

Correlation of nutritional changes with the reproductive potential of *Aphis gossypii* Glover on egg plant

T K BANERJEE and D RAYCHAUDHURI

Aphid Research Unit, Entomology Laboratory, Department of Zoology, University of Calcutta, 35 Ballygunge Circular Road, Calcutta 700 019, India

Abstract. Brinjal (*Solanum melongena* Linn.) leaves of varied maturity show a remarkable variation in respect to the retention of nutrient contents therein. The contents also vary along with the increase of plant age. *Aphis gossypii* Glover, an important pest of the crop, shows high reproductive potential on old and young leaves when the plants are young (2–4 months old) and mature (4–6 months old) respectively. Amongst the nutrient content of the leaves, nitrogen level shows a significant correlation with the reproductive potential of the aphid species leading to its population outbreak and niche selection.

Keywords. Brinjal leaves; *Aphis gossypii*; nutrient contents; reproductive potential; niche selection.

1. Introduction

Nutritional composition of the host plant appears to be a dominating factor in the dynamics of insect-plant-interactions ensuring feeding and oviposition of the insects. Host tissues are related with the nutritional (Ananthakrishnan *et al* 1982; Raman and Sanjayan 1984) and non nutritional (Reese 1929; Rosenthal and Janzen 1979) attributes which reflect the said behavioural responses. Of the phytophagous insects, aphids are too much sensitive to the nutrient values of the food plants and their quantitative availability may also act rapidly on their developmental switch mechanism (Lees 1966; White 1972). Thus, host-plant condition appears as a complement in nutritional ecology of aphids. High correlation between the reproductive activity of aphid species and nitrogen content of the host leaves has been established in *Brevicoryne brassicae* and *Myzus persicae* (van Emden and Bashford 1969) and *Drepanosiphum platanoides* (Dixon 1966).

The present study is an attempt to find out the appreciable correlation, if any, between the nutrient quality of host leaves and reproductive activity of egg plant-aphid, *Aphis gossypii* Glover during kharif season.

2. Materials and methods

In a plot (5 m × 4 m) in Hooghly district (West Bengal) 20 plants of egg plant (brinjal) (Pusa purple cluster variety) were planted during July 1985–86 (kharif season) when the plants were one month old. Observations on population incidence of aphid, *A. gossypii* were made on 3 randomly selected leaves (old, young (mature) and tender) per plant at weekly interval. The plants were uprooted at the end of December. Population distribution of the aphid (%) and its reproductive potential were analysed.

$$r = \frac{\log_e Nt_2 - \log Nt_1}{(t_2 - t_1)}$$

Estimation on reproductive potential (index r) of the aphid species was adopted after the methods of Chapman (1928), Birsh (1948) and Odum (1971).

To analyse the major nutrient contents (carbohydrate, total nitrogen, fat, sterols and inorganic salts) dried and powdered leaves (200 g) of egg plant was thoroughly extracted with chloroform in Soxhlet apparatus. The crude extract (2 g) after removal of the solvent was chromatographed on a silica gel column using solvents of increasing polarity. Residues from eluents of different solvents were analysed (Ananthakrishnan 1986) and their approximate quantities determined. The said experiments were repeated in favour of old, young and tender leaves taking from the plants of 2, 4 and 6 months old during the experimental period.

3. Results

3.1 Aphid incidence

There was a gradual decrease in the population incidence of aphid (figure 1) in the old leaves while in young and tender leaves it was found to increase gradually towards harvest. Again the greater population volume of the aphid appeared in old, young and tender leaves during premature (2 months old), mature (4 months old) and post mature (6 months old) periods of the plant respectively.

