950 tonnes in Tamil Nadu, making a substantial contribution to the agricultural economy of both states (IndiaStat, 2024). Banana plantations support a diverse assemblage of insect species, which are broadly categorized as pests or non-pests based on their interaction with the crop and their potential to cause economic losses (Krishnan et al., 2019). Insect-induced damage can considerably diminish the marketability of bananas (Shankar et al., 2016).

 Among the insect pests associated with banana, the banana pseudostem weevil (*Odoiporus longicollis*) is considered one of the most serious pest, causing substantial reductions in both yield and productivity (Justin et al., 2008). Yield losses ranging from 10% to 90% have been reported, varying according to the stage of crop growth at the time of infestation and the effectiveness of the management practices adopted (Padmanaban and Sathiamoorthy, 2001). Presently, the management of this pest predominantly relies on chemical insecticides; however, numerous instances of control failures have been reported from various banana-growing regions. The indiscriminate and continuous use of insecticides against *O. longicollis* also raises the risk of developing insecticide resistant pest populations, potentially jeopardizing future control efforts.

 In order to encourage the judicious and responsible use of pesticides, it is crucial to first assess and understand the prevailing patterns of pesticide use among banana growers. In light of banana's high commercial value in domestic and international trade, this documentation study aimed to catalog pest incidence and pesticide management approaches utilized by farmers across primary banana-growing regions of Kerala and two bordering districts in Tamil Nadu.

2. materialS and methods

 A detailed documentation study was conducted based on the methodology of Awasthi and Sridharan (2017) with minor modifications on the insect pest spectrum of banana plantations, pesticides used, and insecticide usage patterns for controlling O. longicollis. A study was conducted among banana farmers in the districts of Thiruvananthapuram (TVM), Kollam (KLM), Alappuzha (ALP), Thrissur (TSR), Palakkad (PKD), and Kannur (KNR) in Kerala. Two neighboring districts of Tamil Nadu viz., Coimbatore (CBE) and Kanniyakumari (KKR) were also included with the objective of comparing pesticide use patterns.

 The study areas were selected based on the extent of cultivation of the crop in the state. Ten commercial banana farmers from each district were interviewed using a structured proforma designed to gather information on pest incidence, types of pesticides used, and insecticide use patterns. The proforma was developed through literature review, expert consultations, and preliminary field visits, and was pre-tested with farmers outside the study area to assess its clarity, relevance, and comprehensiveness, followed by necessary revisions based on feedback. Along with documenting the general pest spectrum and pesticide use in banana plantations, the study specifically gathered detailed information on insecticide use against *O. longicollis* which included method of insecticide application, source of technical advice during crop damage, stage of crop and frequency of insecticide application, farmers’ experiences with control failures despite insecticide use, the existence of insecticide rotation practices, and rates of application to assess the possibility of overdose. This effort was aimed at establishing baseline information to support future studies on insecticide resistance in *O. longicollis* populations.

 Owing to practical constraints such as limited availability of willing respondents, variations in farm schedules, and difficulties in accessing widely scattered plantations, a reduced sample size was adopted. Additionally, the focus on experienced commercial banana farmers involved in active pest management further narrowed the respondent pool. Nevertheless, careful selection ensured that the selected farmers remained representative of the major banana growing regions in Kerala and adjoining Tamil Nadu districts, thereby maintaining the validity and reliability of the data.

 Prior to data collection, the objectives and scope of the study were clearly explained to each farmer, and their voluntary informed consent was obtained. Confidentiality of all respondents was ensured. The study allowed multiple responses from each respondent wherever applicable. The recorded data were converted to percentages prior to calculating mean values, and the results were presented using the tabular method based on percentages and averages.

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| **Fig 1. Locations of documentation study** |

3. results and discussion

**3.1 Pests observed during documentation studies**

 The documentation studies conducted in banana plantations revealed the presence of several chewing and sucking pests affecting different parts of the plant, including the pseudostem, rhizome, and leaves (Table 1). Among the chewing pests recorded, *O. longicollis* was the most prevalent, with an incidence of 87.50%, followed by *C. sordidus* (82.5%) and *S. litura* (21.25%). The study reaffirmed the status of *O. longicollis* as a severe threat in banana plantations, consistent with earlier regional and national reports. The high incidence rates of *C. sordidus* and *S. litura* further reflect the vulnerability of banana plantations to multiple chewing pest species, especially under monoculture systems where continuous host availability promotes pest build-up.

