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Studies on some bio-ecological aspects and varietal preference of banana aphid, *Pentalonia nigronervosa* Coquerel (Hemiptera: Aphididae)

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ABSTRACT

Keeping in view of dearth of detailed information regarding life history of banana aphid Pentalonia nigronervosa Coquerel, the present investigation has been undertaken to study some bio-ecological aspects of banana aphid, P. nigronervosa including its biology, correlation and regression studies to know the impact of weather parameters on its development along with varietal preference of the aphid during 2012-13. The results revealed the presence of banana aphids from 2nd week of December on banana and the maximum colonies have been noticed on leaf axil portion of pseudostem and newly unfurled top leaf of banana sucker. The study also revealed that the nymphs passed through four instars to become adult. The nymphal duration, reproductive period, pre-nymphoposition period, fecundity and adult longevity ranged from 10.8 days to 13.0 days, 20.4 days to 30.0 days, 3.0 to 6.0 days, 20.0 to 33.4 nymphs per female and 35.4 to 48.0 days, respectively during the study of subsequent two generations of both the parent aphids. It can also be concluded that 'G9' is more preferable germplasm than 'Martaman' in relation to their nymphal development. Relative humidity and maximum temperature were found to have significant correlation with the nymphal development, however, the combined effects of all the weather parameters considered on the duration of nymphal instars have been found to be statistically non-significant.

***Keywords*:** Biology, *Pentalonia nigronervosa*, varietal preference, weather parameter

India is the largest producer of banana in the world with the production of 29.7 million tons from 7.48 lakh hectare area with an annual productivity of 35.9 tons per ha (Jeyabaskaran and Mustafa, 2010). In India, major banana growing states are Maharashtra, Gujarat, Tamil Nadu, Andhra Pradesh, Assam, Bihar, Karnataka, Kerala, Orissa and West Bengal (Bauri *et al.*, 2014). In West Bengal state, Nadia, Hooghly, North 24 Parganas, Purba Medinipur are the leading banana growers. Low productivity of banana is mainly influenced by various natural constrains of which insect pests contribute a major part thereby affecting both quality and quantity. The serious pests of banana as reported in India are the banana rhizome weevil, *Cosmopolites sordidus* (Germer), the pseudostem weevil, *Odoiporus longicollis* (Olivier), the leaf and fruit scarring beetle, *Nodostoma viridipenne* (Motsch.), *Nodostoma subcostatum* (Jacoby) *etc*. The banana aphid, *Pentalonia nigronervosa* Coquerel (Hemiptera: Aphididae), although has been considered as minor pest in India, causes damage both directly and indirectly to the other banana growing tracts of the world. The banana aphid is present worldwide where banana (*Musa* spp.) is grown. In banana growing areas, it is causing serious damage through weakening the plant and eventually impedes plant development and growth. Heavy infestations may reduce the market value of the fruits due to injury caused by sooty mold that develops on the honey dew secreted by the aphid. However, direct damage by this aphid is generally negligible. The insects do far more harm as vectors of *banana bunchy top virus (BBTV)*, the etiological agent of banana bunchy top disease (BBTD). This aphid also transmits a mosaic virus of cardamom called as "katte". In India, they are commonly spread in eastern and southern parts of the country. The virus is not transmitted mechanically. The aphids acquire the virus from infected plants, and no transovarial infection occurs. BBTV is transmitted persistently, and alate aphids are presumably responsible for spread of the virus (Hu *et al*., 1996). Management of these aphids is difficult owing to their cryptic life-style, with large colonies developing under the sheaths of banana leaves or on underground plant parts (Waterhouse and Norris, 1987). Without understanding the pest biology and ecology, long term management of either insect pest or transmitted disease is difficult. Relevant local studies would be helpful to formulate effective management strategies for the virus and its vectored pathogen. Records on the life history of this pest are few and none is available from West Bengal and hence, the present investigation has been carried out to study some bio-ecological aspects of this pest.