3.2 Reproductive potential

Data on the reproductive potential or natality rate (figure 2) reveals that the aphid showed variations in the reproductive rate at different age segments of the brinjal crop. Same was also seen in old, young and tender leaves at different ages of the crop. Again, the aphid appeared with high reproductive potential in old and young leaves when the crop was 2–4 and 4–6 months old respectively. Furthermore, the high reproductive potential of the aphid was found to be associated with the incidence

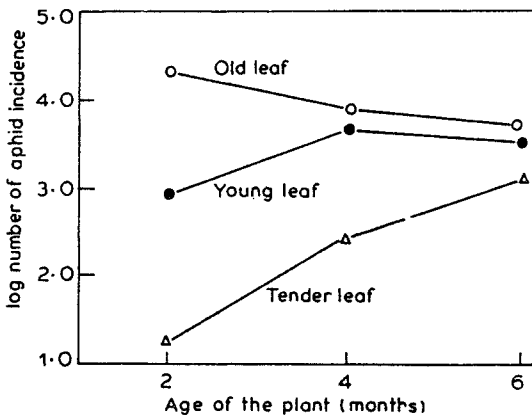


Figure 1. Population incidence of *A. gossypii* on old, young and tender leaves of brinjal at different age of the plant in kharif season during 1985–86.

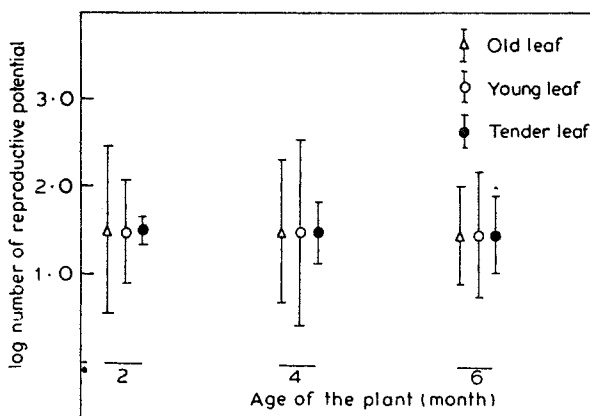


Figure 2. Reproductive potential of *A. gossypii* on old, young and tender leaves of brinjal plant during kharif season (1985–86).

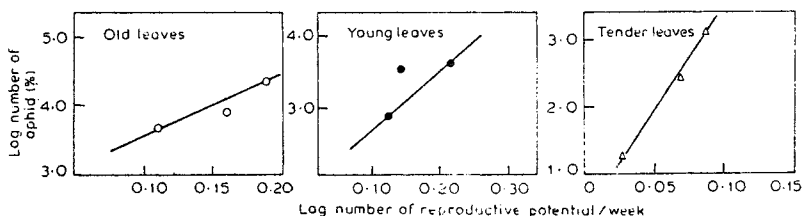


Figure 3. The relationship between the population incidence and reproductive potential of *A. gossypii* on old, young and tender leaves of brinjal plant in kharif season (1985–86).

on the mentioned leaf niches (figure 3). The slopes of the regression lines relating to the reproductive activity and population volume (%) of the aphid showed a significant correlation ($P > 0.05$), when the regression equations were recalculated using the common coefficients, the relationship between the aphid population (x) and reproductive potentials (y) appeared in the following forms

- (i) In old leaves : $-4.59 + 1.19x$
- (ii) In young leaves : $-0.12 + 0.07x$
- (iii) In tender leaves : $-0.01 + 0.03x$.

3.3 Nutrient status of the leaves

There was a marked difference in the major chemical components of the leaves (old, young and tender) at a particular age of the plant (figure 4). Of these nutrients carbohydrate, nitrogen content and fat appeared in greater proportion in young leaves while the sterols and inorganic salts abundantly appeared in old leaves. Again, most of these nutrients were in maximum in old leaves during the young age (2–4 months) of the plant while the same was seen in young and tender leaves at the old age (4–6 months) of the plant. Furthermore, studies on the relationships of the said leaf nutrients with the reproductive potentials of *A. gossypii* (table 1) reveal that