 The predominant sucking pests observed across the documented areas were *A. rugioperculatus* (23.75%), *A. dispersus* (18.75%), and *P. nigronervosa* (15%) whose presence though at comparatively lower incidences, signals a growing concern, particularly given the role of climate change and expanding host ranges in favoring sucking pest outbreaks in perennial cropping systems. In addition to insect pests, damage by non-insect pests were also documented in the studied fields.

 The occurrence of these pests align with previous reports of infestation by *C. sordidus* (Ostmark, 1974), *O. longicollis* (Visalakshi et al., 1989), *O. rhinoceros* (Sivakumar and Mohan, 2013), *S. litura* (Krishnan et al., 2019), *A. rugioperculatus* (Karthick et al., 2018), and *P. nigronervosa* (Harish et al., 2009). The occurrence of *R. ferrugineus* in banana plantations, exhibiting characteristic medium-sized holes and gummy exudation, indicates a possible host range expansion, as documented by Kalita et al. (2023) and corroborated by our findings (Gargi et al. 2024). The ecological implications of such host range expansions could potentially complicate pest management strategies due to overlapping pest complexes and shared ecological niches.

 Given the broad pest complex identified including both established and emerging pests, these findings emphasize the need for continuous pest surveillance, documentation of pest outbreaks, and updating pest management protocols accordingly.

**Table 1. Details of pests recorded during documentation studies in the study areas of districts in Kerala and Tamil Nadu.**

|  |  |  |
| --- | --- | --- |
| **Types of pest** | **Particulars** | **Incidence of pest (%)\*** |
| **Common name** | **Scientific name** | **Family: Order** | **Part of crop infested** | **TVM** | **ALP** | **KLM** | **TSR** | **PKD** | **KNR** | **KKR** | **CBE** | **Mean±SD** |
| Chewing insects | Banana pseudostem weevil | *Odoiporus longicollis* (Olivier) | Curculionidae: Coleoptera | Pseudostem | 90 | 80 | 80 | 100 | 90 | 80 | 90 | 90 | 87.50±7.07 |
| Banana rhizome weevil | *Cosmopolitus sordidus* Germer | Curculionidae: Coleoptera | Rhizome | 80 | 90 | 80 | 90 | 90 | 70 | 70 | 90 | 82.50±8.86 |
| Red palm weevil | *Rhynchophorus ferrugineus* (Olivier) | Curculionidae: Coleoptera | Pseudostem | - | - | - | 10 | - | - | - | - | 1.25±3.54 |
| Rhinoceros beetle | *Oryctes rhinoceros* Linnaeus | Scarabidae: Coleoptera | Pseudostem | 30 | 10 | - | 40 | 40 | - | 10 | - | 16.25±17.68 |
| Tobacco caterpillar | *Spodoptera litura* Fabricius | Noctuidae: Lepidoptera | Leaf | 40 | 20 | 10 | 10 | 10 | 30 | 20 | 30 | 21.25±11.26 |
| Bihar hairy caterpillar | *Spilarctia obliqua* Walker | Erebidae: Lepidoptera | Leaf | - | - | - | - | - | 80 | - | - | 10.00±28.28 |
| Brown tussock moth |  *Olene mendosa* Hübner | Erebidae: Lepidoptera | Leaf | 10 | - | - | - | - | - | - | - | 1.25±3.54 |
| Banana slug caterpillar | *Miresa decedens* Walker | Limacodidae : Lepidoptera | Leaf | - | - | - | - | 20 | - | - | - | 2.50±7.07 |
| Sucking insects | Rugose Spiralling whitefly | *Aleurodicus rugioperculatus* Martin | Aleyrodidae: Hemiptera | Leaf | 20 | 10 | 20 | 30 | 10 | 10 | 40 | 50 | 23.75±15.06 |
| Spiralling whitefly | *Aleurodicus disperses* Russell | Aleyrodidae: Hemiptera | Leaf | 30 | 10 | 30 | 20 | 10 | 20 | 20 | 10 | 18.75±8.35 |
| Banana aphid | *Pentalonia nigronervosa*Coquerel | Aphididae: Hemiptera | Leaf | 20 | - | 10 | 20 | 10 | 20 | 10 | 30 | 15.00±9.26 |
| Cercopid  | *Phymatostetha deschampsi* Lethierry | Cercopidae: Hemiptera | Leaf | 10 | 20 | - | - | - | - | - | - | 3.75±7.44 |
| Non insect pests | Lesser bandicoot rat | *Bandicoota bengalensis* Gray | Muridae: Rodentia | Rhizome | - | 20 | 10 | - | - | - | - | - | 3.75±7.44 |
| Giant African Snail | *Achatina fulica* Ferussac | Achatinidae:Stylommatophora | Leaf | - | 20 | - | - | - | - | - | - | 2.50±7.07 |
| \*Out of 10 respondents/ districtMean of 80 farmersThiruvananthapuram (TVM), Kollam (KLM), Alappuzha (ALP), Thrissur (TSR), Palakkad (PKD), Kannur (KNR), Coimbatore (CBE), Kanniyakumari (KKR) |

