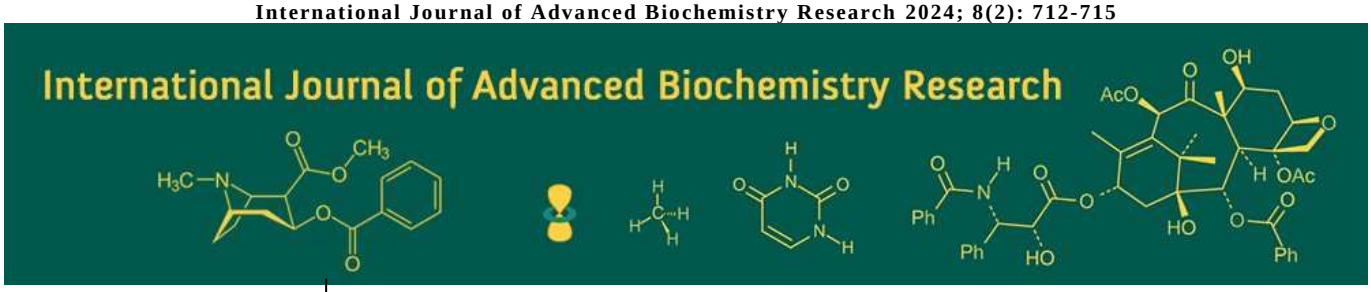

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(2): 712-715
www.biochemjournal.com
Received: 06-12-2023
Accepted: 10-01-2024

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Biology and incidence of banana pseudostem weevil, *Odoiporus longicollis* in Mysuru region

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DOI: https://doi.org/10.33545/26174693.2024.v8.i2i.663

Abstract
Laboratory studies on the biology of the banana pseudostem weevil, *Odoiporus longicollis*, unveiled key insights into its life cycle. The incubation period ranged from 3.00 to 4.00 days. Larval development comprised five instars, with durations of 2.75, 4.05, 5.85, 6.65, and 13.15 days for instars I to V, respectively, resulting in a total larval duration ranging from 25.00 to 36.00 days. The pre-pupal period lasted for 2.00 to 5.00 days, while the pupal period varied from 15.00 to 21.00 days. The entire developmental period from egg hatching to adult emergence spanned from 48.00 to 65.00 days. Adult longevity ranged between 50.00 and 62.00 days. Females laid a total of 17.00 to 21.00 eggs in their lifetime. Field observations indicated varying levels of infestation across different taluks, with H.D. Kote taluk exhibiting the highest infestation rates across all crop stages, followed by Mysuru, T. Narasipura, and Hunsuru. Conversely, Nanjanagudu taluk registered the lowest infestation levels. Notably, the ratoon crop of the Nendran variety showed the highest infestation rate at 35%, followed by Nanjanagudu rasabale and Elakki varieties. In contrast, the G-naine variety displayed resistance to pest incidence. Additionally, the study highlighted a preference of the pest for ratoon crops over fresh crop stages of bananas, resulting in comparatively lower incidence in fresh crops.

Keywords: *Odoiporus*, banana, pseudostem weevil

Introduction
Banana stands as the second most crucial fruit crop in India, following mango. Among the various Indian states, Karnataka emerges as a pivotal player in banana cultivation, boasting an extensive cultivation area spanning 1,01,530 hectares and yielding an impressive production figure of 24,89,500 metric tons. Despite its significance, banana cultivation faces challenges from various pests, with over nineteen species of insects reported to infest banana cultivars (Padmanaban *et al.* 2001) [8]. One such significant pest is the banana pseudostem borer, *Odoiporus longicollis* (Olivier) (Coleoptera: Curculionidae). This pest poses a significant threat to banana production and productivity banana, capable of causing damage of up to 40%. *O. longicollis* is widely distributed across diverse geographical locations in India (Isahaque, 1978) [4], leading to substantial crop losses where infestations occur.
Infestations by *O. longicollis* can disrupt the banana plant's growth cycle, particularly during the pre-flowering stage, where they hinder flower emergence. Furthermore, the larval tunneling activity can induce stem rot, weakening and ultimately causing the collapse of affected plant parts. The damaged areas provide an ideal environment for microorganisms that promote rotting, exacerbating the harm inflicted on banana plants.
Despite the widespread prevalence and significant economic impact of *O. longicollis*, comprehensive studies on its biology and incidence, especially in key banana-producing regions like Mysuru, remain limited. Therefore, this research aims to fill this knowledge gap by conducting an in-depth investigation into the biology and incidence patterns of the banana pseudostem weevil. Additionally, the study aims to explore the preferences of *O. longicollis* towards different banana varieties. Through these efforts, the research aims to provide valuable insights that can serve as a crucial foundation for the development of effective management strategies to mitigate the impact of this pest on banana cultivation.