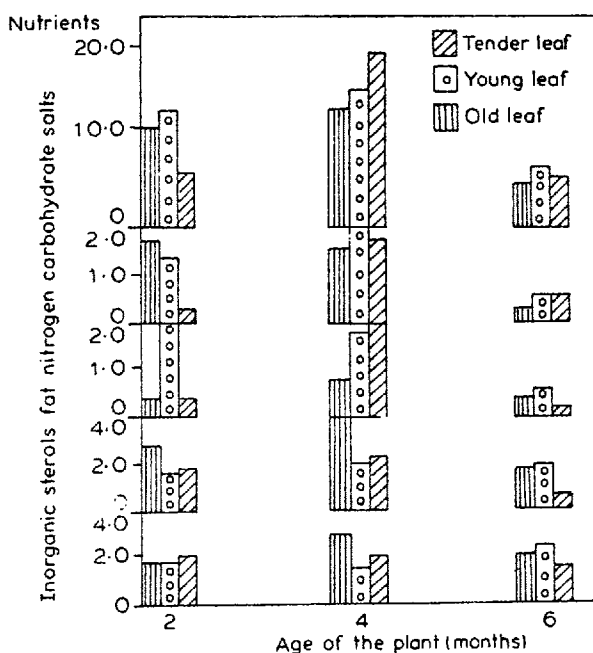


Figure 4. Distribution of nutrient content of leaves of brinjal at different age of the plant in kharif season (1985-86).

Table 1. Correlation coefficients between the reproductive potentials of *A. gossypii* and nutrient contents of the leaves.

Different leaves	Nutrients of the leaves				
	Carbohydrate	Nitrogen	Fat	Sterol	Inorganic salts
Old	-0.280	0.792*	-0.333	-0.765	-0.553
Young	-0.079	0.889*	-0.812	-0.111	-0.917
Tender	0.435	0.910*	-0.235	-0.718	-0.089

*Significance at 5% level.

the nitrogen content of the leaves appear to show significant correlation and that was true for all the 3 types of leaves.

4. Discussion

It is evident from above that population density and reproductive potential of aphid are extremely varied, as varied as the nutrient content of the leaves along with the increase of crop age. Thus, variation in the nutrient content of the leaf niches (old, young and tender) of egg plant indicate an impending condition of host plant or parts therein. Positive correlation between the nitrogen content of the leaves and the reproductive activity of the aphid species appear to show a preferential response of aphid to nitrogen content of the leaves on which the aphid feeds. Again, the variation in the natality of the said aphid species in accordance with the natality of the host

plant deserves a considerable importance. However, it is apparent that the survival and reproduction of insects are bound to be influenced by the quantity and quality of nitrogen present in the tissues which are subjected to variation with the host plant age (Raman and Ananthkrishnan 1986). Again, the reproductive activity of different aphid species has been found to vary at different age of the host due to the changes of amino acid contents of the tissue concerned (van Emden and Bashford 1969; Daiber 1970; Harrewijn 1970; El Ibrashy *et al* 1972). Therefore, it appears to be possible for *A. gossypii* to present a high reproductive activity by changing the niches from old to young to have greater amount of nitrogen content during the increase of crop age. This study though does not conclusively demonstrate the key factor responsible for reproductive response of *A. gossypii*, but the present observation is in well conformity with the findings of Kennedy and Booth (1951), Dixon (1971), Sogawa (1971), Cheng and Pathak (1972), Mc Neill (1973) and Mc Neill and Southwood (1978) about the nutrient discrimination of insects in host selection to exert greater reproductive performance.

Acknowledgements

Authors remain indebted to Prof. T N Ananthkrishnan, Director, Entomology Research Institute, Loyola College, Madras, who kindled the light of inspiration for such an investigation. Thanks are also due to Dr S Sengupta, Raja Peary Mohan College, Uttarpara, West Bengal for biochemical analysis.