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MATERIALS AND METHODS

To study the incidence of *P. nigronervosa*, an experiment was conducted in the field of AICRP on Fruits (Mohanpur Centre) at Mondouri, Nadia, West Bengal during 2012-13 on banana cv. Martaman (AAB). The laboratory experiments were carried out in the Department of Agricultural Entomology, BCKV, Mohanpur, Nadia. For laboratory studies, aphids (*P. nigronervosa*) and plant materials were collected from the banana orchard of the project. Life cycle of the banana aphid was studied during December, 2012 to April, 2013 as per the method suggested by Padmalatha and Singh (2002a). Two consecutive generations of two mother aphids were studied. The studies were initiated with field collected apterous females. Nymphs laid overnight by the females were examined to select the nymph of similar size to start the life history studies. From that, two new born female aphids were reared in separate Petri dishes in laboratory; one from 30th December, 2012 and another from 1st January, 2013, on banana cv. 'Martaman'. As well as, two other new born aphids were also reared separately on banana cv. 'Martaman' and 'G9'in the laboratory for studying the varietal preference. At the onset of first generation of these two aphids five nymphs each from two mother aphids based on different dates of birth were kept separately in petridishes and observations on different biological parameters were recorded. After completion of first generation, study of second generation was also undertaken by taking one new born nymph from the five aphids from first generation separately and the similar observations were recorded. For the experiments, the petiole portion of leaf of sucker was taken for rearing of aphids. In all the experiments, mean value of different biological parameters of *P. nigronervosa viz*. duration of nymphal instars, reproductive phase and pre-nymphoposition period as well as the fecundity and longevity was worked out. Afterwards, the results were tested for significance considering the Complete Randomized Design (Panse and Sukhatme, 2000). For correlation study, the duration of nymphal development recorded for biological study was considered along with four meteorological parameters *viz*. Maximum temperature (T_{Max}), minimum temperature (T_{Min}), morning relative humidity (RH_{Morn}) and evening relative humidity (RH_{Even}). The regression analysis was also carried out taking the same parameters.

RESULTS AND DISCUSSION

Incidence and distribution of banana aphid on banana plant

During the course of the investigation, it was found that the presence of banana aphids (both alate and apterous) was noticed from 2nd week of December on banana. The colonies were seen congregated mostly on leaf axil portion of pseudostem and newly unfurled top leaf of banana sucker and at the base of the pseudostem in case of mother plant. Maximum colony of banana aphids was found at the leaf axil portion of pseudostem. The base of mother plant contained less aphid colony. The present study supports the findings of Hooks *et al*. (2011).

Biological studies of banana aphid in laboratory condition

This study revealed that the nymphs passed through four instars to become adult and reproduction of banana aphids was totally parthenogenetic. This result is in conformity with the reports of Rajan (1981) from India and Yang (1989) from China. A nymph that was placed in Petri dish on 30th December, and was reared up to 17th February, completed its first, second, third and fourth instar in 3, 3, 3 and 3 days, respectively (Fig. 1). The nymphal duration during the first generation was 12 days *i.e.* from 30th December to 11th January. The adult female had reproductive period of 30 days as well as pre-nymphoposition period (the time taken by the female to give its first nymph birth after being adult) of 6 days and the female laid 28 nymphs. The total longevity was 48 days.

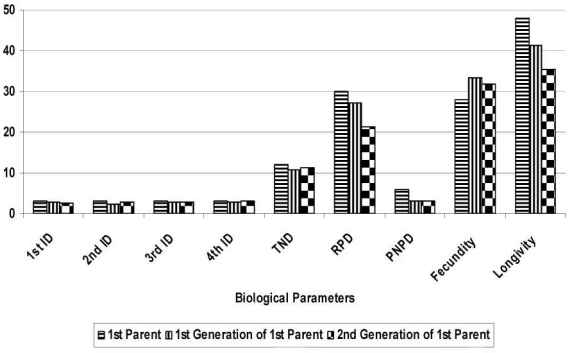

Fig. 1: Different biological parameters of 1st parent of *P. nigronervosa* and its two following generations on banana cv. Martaman