Materials and Methods

Odoiporus longicollis specimens at various developmental stages were gathered from infested banana fields in the vicinity of Mysuru and utilized as a foundational culture for investigating the weevil's biology. These weevils were housed in plastic containers furnished with banana pseudostems for sustenance, mating, and egg-laying, with the pseudostems replaced every two days. Eggs were harvested together with strips of pseudostem and transferred to another plastic container equipped with moist filter paper discs. Upon hatching, first-instar larvae were relocated to fresh pseudostem segments to continue their development. This protocol was repeated to observe different larval instars. Following the completion of larval, prepupal, and pupal phases, adult weevils were collected and utilized for further analysis.

Laboratory investigations were conducted to study the life cycle of the weevil. Individual pairs of newly emerged weevils were introduced into plastic boxes containing pseudostem strips, with ten such boxes maintained for observation. Food was replenished every two days, and strips containing eggs were placed in separate plastic containers with moist paper to facilitate the incubation period. Previous attempts without moist paper resulted in drying and no egg hatching. Upon hatching, the larvae were transferred to fresh pseudostems with small holes on the first leaf sheath. To determine the number and duration of instars, larvae were extracted from the pseudostems, and tunnels were meticulously examined for discarded head capsules. The same procedure was followed to ascertain the duration of pupation and emergence of adult weevils. The aforementioned setup was also utilized to evaluate pre-oviposition, oviposition, and post-oviposition periods, as well as fecundity and adult longevity. Data regarding these parameters were meticulously recorded and tabulated, with the range and mean±standard deviation calculated. The parameters observed during the biological study included the incubation period, total number of larval instars, total duration of the larval period and duration of each instar, pupal period, fecundity, adult longevity, and sex ratio.

A comprehensive survey was conducted in Mysuru district during 2018-2019 to assess the incidence of banana pseudostem weevil. The survey covered five banana-growing taluks: H.D. Kote, Hunasur, Mysuru, Nanjanagudu, and T. Narasipura. Roving surveys were conducted twice, from September to October 2018 and from January to February 2019. In each taluk and season, ten orchards were randomly selected, regardless of banana variety or crop type (fresh or ratoon). A total of 50 orchards were surveyed in each season. Within each orchard, ten rows were randomly chosen, and ten plants were selected from each row to observe the presence of bored holes on the pseudostem and to count the number of bored holes. The percentage of infestation was calculated for each orchard, and the overall infestation for each taluk was determined. Additionally, data on the percentage of infestation and mean number of bored holes per plant in both fresh and ratoon crops were compiled separately to assess the relative abundance of pseudostem weevil in each crop type. Similarly, to understand the preference of pseudostem weevil for different banana varieties, the percentage of infestation and number of bored holes on each variety were observed during both surveys.

Results and Discussion

The life cycle of *Odoiporus longicollis* was investigated in laboratory conditions. Eggs, laid singly within the air chamber, appeared translucent and yellowish. The incubation period ranged from 3 to 4 days during August to October, consistent with previous studies by Dutt and Maiti (1979) [3], Padmanaban and Sathiamoorthy (2001) [8], Thippaiah (2004) [6], Priyadarshini *et al.* (2014) [9], and Krishnana and Jayaprakash (2015) [6], reporting an incubation period of 3-5 days from January to August.

The larvae passed through five instars to complete the larval period. Before each moult, larvae ceased feeding and boring, becoming inactive. The head capsule ruptured along the ecdysial cleavage line during each moult, with the freshly moulted larvae appearing white, except for their light brown mandibles. The total larval period ranged from 25 to 36 days, averaging 32.45±2.91 days from August to October. Thippaiah (2004) noted seasonal variations, with the average total larval period increasing from 33.10±1.85 days during March to August to 58.70±3.71 days from December to February, attributed to climatic conditions.