**3.2 Pesticides commonly used in the banana plantations studied in selected districts of Kerala and Tamil Nadu.**

 The insecticides documented in the study were categorized into various groups *viz*., organophosphates, carbamates, synthetic pyrethroids, nereistoxin analogues, phenyl pyrazoles, diamides, and oxadiazines (Table 2). Among the organophosphate group, chlorpyrifos (27.50%) emerged as the most frequently applied insecticide, followed by quinalphos (12.50%) and the restricted insecticide, monocrotophos (5.00%). Within the synthetic pyrethroids, lambda-cyhalothrin (8.75%) and cypermethrin (5.00%) were predominantly employed for pest management. Notably, the use of the restricted carbamate insecticide, carbofuran (2.50%), was also recorded in certain plantations. Farmers practiced insecticide rotation within the same cropping season, with combinations such as chlorpyrifos + quinalphos (12.50%) and chlorpyrifos + cartap hydrochloride (8.75%) being extensively adopted. The frequent use of restricted and highly toxic insecticides for crop protection raises significant concerns regarding environmental safety and human health. This emphasizes the urgent need for enhanced extension services to encourage the adoption of safer alternatives and promote best pest management practices. Although insecticide rotation is a recommended strategy to manage resistance, it was observed that farmers often rotated insecticides within the same mode of action, a critical factor which can contribute to the development of insecticide resistance.

 These observations align with previous reports by Polidoro et al. (2008) from Costa Rica, where chlorpyrifos was documented as the most commonly used insecticide in plantain production systems. Similarly, Awasthi and Sridharan (2017), reported monocrotophos as the primary insecticide applied against banana pests, alongside chlorpyrifos, cypermethrin, and carbofuran. Corresponding trends were also observed in the study by Bhandari et al. (2023), which identified chlorpyrifos as the most frequently utilized insecticide, followed by cypermethrin in banana plantations. However, as per the Directorate of Plant Protection, Quarantine and Storage (2024), only carbofuran 3% CG, quinalphos 25% EC, and oxydemeton-methyl 25% EC hold approved label claims for application in banana, while the study highlighted the continued use of several non-labelled pesticides in banana plantations.

 In the studied banana plantations, the principal fungicides in use were carbendazim (35%), mancozeb (26.25%), copper oxychloride (13.75%), while fluopyram was recorded as the nematicide applied for nematode management. Polidoro *et al*. (2008) reported that 84% of banana growers in their study area employed nematicides, and 22% utilized fungicides such as mancozeb, tridemorph, bitertanol, difenoconazole, and propiconazole. Similarly, Awasthi and Sridharan (2017) documented the application of fungicides including carbendazim, mancozeb, difenoconazole, propiconazole, tebuconazole, and copper oxychloride in banana plantations across Tamil Nadu.

 Though the fungicides identified through this study were reported effective in disease management, the frequent and repetitive application raises concern about the potential development of fungal resistance. Integrated disease management practices combining cultural, biological, and chemical controls should be encouraged to reduce dependency on fungicides. The use of fluopyram as a nematicide, though less frequently reported in earlier studies, indicates a rising incidence of nematode related problems in banana plantations and reflects growing farmer awareness and adoption of chemical control measures for nematode management in the studied regions.

 In the banana plantations, non-chemical methods employed for pest management included neem oil (11.25%), *Pseudomonas fluorescens* (13.75%), *Beauveria bassiana* (3.75%), and entomopathogenic nematodes (EPN) (2.5%). Consistent with earlier findings by Mgenzi (2005) and Bagamba et al. (2006), neem-based products remained relatively popular than all other biocontrol agents, in our study due to their affordability, availability, and broad-spectrum efficacy against multiple pests. According to Aguilar et al. (2014) some farmers reported that adopting a purely organic approach was effective in managing pests in their banana fields, while others believed it fell short in reducing pest populations and improving productivity. In contrast, the survey by Okonya et al. (2019) documented the complete absence of chemical pesticide use for pest management in banana cultivation systems in Rwanda and Burundi, where farmers predominantly relied on non-chemical approaches. The relatively low adoption rates of biocontrol agents in our study suggest knowledge gaps, supply issues, or doubts regarding field-level efficacy. Extension and demonstration programs showcasing the practical benefits of these agents could alter the approach of farmers and improve sustainable pest management strategies.