Note: ID = Instar Duration (days), TND = Total Nymphal Duration (days), RPD = Reproductive Phase Duration (days), PNPD = Pre-nymphoposition Duration (days)

Figure-1 revealed that during first generation the nymphal duration was 10.8 days (range 9-12) on an average. The first, second, third and fourth instar took 2.8 days (range 2-3), 2.4 days (range 2-3), 2.8 days (range 2-3) and 2.8 days (range 2-4), respectively. Adult female had the reproductive period of 27.2 days (range 15-34). The adult obtained from the parent generation laid nymphs on an average 33.4 (range 17-53) which had pre-nymphoposition period of 3.2 days (range 2-4). Adult longevity was 41.2 days (range 30-48).

In second generation, the average time taken for completion of first, second, third and fourth instar was 2.6 days (range 2-3), 2.8 days (range 2-3), 2.8 days (range 2-3) and 3.0 days (range 2-4), respectively (Fig. 1). The total nymphal duration recorded was 11.2 days (range 8-13). Reproductive period was 21.2 days (range 16-26). This generation had an average pre-nymphoposition period of 3.0 days (range 2-3), the adult female laid on an average 31.8 nymphs (range 27-38). The average adult longevity was 35.4 days (range 31-41).

Another nymph that was placed in Petri dish on 1st January which was reared up to 14th February, completed its first, second, third and fourth instar in 3, 3, 3 and 4 days, respectively (Fig. 2). The total nymphal duration during the first generation was 13 days i.e. from 1st January to 14th January. The adult female had a reproductive period of 26 days. The female had a pre-nymphoposition period of 5 days and it laid total 20 nymphs during this period. The total longevity was 44 days.

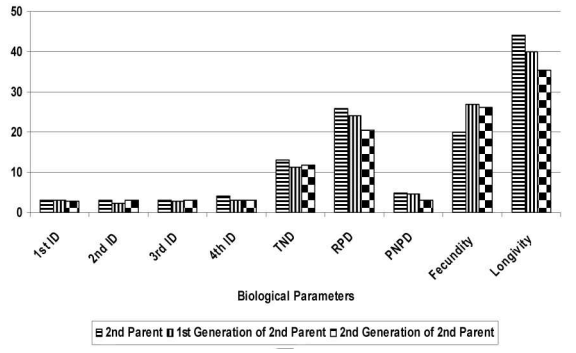

Fig. 2: Different biological parameters of 2nd parent of *P. nigronervosa* and its two following generations on banana cv. Martaman

The average time taken to complete the first, second, third and fourth instar for the first generation of the second parent was 3.0 days (range 2-4), 2.4 days (range 2-3), 2.8 days (range 2-3) and 3.0 days (range 2-4), respectively (Fig. 2). Total nymphal duration recorded was 11.2 days (range 9-13). During this generation, adult had a reproductive period of 24.2 days (range 22-25) and pre-nymphoposition period of 4.6 days (range 3-7). Adult female laid 26.8 nymphs (range 18-31). The longevity found was recorded to be 40.0 days (range 37-45) in this generation.

In second generation, the average time taken for completion of first, second, third and fourth instar was 2.8 days (range 2-3), 3.0 days (range 3-3), 3.0 days (range 2-4) and 3.0 days (range 2-4), respectively (Fig. 2). The total nymphal duration was observed to be 11.8 days (range 11-13). Reproductive period and pre-nymphoposition period had been recorded as 20.4 days (range 16-26) and 3.2 days (range 2-4), respectively. The adult female laid 26.2 numbers of nymphs (range 20-32) while adult longevity had been recorded as 35.4 days (range 32-40).

The total nymphal duration was 12, 10.8, 11.2, 13, 11.2 and 11.8 days for 1st parent, 1st generation of 1st parent, 2nd generation of 1st parent, 2nd parent, 1st generation of 2nd parent and 2nd generation of 2nd parent, respectively. Rajan (1981) also observed similar trends in case of duration of nymphal instars (10-15 days) though he took cardamom as host plant. Whereas, according to Padmalatha and Singh (2002a), the nymphal stage lasted for 8-11 days on banana which may be due to the change of agro-ecological situations or species form used for experiments.