After constructing a cocoon, the larva gradually shrank to about 2/3 of its normal size, entering the pre-pupal stage, characterized by a change in colour to pale yellow. The pre-pupal period lasted 2 to 5 days, averaging 3.45±1.07 days, consistent with Thippaiah's (2004) [10] findings of a pre-pupal period of 3-5 days. The exarate pupa exhibited a yellowish body colour, with setae on the head and legs held close to the body. The pupal period lasted 15 to 21 days, averaging 18.25±2.16 days, similar to Thippaiah's (2004) [10] observations of a pupal period of 17-21 days.

The total developmental period from egg to adult emergence varied from 48 to 65 days, averaging 58.10±5.00 days during August to October, aligning with Thippaiah's (2004) [10] findings of a total developmental period ranging from 53 to 66 days. Upon completing the pupal stage, adults remained inside the cocoon for 3-4 days before emergence. They appeared reddish-brown, turning black before emergence, with some adults feeding on dead plant tissue within the pseudostem.

The pre-oviposition period lasted 18 to 33 days, with an average of 26.20±3.89 days, while the oviposition period ranged from 17 to 26 days, averaging 22.30±3.07 days. The post-oviposition period varied from 15 to 20 days, averaging 17.90±1.45 days, consistent with earlier findings by Dutt and Maiti (1972) [3], Padmanaban and Sathiamoorthy (2001) [8], and Thippaiah (2004) [10]. Fertilized females laid 17 to 21 eggs, averaging 17.90±1.45 eggs during their lifetime, in line with Thippaiah's (2004) [10] observations. Adult individuals survived for 50 to 62 days, averaging 55.60±4.07 days, akin to Thippaiah's (2004) [10] recorded longevity of 52-60 days. The sex ratio varied from 1:1.20 to 1:1.54, similar to observations by Dutt and Maiti (1972) [3] and Thippaiah (2004) [10].

The survey conducted across five taluks of Mysuru revealed varying degrees of incidence of the pseudostem weevil. From August to October 2018, the infestation ranged from 7.25% to 25.66%, while from January to February 2019, it ranged from 1.33% to 13.67%, irrespective of crop stages. H.D. Kote taluk exhibited the highest infestation during August to October 2018, followed by Mysuru, T. Narasipura, Nanjanagudu, and Hunasuru taluks. In contrast, during January to February 2019, T. Narasipura taluk showed the highest infestation, followed by Mysuru, Hunasuru, H.D. Kote, and Nanjanagudu taluks. This trend aligns with previous findings by Thippaiah (2004) [10] and Devi *et al.* (2015) [2], indicating an increase in infestation over the years due to expanded crop cultivation, limited

farmer awareness, and inadequate pest management strategies.

The survey also assessed the susceptibility of four banana varieties to pseudostem weevil infestation. Nendran exhibited the highest susceptibility across all crop stages and seasons, with infestation rates of 19.50%±1.50 to 10.33%±6.51 during August-October and January-February in fresh crop, and 35.00%±2.00 to 17.5%±3.42 during the same periods in ratoon crop. Nanjanagudu rasabale and Elakki varieties followed, while G-naine showed the least susceptibility. Consistently, Nendran also exhibited the highest number of bored holes per plant, followed by Nanjanagudu rasabale and Elakki, with G-naine showing the least infestation. These findings corroborate with earlier studies by Jayanthi and Varghese (1999) [5], Visalaksi *et al.* (1989) [11], Padmanaban and Sundararaju (1999) [7], Anitha (2004) [1], and Thippaiah (2004) [10], highlighting Nendran's high susceptibility to pseudostem weevil infestation and the relative resilience of G-naine.

Table 1: Developmental periods of different stages of banana pseudostem weevil, *O. longicollis*

Life stage (Days)	Range	Mean±SD
Incubation period	3.00-4.00	3.95 ±1.09
Larval period	25.00-36.00	32.45 ±2.91
Prepupal period	2.00-5.00	3.45 ±1.07
Pupal period	15.00-21.00	18.25 ±2.16
Total developmental period	48.00-65.00	58.10±5.00
Adult longevity	50.00-62.00	55.60±4.07

Table 2: Developmental periods of different larval instars of banana pseudostem weevil, *O. longicollis*

Instar	Range (Days)	Mean±SD
I	2.00-4.00	2.75±0.77
II	3.00-5.00	4.05±0.89
III	3.00-8.00	5.85±1.49
IV	5.00-9.00	6.65±1.57
V	9.00-15.00	13.15±1.93