 The variation in pesticide usage between this study and past studies may reflect differences in pest pressure, farmer awareness, availability of products, and regional agricultural practices. Continuous monitoring is essential to adapt pest management strategies accordingly.

**Table 2. Pesticides commonly used in the banana plantations studied in selected districts of Kerala and Tamil Nadu.**

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| --- | --- |
| **Particulars** | **Farmer’s response/ district (%)** |
| **Pesticides** | **TVM** | **KLM** | **ALP** | **TSR** | **PKD** | **KNR** | **CBE** | **KKR** | **Mean±SD** |
| **Insecticide** |
| **Single insecticide** |
| Chlorpyrifos | 10 | 40 | 20 | 40 | 50 | 20 | 20 | 20 | 27.50±13.89 |
| Quinalphos | 10 | 10 | 20 | 10 | 20 | 20 | - | 10 | 12.50±7.07 |
| Monocrotophos | - | - | - | - | - | - | 20 | 20 | 5.00±9.26 |
| Carbofuran | 10 | - | - | - | - | - | - | 10 | 2.50±4.63 |
| Cypermethrin | 10 | - | - | - | - | 10 | - | 20 | 5.00±7.56 |
| Lambda cyhalothrin | 10 | - | 10 | 10 | 10 | 20 | - | 10 | 8.75±6.41 |
| Bifenthrin | - | - | 10 | - | - | - | - | - | 1.25±3.54 |
| Cartap hydrochloride | 10 | 10 | - | - | - | - | - | - | 2.50±4.63 |
| Fipronil | - | - | - | - | - | - | 20 | - | 2.50±7.07 |
| Flubendiamide | - | - | - | 10 | - | - | - | - | 1.25±3.54 |
| Indoxacarb | - | - | - | 10 | - | - | - | - | 1.25±3.54 |
| **More than one insecticide/ field**  |
| Chlorpyrifos + Quinalphos | 30 | 20 | 10 | 20 | 10 | 10 | - | - | 12.50±10.35 |
| Chlorpyrifos+ Monocrotophos | - | - | - | - | - | - | 20 | 10 | 3.75±7.44 |
| Chlorpyrifos + Cartap hydrochloride | 10 | 20 | 10 | - | 10 | 10 | 10 | - | 8.75±6.41 |
| Chlorpyrifos+ Cypermethrin | - | - | 10 | - | - | 10 | - | - | 2.50±4.63 |
| Chlorpyrifos + Fipronil | - | - | - | - | - | - | 10 | - | 1.25±3.54 |
| **Botanicals** |  |
| Neem oil | 20 | 10 | 10 | 20 | 10 | 10 | - | 10 | 11.25±6.41 |
| **Fungicides** |  |
| Carbendazim | 40 | 50 | 20 | 40 | 30 | 20 | 40 | 40 | 35±10.69 |
| Mancozeb | 40 | 40 | 20 | 30 | 20 | 10 | 20 | 30 | 26.25±10.61 |
| Copper oxychloride | 20 | 10 | - | 10 | 20 | 10 | 10 | 30 | 13.75±9.16 |
| Fosetyl Aluminium | - | - | - | - | - | - | 10 | - | 1.25±3.54 |
| Tebuconazole | - | - | - | - | - | - | 10 | - | 1.25±3.54 |
| Nematicide |  |
| Fluopyrum | - | - | - | - | - | - | 10 | - | 1.25±3.54 |
| **Microbial Biopesticides** |  |
| *Pseudomonas flourescens* | 10 | 30 | 20 | 30 | 10 | 10 | - | - | 13.75±11.78 |
| *Beauveria bassiana* | 10 | 10 | - | 10 | - | - | - | - | 3.75±5.18 |
| EPN | - | - | - | 20 | - | - | - | - | 2.50±7.07 |
| EPN= Entomopathogenic Nematodes\*Out of 10 respondents/ districtMean of 80 farmersThiruvananthapuram (TVM), Kollam (KLM), Alappuzha (ALP), Thrissur (TSR), Palakkad (PKD), Kannur (KNR), Coimbatore (CBE), Kanniyakumari (KKR) |