References

- Ananthkrishnan T N 1986 *Instructional Manual on Insect-Plant Interactions* (eds) V Subramanian and S Viswanathan, pp 1-114
- Ananthkrishnan T N, Daniel A M and Suresh Kumar N 1982 Spatial and seasonal distributional patterns of some phytophagous thrips infesting *Ricinus communis* L. (Euphorbiaceae) and *Achyranthes aspera* L. (Amaranthaceae); *Proc. Indian Natl. Sci. Acad.* **B48** 183-189
- Birsh L C 1948 The intrinsic rate of natural increase of an insect population; *J. Anim. Ecol.* **17** 15-26
- Chapman R N 1928 The quantitative analysis of environmental factors; *Ecology* **9** 111-122
- Cheng C H and Pathak M D 1972 Resistance to *Nephotettix virescens* in rice varieties; *J. Econ. Entomol.* **65** 1148-1153
- Dabier C C 1970 The influence of host plant on the biology of cabbage aphids; *Phytophylactica* **2** 149-156
- Dixon A F G 1966 The effect of population density and nutritive status of the host on summer reproductive activity of the sycamore aphid *Drepanosiphum platanooides* (Schr.); *J. Anim. Ecol.* **35** 105-112
- El Ibrashy M T, El-Ziady S and Riad A A 1972 Laboratory studies on the biology of corn leaf aphid, *Rhopalosiphum maidis* (Homoptera: Aphididae); *Entomol. Exp. Appl.* **15** 166-174
- Harrewijn P 1970 Reproduction of aphid, *Myzus persicae* related to mineral nutrition of potato plants; *Entomol. Exp. Appl.* **13** 307-319
- Kennedy J S and Booth C O 1951 Host alternation in *Aphis fabae* Scop. I feeding preferences and fecundity in relation to the age and kind of leaves; *Ann. Appl. Biol.* **38** 25-64
- Lees A D 1966 The control of polymorphism in aphids; *Adv. Insect Physiol.* **3** 207-277
- Mc Neill S 1973 The dynamics of a population of *Leptopterna dolabrata* (Heteroptera: Miridae) in relation to its food resources; *J. Anim. Ecol.* **42** 495-507
- Mc Neill S and Southwood T R E 1978 The role of nitrogen in the development of insect/plant relationships; in *Biochemical aspects of plant and animal coevolution* (ed) J Hasborne (London: Academic Press) pp 77-98
- Odum E P 1971 *Fundamentals of Ecology*; (London: W B Saunders Company) pp 179-183
- Raman A and Ananthkrishnan T N 1986 Mechanisms of host plant selection in phytophagous insects; in

- Dynamics of Insect Plant Interactions* (eds) T N Ananthkrishnan and S Viswanathan (P & P Pvt. Ltd.) pp 16-36
- Raman K and Sanjayan K P 1984 Host plant relationships and population dynamics of the mirid, *Cyrtopeltis tenuis* Reut (Hemiptera: Miridae); *Proc. Indian Natl. Sci. Acad.* **B50** 351-361
- Reese C J C 1929 Interactions of allelochemicals with nutrients in herbivore food; in *Herbivores: Their interaction with secondary plant metabolites*, (eds) G A Rosenthal and D H Janzen (New York: Academic Press)
- Rosenthal G A and Janzen D H 1979 *Herbivores: Their interaction with secondary plant metabolites* (New York: Academic Press) pp 718
- Sogawa K J 1971 Effects of feeding of brown plant-hopper on components of leaf blade of rice plants; *Jpn. J. Appl. Entomol. Zool.* **15** 175-179
- van Emden H F and Bashford M A 1969 A comparison of the reproduction of *Brevicoryne brassicae* and *Myzus persicae* in relation to soluble nitrogen concentration and leaf age (leaf position) in the Brussels sprout plant; *Entomol. Exp. Appl.* **12** 351-364
- White D 1972 Effect of varying dietary amino acid and sucrose concentrations on production of apterous cabbage aphids; *J. Insect Physiol.* **18** 1241-1248