Table 3: Reproductive parameters of banana pseudostem weevil, *O. longicollis*

Instars	Range (Days)	Mean±SD
I	2.00-4.00	2.75±0.77
II	3.00-5.00	4.05±0.89
III	3.00-8.00	5.85±1.49
IV	5.00-9.00	6.65±1.57
V	9.00-15.00	13.15±1.93

Table 4: Infestation of pseudostem weevil, *O. longicollis* at different stages of banana crop in different taluks of Mysuru district

Season	Taluk	Fresh Crop		Ratoon Crop		Over all Crop	
		Per cent of infestation	Mean number of bored holes	Per cent of infestation	Mean number of bored holes	Per cent of infestation	Mean number of bored holes
August to October, 2018	H.D Kote	15.33±6.03	0.73±0.38	25.66±8.57	2.15±0.71	22.22±8.35	01.68±0.89
	Hunsuru	11.00±7.11	0.34±0.29	15.20±7.53	0.95±0.48	12.44±7.25	0.65±0.49
	Mysuru	12.25±6.18	0.67±0.45	17.00±10.80	1.19±1.04	15.10±9.15	0.98±0.86
	Nanjanagudu	07.25±2.22	0.54±0.27	15.00±6.69	1.03±0.82	11.90±6.52	0.83±0.68
	T.N.pura	10.15±5.46	0.62±0.58	20.33±9.29	1.82±1.93	13.20±7.96	0.98±0.94
January to February, 2019	H.D Kote	01.33±02.31	0.30±0.05	10.29±8.90	0.53±0.54	07.60±08.53	0.38±0.05
	Hunsuru	07.00±04.08	0.45±0.33	09.60±5.76	0.30±0.22	08.20±05.01	0.39±0.26
	Mysuru	07.75±02.87	0.25±0.18	13.67±4.08	0.88±1.07	11.30±04.62	0.74±0.87
	Nanjanagudu	03.50±03.02	0.15±0.16	03.25±4.11	0.70±0.35	07.44±06.00	0.37±0.37
	T.N.pura	11.50±04.23	0.66±0.34	13.33±1.53	0.84±0.15	12.60±03.57	0.75±0.29

Table 5: Infestation of pseudostem weevil, *O. longicollis* on different varieties of banana cultivated in Mysuru

Season	Variety	Fresh Crop		Ratoon Crop		Over all Crop	
		Per cent of infestation	Mean number of bored holes	Per cent of infestation	Mean number of bored holes	Per cent of infestation	Mean number of bored holes
August to October, 2018	Elakki	12.27±05.18	0.69±0.31	23.67±3.71	1.97±0.67	17.40±7.33	1.27±0.81
	G- naine	08.13±03.48	0.37±0.18	12.14±5.78	0.75±0.51	10.68±5.59	0.61±0.47
	Nendran	19.50±01.50	01.46±0.34	35.00±2.00	2.74±0.04	27.25±8.64	2.10±0.73
	Nanjanagudu rasabale	Crop was not available		30.00	2.69	30.00	2.69
January to February, 2019	Elakki	07.83±05.53	0.47±0.40	12.14±07.08	0.87±0.99	10.15±5.92	0.65±0.38
	G- naine	06.13±04.78	0.27±0.28	09.73±04.99	0.39±0.31	7.93±5.83	0.33±0.37
	Nendran	10.33±06.51	0.57±0.48	17.5±3.42	1.02±0.21	14.43±5.48	0.83 ±0.41

Conclusion

In conclusion, the investigation into the life cycle of Odoiporus longicollis in laboratory conditions has provided valuable insights into its developmental stages and behavior. The findings regarding egg incubation, larval instars, pupal stage, and adult characteristics align with previous studies, underscoring the consistency of the species' life cycle dynamics. The observed variations in developmental periods and infestation rates across seasons and regions emphasize the influence of climatic factors and agricultural practices on pseudostem weevil populations. Moreover, the susceptibility of banana varieties to infestation underscores the importance of crop selection in pest management strategies. These findings contribute to our understanding of Odoiporus longicollis biology and offer valuable implications for pest control and banana cultivation practices. Further research and implementation of effective management strategies are crucial to mitigate the impact of pseudostem weevil infestation on banana crops.

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