**3.3 Information on insecticide use against *O. longicollis* in banana plantations of Kerala and Tamil Nadu**

 In the studied plantations, the most commonly adopted method for insecticide application was spraying on the pseudostem and leaf axil (63.75%), followed by sucker treatment (50.00%), soil incorporation (26.25%), and leaf axil filling alone (3.75%) (Table 3). These findings are consistent with the observations of Awasthi and Sridharan (2017), who reported that spraying was the predominant method of pesticide application, which was supplemented by practices such as sucker treatment, pseudostem injection, and whorl application of chemical. They further noted that labour-intensive techniques like pseudostem injection and swabbing of the pseudostem were less frequently practiced due to operational constraints, a trend that was reflected in our study also. Similarly, Henriques et al. (1997), in their review of pest management strategies in Latin America, identified both aerial and manual spraying as the principal methods for insecticide application in infested fields, alongside cultural practices like dipping susceptible plant parts in insecticide solutions. Notably, the use of aerial spraying, though not practiced in the studied areas of Kerala and Tamil Nadu regions, has been flagged by Barraza et al. (2011) as a significant health hazard for communities residing near banana plantations due to pesticide drift and environmental contamination. While such exposure risks are comparatively lower in manually applied systems like those documented here, the high reliance on spraying still raises concerns regarding operator safety, pesticide residues on edible plant parts, and ecological consequences.

 These observations emphasize the need for promoting safer, more efficient, and context appropriate application techniques in banana pest management programs. Extension services should actively advocate for selective, target-specific application methods like sucker treatment, pseudostem injection, or biological control which could reduce the environmental footprint while maintaining effective pest suppression. Additionally, the integration of cultural and mechanical control practices could further minimize dependence on chemical insecticides, supporting a more environment friendly pest management system.

 In our study, a substantial proportion of banana farmers (78.75%) accessed technical information pertaining to improved agricultural practices predominantly through government agencies, followed by progressive farmers (17.50%) and pesticide dealers (11.25%), which is a notable shift from the trends reported in earlier studies. Conversely, Tiwari et al. (2006) reported that farmers depended on other farmers, followed by pesticide dealers, government agencies and radio for technical help on crop protection. Awasthi and Sridharan (2017) documented a different trend wherein a majority of banana cultivators (46.25%) relied on private agro-pesticide dealers for technical advisory services, followed by agricultural officers and scientists (42.92%). This contrast suggests a positive transition in the selected regions toward institutionalized advisory services, potentially reflecting strengthened government extension programs, farmer training initiatives, and awareness campaigns in recent years.

 With respect to insecticide application schedules, 55.00% of the respondents adhered to a one-month interval from 4 months after planting (MAP) to 8MAP, whereas 26.25% followed a two-month interval during the same period. Furthermore, 50.00 % of the farmers adopted the incorporation of insecticides at the time of planting either as sucker treatment or soil incorporation. Study of Awasthi and Sridharan (2017), revealed that pesticide applications were predominantly carried out at three-month intervals (48.33%), while 30.83% of farmers practiced need-based applications and 6.25% adhered to a two-month interval schedule. The higher frequency of pesticide application observed in the present study could be attributed to increased pest pressure, improved farmer awareness, or perceptions of routine prophylactic spraying as a preventive strategy. These findings highlights the importance of reinforcing Integrated Pest Management (IPM) practices that emphasize pest monitoring, economic threshold based interventions and promotion of decision-making based on pest surveillance rather than fixed interval schedules to minimize unnecessary pesticide applications, resistance development, and environmental risks.

