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NATURAL ENEMIES OF *PENTALONIA NIGRONERVOSA* COQUEREL, A VECTOR OF BUNCHY TOP OF BANANA AND BIOLOGY OF ITS MOST EFFECTIVE PREDATOR *SCYMNUS NUBILUS* MULSANT

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ABSTRACT

Natural enemies of *Pentalonia nigronervosa* Coquerel (Hemiptera: Aphididae), a vector of bunchy top of banana, are reported from Tamil Nadu, South India. Totally four predators including three coccinellids (*Pseudaspidimerus trinotatus* (Thunberg), *Scymnus* (*Scymnus*) *nubilus* Mulsant, *Cheilomenes sexmaculata* (F.)) and one hemerobiid (*Micromus timidus* Hagen) were recorded. Only one parasitoid, *Aphelinus* sp. nr. *gossypii* Timberlake (Hymenoptera: Aphelinidae) was recorded. Biology of *S. nubilus*, the most effective predator of *P. nigronervosa,* was also studied in the laboratory and the results are presented.

Key words: Banana, aphid, bunchy top, population dynamics, predators, parasitoid, India, predatory potential, biology, *Scymnus nubilus*

Banana production in the tropical countries including India is greatly hampered by the bunchy top disease caused by the *Banana bunchy top virus* (BBTV) and it is considered as the most devastating virus disease affecting bananas and plantains (Vézina et al., 2020). The disease is transmitted primarily by infected planting material and secondarily by the banana black aphid (*Pentalonia nigronervosa* Coquerel), its only known vector, in a persistent circulative manner. The aphid also transmits the banana bract mosaic virus in a non-persistent manner (Selvarajan, 2015). The aphid is usually controlled by the application of recommended systemic insecticides, but the aphids tend to remain hidden under leaf sheaths on banana plants and this may limit the efficacy of insecticide applications on aphid populations (Robson et al., 2006). Despite the presence of many bioagents in the banana ecosystem, systematic attempts have not been made to document and utilize them in aphid management. In this study, the natural enemies of banana aphid in Tamil Nadu, South India, were documented. The biology of *Scymnus nubilus* Mulsant (Coleoptera: Coccinellidae), known to be an efficient predator of banana aphid (Johnson 1972; 1983) was also studied in the laboratory and the details are presented.

MATERIALS AND METHODS

Seasonal incidence of banana aphid and its natural enemies was monitored in the field banana germplasm bank maintained in the research farm of the National Research Centre for Banana (NRCB), Trichy, Tamil Nadu, during 2018-21. Natural enemies collected in the field were identified and the voucher specimens are maintained in the banana insect collection at the NRCB. Immature stages and adults of the bioagents were observed and photographed under a Leica M205A stereo microscope fitted with a DMC 4500 digital camera. The biology of *S. nubilus,* the most common predator, was studied on banana aphid maintained on excised banana leaf bits with intact midribs. Five mating pairs of beetles were allowed to oviposit on banana leaves colonised by the aphid. Freshly hatched, first instar larvae were transferred to banana leaf bits in petri dishes covered with a muslin cloth and secured with a rubber band and reared individually. Leaf bits with aphids were provided every day to each larva and the feeding rate/ day was recorded. Total number of aphids fed by each larva and per day feeding were worked out from the mean consumption of larvae that reached the pupal stage. Observations on the number of eggs laid/ day, total fecundity and adult longevity were also recorded.

RESULTS AND DISCUSSION

In this study, aphid activity on banana was almost absent during summer (May- October). The aphid was active during the cooler months and the incidence was maximum during November–February on all the germplasm accessions maintained at NRCB, Trichy. Aphid incidence started building up from November and the peak was observed during winter (January-February) and thereafter steadily declined. Incidence was observed on 369 germplasm accessions belonging

to various genome types of banana (30 AA, 33 AAA, 113 AAB, 26 AB, 119 ABB, 10 ABBB, 36 BB and 2 *Musa ornata* / *Rhodochlamys*). Only one accession (Bathesa Ash – ABB genome type) was found to be free from aphids. It is interesting to note that certain banana genome types appear to be resistant to bunchy top disease transmitted by *P. nigronervosa* though the aphid seems to be present across banana genotypes.

In field conditions, five predators (one hemerobiid and four coccinellids) and one aphelinid parasitoid were recorded as natural enemies of *P. nigronervosa* in Tamil Nadu. Totally four predators were found to feed on banana aphid in the field conditions (Fig. 1). Immature stages and adults of three coccinellids, *Cheilomenes sexmaculata* (F.) (Fig. 1a, e), *Pseudaspidimerus trinotatus* (Thunberg) (Fig. 1c, g), and *Scymnus* (*Scymnus*) *nubilus* Mulsant (Fig. 1d, h) (Coleoptera: Coccinellidae) and one brown lacewing, *Micromus timidus* Hagen (Fig. 1b, f) (Neuroptera: Hemerobiidae) were found to be active predators. Of these, *P. trinotatus, S. nubilus,* and *C. sexmaculatus* have been recorded as predators of banana aphid from Kerala by other workers (Johnson, 1972, 1983; Padmalatha and Singh, 1998). Padmalatha and Singh (1998) recorded seven species of coccinellids in banana aphid colonies from Kerala, which included *C. sexmaculata, P. trinotatus, Scymnus quadrillum, S. pyrocheilus, Adalia bipunctata, Coccinella septempunctata* and *Nephus luteus*.