The duration of 1st instar nymph was 3, 2.8, 2.6, 3, 3.0 and 2.8 days for 1st parent, 1st generation of 1st parent, 2nd generation of 1st parent, 2nd parent, 1st generation of 2nd parent and 2nd generation of 2nd parent, respectively. According to Padmalatha and Singh (2002b), the duration of first instar nymph was 2.5 days. Likewise, the duration of 2nd instar nymph recorded was 3, 2.4, 2.8, 3, 2.4 and 3.0 days for 1st parent, 1st generation of 1st parent, 2nd generation of 1st parent, 2nd parent, 1st generation of 2nd parent and 2nd generation of 2nd parent, respectively.

According to Padmalatha and Singh (2002b), the duration of first instar nymph varied from 3-4 days with a mean of 3.2 days. Though in same experiment, they observed the duration of third instar nymph to be 1.8 days within the range from 1-3 days, however, it was recorded as 3, 2.8, 2.8, 3, 2.8 and 3.0 for 1st parent, 1st generation of 1st parent, 2nd generation of 1st

parent, 2nd parent, 1st generation of 2nd parent and 2nd generation of 2nd parent, respectively in the present study. The mean value of duration of 4th instar nymph recorded was 3, 2.8, 3.0, 4, 3.0 and 3.0 days for 1st parent, 1st generation of 1st parent, 2nd generation of 1st parent, 2nd parent, 1st generation of 2nd parent, 2nd generation of 2nd parent, respectively as observed in the present study. But Padmalatha and Singh (2002b) recorded 2.8 days of duration for 4th instar nymph.

In the present study, in case of adult longevity, it was 48, 41.2, 35.4, 44, 40.0 and 35.4 days for 1st parent, 1st generation of 1st parent, 2nd generation of 1st parent, 2nd parent, 1st generation of 2nd parent and 2nd generation of 2nd parent, respectively. Rajan (1981) obtained 8-26 days of adult longevity on cardamom. Again, according to Padmalatha and Singh (2002a), it was 11-12 days. Both these experiments reported shorter duration of adult stage and differed from the present study. However, in another experiment, Padmalatha and Singh (2002a) recorded 10-26 days adult longevity with a mean of 19.6 days.

Again, in the present study, resulted fecundity of 28, 33.4, 31.8, 20, 26.8 and 26.2 for 1st parent, 1st generation of 1st parent, 2nd generation of 1st parent, 2nd parent, 1st generation of 2nd parent and 2nd generation of 2nd parent was recorded, respectively. Rajan (1981) and Padmalatha and Singh (2002a) observed fecundity of 14 and 21.9, respectively. However, Padmalatha *et al*. (2004) obtained 43.7 numbers of offspring laid by a single apterous female.

Varietal preference studies of banana aphid in laboratory condition

The results indicated that the average time taken by aphids reared on 'G9' for first, second, third and fourth instar was 3.2 days (range 3-4), 2.8 days (range 2-3), 2.0 (range 2-2) and 2.0 (range 2-2) days, respectively (Table 1). The mean duration of nymphal development was recorded as 10.0 days. Whereas, in case of 'Martaman' the mean duration for first, second, third and fourth instar was 3.6 days (range 3-4), 3.0 (range 3-3) days, 3.0 (range 3-3) days and 2.0 (range 2-2) days, respectively and the total nymphal duration was 11.8 days (range 11-12). Therefore, from the above observations, it can be concluded that 'G9' is more preferable germplasm than 'Martaman' in relation to their nymphal development.

The data in table- 1 revealed that in case of 'G9' germplasm, there was no significant difference between duration of mean days of first and second instar as well as between third and fourth instar. However, significant difference was observed between first and third instar, between first and fourth instar, between second and third instar and between second and fourth instar. While in case of 'Martaman' significant difference existed between the mean days of first and second, first and third, first and fourth, second and fourth as well as third and fourth instar.