**Table 3. Information on insecticide use against *O. longicollis* in banana plantations of Kerala and Tamil Nadu**

|  |  |
| --- | --- |
| **Particulars** | **Farmer’s response/ district (%)** |
| **TVM** | **KLM** | **ALP** | **TSR** | **PKD** | **KNR** | **CBE** | **KKR** | **Mean±SD** |
| **Method of application of insecticide** |  |
| Sucker treatment | 40 | 80 | 60 | 50 | 40 | 60 | 60 | 10 | 50.00±20.70 |
| Soil incorporation | 30 | 50 | 40 | 40 | 20 | 30 | - | - | 26.25±18.47 |
| Spraying on pseudostem and leaf axil | 40 | 80 | 60 | 60 | 60 | 70 | 70 | 70 | 63.75±11.88 |
| Leaf axil filling | 10 | - | - | - | - | - | 10 | 10 | 3.75±5.18 |
| **Source of technical information** |  |
| Government Agencies(KB/ KVK/ VFPCK/SAUs) | 80 | 100 | 90 | 100 | 80 | 90 | 40 | 50 | 78.75±22.32 |
| Pesticide retailers/dealers | 20 | - | - | 10 | 10 | - | 20 | 30 | 11.25±11.26 |
| Other progressive farmers | 30 | 20 | 10 | 20 | - | 10 | 30 | 20 | 17.50±10.35 |
| Media | - | - | - | - | - | - | 20 | 10 | 3.75±7.44 |
| **Stage of crop and frequency of pesticide application** |  |
| At the time of planting | 60 | 50 | 50 | 60 | 40 | 50 | 60 | 30 | 50.00±10.69 |
| 1 -3 MAP | 10 | 0 | 0 | 10 | 0 | 10 | 30 | 20 | 10.00±10.69 |
| 1 month interval from 4 MAP to 8 MAP | 60 | 50 | 30 | 70 | 40 | 50 | 80 | 60 | 55.00±16.04 |
| 2 months interval from 4 MAP to 8 MAP | 30 | 40 | 50 | 10 | 30 | 30 | - | 20 | 26.25±15.98 |
| Need based application | - | - | - | - | - | - | - | 10 | 1.25±3.54 |
| \*Out of 10 respondents/ districtMean of 80 farmersKB= Krishibhavan, KVK= Krishi Vigyan Kendra, VFPCK= Vegetable and Fruit Promotion Council Keralam, SAU= State Agricultural University, MAP=Months After PlantingThiruvananthapuram (TVM), Kollam (KLM), Alappuzha (ALP), Thrissur (TSR), Palakkad (PKD), Kannur (KNR), Coimbatore (CBE), Kanniyakumari (KKR) |

**3.4 Farmers’ responses on control failures, insecticide rotation and rate of application against *Odoiporus longicollis* in selected districts of Kerala and Tamil Nadu**

 The present findings revealed that 26.25% of farmers experienced pest management failures despite pesticide applications, indicating gaps in the effectiveness of current pest control practices in banana plantations. Notably, only 12.5% of respondents reported practicing insecticide rotation, a widely recommended resistance management strategy. This low adoption rate increases the likelihood of resistance development in key pests like *O. longicollis*, particularly when combined with the high incidence (55%) of insecticide over application detected in the selected regions. These patterns are consistent with earlier reports by Henriques et al. (1997) and Awasthi and Sridharan (2017), who documented widespread indiscriminate and excessive pesticide use among banana growers.

 In contrast, Gurbuz et al. (2023) highlighted a positive example from Somalia, where the implementation of IPM training programs led to a significant reduction in pesticide quantities and application frequency among banana growers. This underscores the potential of targeted farmer education and participatory extension models in transforming pest management behaviors and improving the sustainability of banana cultivation systems.

**Table 4. Farmers’ responses on control failures, insecticide rotation and rate of application against *Odoiporus longicollis* in selected districts of Kerala and Tamil Nadu**

|  |  |
| --- | --- |
| **Particulars** | **Farmer’s response/ district (%)** |
| **TVM** | **KLM** | **ALP** | **TSR** | **PKD** | **KNR** | **CBE** | **KKR** | **Mean±SD** |
| **Control Failures** |
| Report of control failures | 40 | 20 | 10 | 30 | 20 | 10 | 50 | 30 | 26.25±14.08 |
| **Insecticide rotation** |
| Practice of insecticide rotation | 10 | 20 | 30 | - | 10 | 20 | 10 | - | 12.50±10.35 |
| **Rate of application of insecticide** |
| Recommended dose | 30 | 50 | 40 | 40 | 40 | 50 | 10 | 10 | 33.75±15.98 |
| Above recommended dose | 70 | 50 | 40 | 50 | 30 | 30 | 90 | 80 | 55.00±22.68 |
| Below recommended dose | - | - | 20 | 10 | 30 | 20 | - | 10 | 11.25±11.25 |
| \*Out of 10 respondents/ districtMean of 80 farmersThiruvananthapuram (TVM), Kollam (KLM), Alappuzha (ALP), Thrissur (TSR), Palakkad (PKD), Kannur (KNR), Coimbatore (CBE), Kanniyakumari (KKR) |

4. Conclusion

This study establishes the predominance of O. longicollis and other associated pests as persistent challenges in banana plantations across Kerala and select districts of Tamil Nadu. The findings reveal an overwhelming dependence on chemical insecticides, particularly organophosphates such as chlorpyrifos, as the principal means of pest control. The prevalent practice of frequent insecticide applications at one month intervals, coupled with the limited implementation of insecticide rotation strategies and occasional use of restricted or highly toxic molecules, raises serious concerns regarding the potential for pest resurgence, environmental contamination, and the acceleration of insecticide resistance.