Of these, *A. bipunctata* and *N. luteus* are certainly based on wrong identifications. There is no record of hemerobiids feeding on banana aphid in India until now and the association of *M. timidus* with *P. nigronervosa* appears to be new for this region. In Hawaii, *M. timidus* has been used for controlling aphids, including banana aphid (under the name *Nesomicromus navigatorum* (Brauer)) (Tinzaara and Gold, 2008). Only one parasitoid, *Aphelinus* nr. *gossypii* Timberlake (Hymenoptera: Aphelinidae) (Fig. 2c) was recorded on *P. nigronervosa* in Tamil Nadu. The parasitoid was found to parasitize older nymphs (3-4 instar stage) (Fig. 2a, b). Few parasitoids of banana aphid are known from India and elsewhere. Stary and Stechmann (1990) successfully propagated *Ephedrus cerasicola* Starý (Hymenoptera: Braconidae: Aphidiinae) on *P. nigronervosa* in a glasshouse and found it to be a promising agent in the biocontrol of *P. nigronervosa* in Pacific islands (Tonga). Muratori et al. (2009) described a new species of cecidomyiid parasitoid, *Endaphis fugitiva* Gagné and Muratori, on banana aphid and described its life history.

The biology of *S. nubilus* was studied on banana aphid in the laboratory at 25–30°C and 75–85% RH. The eggs (Fig. 3a) are oval, pale pink to yellowish-orange and the chorion has a conspicuous reticulate pattern. The larva (Fig. 3b, c) is pale yellow and covered with characteristic white waxy strands. The pupa (Fig. 3d)

Fig. 1. Predators of *P. nigronervosa*: a, e. *Cheilomenes sexmaculata*: b, f. *Micromus timidus*, c, g. *Pseudaspidimerus trinotatus*; d, h. *Scymnus nubilus*

Fig. 2. a, b. Parasitized banana aphids; c. Adult female of *Aphelinus* sp. nr. *gossypii*

Fig. 3. Life stages of *Scymnus nubilus*: a. Eggs; b, c. Larva; d. Pupa; e, f. Adult

is yellow and covered with white waxy filaments. The adult (Fig. 3e, f) is reddish or yellowish brown with a median black marking on pronotum and a black sutural stripe of variable width starting from basal margin and gradually narrowed towards apex and occasionally the lateral borders are narrowly dark brown to black at middle. Egg laying started a week after adult emergence. Eggs were laid either singly or in small groups on the leaf substrate on which the aphid colony was found or glued to the moulted skins of the aphids. The number of eggs laid / day / female was 3–36 (mean 9.86 eggs/ day). Egg laying started from the sixth day after adult emergence and continued for up to 46 days. *Scymnus nubilus* passed through four larval instars and the total development from egg to adult emergence took 15–19 days. The egg, larval, prepupal and pupal period lasted 4.5± 0.53, 7.88± 0.88, 1.50± 0.46 and 3.0± 0.76 days, respectively (Table 1). The number of aphids consumed/ day by the larvae of *S. nubilus* gradually increased with age and the daily consumption rate was 2–4 aphids in the first instar, 3–5 in the second instar, 4–9 in the third instar and 2–20 in the fourth instar. Total prey consumption during the entire larval period was 36.0–65.0 nymphs. Adult longevity was greater in females (62.13± 5.22 days) than males (18.86± 6.74 days) and the longest-lived adult female consumed 534 aphids in its lifetime of 71 days and the per day prey consumption by an adult beetle ranged from 7.15 to 11.53 (mean 8.42± 1.35).

Johnson (1972) studied the biology of *S. nubilus* on *P. nigronervosa* in Kerala conditions. He stated that

Table 1. Biology and prey consumption of *S. nubilus* reared on *P. nigronervosa* in the laboratory

Parameter	Duration (days)	Mean± SD	Prey consumption/ day	Mean ± SD
Egg period	4–5	4.5± 0.53	--	--
Larval period				
I instar	1.0–1.5	1.13± 0.23	2.0–4.0	2.88± 0.83
II instar	1.0–1.5	1.19± 0.26	3.0–5.0	4.63± 1.41
III instar	1.0–1.5	1.31± 0.26	4.0–9.0	7.88± 2.10
IV instar	4.0–5.0	4.25± 0.46	2.0–20.0	32.63± 7.37
Total larval period	7.0–8.0	7.88± 0.88	36.0–65.0	48.0± 10.31
Prepupal period	1.0–2.0	1.50± 0.46	--	--
Pupal period	3.0–4.0	3.0± 0.76	--	--
Adult longevity				
Female	58.0–71.0	62.13± 5.22	7.15–11.53	8.42± 1.35
Male	12.0–30.0	18.86± 6.74		
Total fecundity	298–454	393.38± 48.76	--	--

eggs were laid singly during an oviposition period of more than a month. Our observations indicate eggs are laid either singly or in groups, but the durations of life stages are within the range recorded by Johnson (1972). However, development of *S. nubilus* took longer when reared on pink mealybug (*Maconellicoccus hirsutus* (Green)), with the egg, larval, prepupal and pupal stages lasting 5.5, 10.45, 1.7 and 7.71 days, respectively, and the fecundity / day was 13.7 and the adult longevity was 49.9 days (male) and 57.23 days (female) (Santhakumar and Chakraborty, 1997). Aphids appear to be the more favourable host insects because the adult females lived longer (62.13±5.22) with high fecundity on *P. nigronervosa*. Rosagro et al. (2020) found *S. nubilus* was a promising bioagent for managing *Aphis spiraecola* Patch and *Cinara juniperi* (De Geer) (Hemiptera: Aphididae) infesting Azorean endemic plants reared in forestry nurseries. Calilung (2008) recorded four species of coccinellids feeding on *P. nigronervosa* on banana and abaca, none of which are found in India and studied their life history. *Scymnus nubilus* is one of the most common species of coccinellids in India and has a wide distribution in the Oriental and Palaearctic regions. Its high fecundity, adult longevity and feeding potential are ideal for its utilization for augmentative biological control, for which protocols for mass production need to be standardized.

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