Table 1: Nymphal development of banana aphid, *P. nigronervosa* on different germplasms of banana

	Duration in days Mean ± SEm	
Instars	**'G9'**	**'Martaman'**
1st instar	3.2 ± 0.141	3.8 ± 0.100
2nd instar	2.8 ± 0.141	3.0 ± 0.100
3rd instar	2.0 ± 0.141	3.0 ± 0.100
4th instar	2.0 ± 0.141	2.0 ± 0.100
Total nymphal duration	10.0 ± 0.141	11.8 ± 0.100
LSD (0.01)	**0.428**	**0.302**

Effect of weather parameters on nymphal development of banana aphid

The duration of nymphal development was negatively correlated with maximum temperature and minimum temperature in first generation of first parent while it had positive correlation with relative humidity (Table 2). However, only morning relative humidity had been found to have significant correlation with the nymphal development. While in second generation of first parent, the results were reverse. Here, temperature (both maximum and minimum) showed positive correlation and relative humidity (both morning and evening) had negative correlation with nymphal development.

The Overall study revealed that both the relative humidity morning as well as evening had positive correlation with the nymphal development of 1st generation of both the parents. Earlier, Rajan (1981) as well as Young and Wright (2005) found negative correlation of banana aphid with increased rainfall.

The table (Table 3) clearly showed that the combined effect of all the weather parameters

(maximum and minimum temperature as well as relative humidity of morning and evening) on the duration of nymphal instars was statistically non-significant. However, the combined effect of these weather parameters on duration of nymphal development of banana aphid varied widely in magnitude from 17.4% (for 2nd generation of 2nd parent) to 34.0% (for 1st generation of 1st parent). The weather parameters can describe the effect of 17.6% for nymphal development of 2nd generation of 1st parent and 27.9% for the same in case of 1st generation of 2nd parent as shown in table3.

Table 2: Correlation studies showing relationship between nymphal development of *P. nigronervosa* and weather parameters

Weather parameters	Correlation coefficient			
	Duration of nymphal development			
	1st generation of 1st parent	2nd generation of 1st parent	1st generation of 2nd parent	2nd generation of 2nd parent
T_{Max}	-0.138	0.403*	-0.188	0.107
T_{Min}	-0.125	0.270	0.042	0.071
RH_{Morn}	0.533*	-0.302	0.055	-0.347
RH_{Even}	0.160	-0.303	0.465*	0.008

*Note: * indicates significant at 5 % level of significance*

Table 3: Regression studies showing effect of weather parameters on nymphal development of *P. nigronervosa*

Generations of nymphal development	R^2	Adj R^2	F	Regression Co-efficient				
				Intercept	T_{Max}	T_{Min}	RH_{Morn}	RH_{Even}
1st generation of 1st parent	0.340	0.164	1.932ns	-12.244	0.058	-0.084	0.146	0.010
2nd generation of 1st parent	0.176	-0.043	0.802ns	-3.204	0.150	-0.073	0.019	0.016
1st generation of 2nd parent	0.279	0.086	1.450ns	-4.409	-0.104	-0.063	0.085	0.065
2nd generation of 2nd parent	0.174	-0.046	0.792ns	16.968	-0.162	0.127	-0.108	-0.015

Overall, it is concluded that the nymphs passed through four instars to become adult and the nymphal duration varied from 10.8 days to 13.0 days, reproductive period ranged from 20.4 days to 30.0 days, pre-nymphoposition period ranged from 3.0 to 6.0 days, fecundity ranged from 20.0 to 33.4 nymphs per female and adult longevity varied from 35.4 to 48.0 days during the study of subsequent two generations of both the parent aphids. It can also be concluded that 'G9' was more preferable than 'Martaman' in relation to their nymphal development. Relative humidity and maximum temperature had been found to have significant correlation with the nymphal development, however, the combined effects of all the weather parameters considered on the duration of nymphal instars was statistically non-significant. The pest in West Bengal condition was observed to occur from 2nd week of December on banana and the aphid colonies were seen congregated mostly on leaf axil portion of pseudostem and newly unfurled top leaf of banana sucker and at the base of the pseudostem in case of mother plant.

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