 While the gradual introduction of biopesticides into pest management practices is a positive trend, their current usage remains comparatively limited. Factors such as restricted availability, variable farmer awareness, and concern about their field efficacy appear to hinder broader adoption. These patterns highlight the pressing need to enhance farmer education on IPM, rational insecticide use, and resistance management strategies. Promoting sustainable practices through demonstration trials, participatory farmer training, and targeted awareness programs will be critical in advancing safer, environmentally sound, and economically viable pest management approaches in banana cultivation.

 The outcomes of this baseline study provide valuable insights into existing pest management practices and challenges, offering a foundation for future insecticide resistance monitoring programs in O. longicollis populations. Furthermore, the information generated will serve as a crucial resource for developing region-specific, ecologically sustainable pest management frameworks tailored to the unique needs of banana-growing areas in southern India.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) here by declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**DISCLAIMER (ETHICAL ISSUES)**

Authors here by declare that, this research article is original work submitted compiling all the guidelines, there is no deviation from any ethical issues.

References

Aguilar, C. H., Zapico, F. L., Namocatcat, J., Fortich, A. & Bojadores, M. (2014). Farmers' perceptions about banana insect pests and integrated pest management systems in banana plantations in SOCSARGEN [South Cotabato, Saranggani and General Santos City] area, Mindanao Philippines. *Philippine Journal of Crop Science (Philippines)*, 63(5). 22-27.

Awasthi, N. S., & Sridharan, S. (2017). Documentation of pest management practices among banana growers in major banana growing districts of Tamil Nadu. *International Journal of Plant Protection*, 10(1), 63-68.

Bagamba, F., Karamura, E., Gold, C.S., Barekye, A., Blomme, G., Tushemereirwe, W.K. & Tinzaara, W. (2006). Socioeconomic assessment of pest management practices in Lwengo sub-county, Uganda. In: Blomme, G., Gold, C.S. & Karamura, E. (eds.) *Farmer-participatory testing of integrated pest management options for sustainable banana production in Eastern Africa: Proceedings of the workshop held in Seeta, Uganda, 8–9 December 2003*. Montpellier, France: The International Network for the Improvement of Banana and Plantain (INIBAP), pp. 17–25.

Barraza, D., Jansen, K., de Joode, B.V.W., & Wesseling, C. (2011). Pesticide use in banana and plantain production and risk perception among local actors in Talamanca, Costa Rica. *Environmental Research*, 111(5), 708-717.

Bhandari, G., Chiaia-Hernández, A.C., Atreya, K., Geissen, V., & Singh, S.P. (2023) Knowledge and practices of commercial banana farmers related to pesticide use in Chitwan district, Nepal; a cross-sectional study and meta-analyses. *Environmental Monitoring and Assessment*, 195(12), p.1490.

Directorate of Plant Protection, Quarantine & Storage. (2024). *Major uses of insecticides (registered under the Insecticides Act, 1968) as on 30.11.2024*. Department of Agriculture & Farmers Welfare, Government of India. Retrieved from <https://ppqs.gov.in/sites/default/files/mup_insecticide_30.11.2024_0.pdf>

Gargi, C., Paul, A., Anitha, N., Manu, C.R., Alex, S., & Sheena, A. (2024).First report of the occurrence of red palm weevil, *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) on banana in Kerala, India. *Insect Environment*, 27(1), 24–26.

Gurbuz, I.B., Abdullahı, A.M., & Ozkan, G. (2023). Integrated pest management practices in Somalia to reduce pesticide use in banana production. *Erwerbs-Obstbau*, 65(5), 1793-1801.

Harish, S., Kavino, M., Kumar, N., & Samiyappan, R. (2009). Differential expression of pathogenesis-related proteins and defense enzymes in banana: interaction between endophytic bacteria, Banana bunchy top virus and *Pentalonia nigronervosa*. *Biocontrol Science and Technology*, *19*(8), 843-857.

Henriques, W., Jeffers, R. D., Lacher Jr, T.E., & Kendall, R. J. (1997). Agrochemical use on banana plantations in Latin America: perspectives on ecological risk. *Environmental Toxicology and Chemistry*, 16(1), 91-99.

IndiaStat. 2024. State-wise area, production and productivity of banana in India (2023-2024). Available at: <https://www.indiastat.com/> (Accessed on: 7 May, 2025).

Justin, C., Leelamathi, M., & Nirmaljohson, S. B. (2008). Bionomics and management of the pseudostem weevil, *Odoiporus longicollis* Oliver (Coleoptera: Curculionidae) in banana–A review. *Agricultural Reviews*, 29(3), 185 192.

Kalita, B., Bhattacharyya, B., Das, P.P.G., Gogoi, I., Hazarika, J., & Borkataki, S. (2023). First report of red palm weevil, *Rhynchophorus ferrugineus* on banana cultivar ‘AsomiyaMalbhog’ in Assam, India. *Pest Management in Horticultural Ecosystems*, 29(1), 166-168.

Karthick, K. S., Chinniah, C., Parthiban, P., & Ravikumar, A. (2018). Newer report of Rugose Spiraling Whitefly, Aleurodicus *rugioperculatus* Martin (Hemiptera: Aleyrodidae) in India. *International Journal of Research Studies in Zoology*, *4*(2), 12-16.

Krishnan, J.U., Jayaprakas, C.A., Harish, E.R., & Rajeswari, L.S. (2019). Banana (*Musa* spp.)-an unseen umbrella crop? Insect diversity on *Musa* spp. in the Indo-Pacific region. *Oriental Insects*, 54(3), 433-445.

Mgenzi, S.R.B., Mkulila, S.I., Blomme, G., Gold, C.S., Ragama, P.E., Karamura, E.B. & Nkuba, J.M. (2005). The effect of pest management practices on banana pests in the Kagera region of Tanzania. In: Blomme, G., Gold, C.S. & Karamura, E.B. (Eds.), *Farmer-participatory testing of integrated pest management options for sustainable banana production in Eastern Africa*. Proceedings of the workshop held in Seeta, Uganda, 8–9 December 2003. Montpellier, France: International Plant Genetic Resources Institute, pp. 43–52.

Okonya, J.S., Petsakos, A., Suarez, V., Nduwayezu, A., Kantungeko, D., Blomme, G., Legg, J.P., & Kroschel, J. (2019). Pesticide use practices in root, tuber, and banana crops by smallholder farmers in Rwanda and Burundi. *International Journal of Environmental Research and Public Health*, 16(3), p.400.

Ostmark, H.E. (1974). Economic insect pests of bananas. *Annual Review of Entomology*, 19, 161–176.

Padmanaban, B., & Sathiamoorthy, S. (2001). Banana stem weevil, *Odoiporus longicollis*. *Musa* Pest Fact Sheet No.5, INIBAP, France.

Polidoro, B. A., Dahlquist, R. M., Castillo, L. E., Morra, M. J., Somarriba, E., & Bosque-Pérez, N. A. (2008). Pesticide application practices, pest knowledge, and cost-benefits of plantain production in the Bribri-Cabécar Indigenous Territories, Costa Rica. *Environmental Research*, *108*(1), 98-106.

Shankar, U., Singh, A.K., Mondal, A. (2016). Integrated pest management in banana. In: Abrol DP (ed) Integrated pest management in the tropics. New India Publishing Agency, New Delhi, pp 329–349

Sivakumar, T., & Mohan C. (2013). Occurrence of rhinoceros beetle, *Oryctes rhinoceros* (L.), on banana cultivars in Kerala. *Pest Management in Horticultural Ecosystems*. 19(1):99–101.

Thangavelu, R., & Mustaffa, M. M. (2012). Current advances in the *Fusarium* wilt disease management in banana with emphasis on biological control. *Plant Pathology*, 273-298.

Tiwari, S., Thapa, R. B., Gautam, D. M. & Shrestha, S. K. (2006). Survey of banana stem weevil, *Odoiporus longicollis* (Oliv.)(Coleoptera: Curculionidae) in Nepal. *Journal of the Institute of Agriculture and Animal Science*, 27, 127-131.

Visalakshi A, Nair, G. M, Beevi, S. N., Amma, A.M.K. (1989). Occurrence of *Odoiporus longicollis* Oliver (Coleoptera: Curculionidae) as a pest of banana in Kerala. *Entomon*. 14 (3–4), 367–368.