SINET: ETHIOP. J. SCI., 26(1):83–87, 2003
 ISSN: 0379–2897

Short communication

OCCURRENCE OF THE PEA APHID, *ACYRTHOSIPHON PISUM* (HARRIS) (HOMOPTERA: APHIDIDAE) ON WILD LEGUMINOUS PLANTS IN WEST GOJAM, ETHIOPIA

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ABSTRACT: The occurrence of pea aphid, ***Acyrthosiphon pisum*** (Harris) (Homoptera: Aphididae), on wild annual and perennial leguminous plants was studied at two locations (Adet and Wondata) in West Gojam, Ethiopia in 1999/2000 seasons. Annual and perennial leguminous wild or volunteer plants encountered in the study areas were closely monitored for the presence of pea aphid. The results showed that pea aphids infested annual legumes such as clover (*Trifolium ruepellainum*) (wild) and vetch (*Vicia* spp) carried more aphid load than clover. The aphid attacked more vetch in September and clover in October. From perennial legumes, pigeon pea (*Cajanus cajan*) was the most susceptible to attack by pea aphids and it was heavily infested and damaged in September and October. High plant density of vetch carried more aphid load than low plant density; sole stand of vetch plants suffered more damage than when grown mixed up with other crops or weeds suggesting the advantage of intercropping to reduce pea aphids.

Key words/phrases: ***Acyrthosiphon pisum*, Ethiopia, leguminous plants, pea aphid, wild hosts**

INTRODUCTION

The pea aphid, *Acyrthosiphon pisum* (Harris) (Homoptera: Aphididae) is an important pest on different kinds of crops throughout the world. It feeds on a wide range of food plants in 14 different genera, of which the major ones are *Coronilla*, *Lens*, *Lotus*, *Medicago*, *Melilotus*, *Pisum*, and *Vigna* (Ellsbury and Nielsen, 1981). It attacks all kinds of peas (garden peas and field peas) *Pisum sativum)* alfalfa (*Medicago sativa*), clover (*Trifolium* sp.) and other leguminous crops except those in the genus *Phaseolus* (Ellsburry and Nielsen, 1981; Davidson and Lyon, 1987). Lucerne (*Medicago sativa)*, pea *(Pisum sativum*), clover (*Trifolium ruepellanium*) egg-plant (*Solanum melongena*), vetch (*Vicia* spp), and also broad bean (*Vicia faba*) are heavily attacked (Archibald, 1979). It infests lucerne to such an extent that the ground turns white due to exuviae (Archibald, 1979). Apart from an irreversible damage due to direct plant sap sucking, pea aphids can also transmit viral diseases that cause complete crop loss.

Losses in the production of pea probably exceed that caused by any other pest of the crop (Davidson and Lyon, 1987). This insect pest is assumed to be of European or Asiatic origin (Davidson and Lyon, 1987). It is distributed throughout North America (Davidson and Lyon, 1987), Europe, Asia and cooler areas of East Africa (Autrique *et al*., 1989). Host variety and aphid biotype are important for the host and aphid association (Bournoville *et al*., 2000; Caillaud and Via, 2000; Morgan *et al*., 2001). However, the biology of pea aphid was not observed to be affected by four different legumes tested under green house condition (Melaku Wale *et al*., 2000).

Prior to 1983 when Crowe and Kemal Ali (1983) published a checklist of 64 species of aphids recorded in Ethiopia, *A. pisum* was reported, but was not considered important. Tsedeke Abate *et al*. (1982) and Kemal Ali and Tadesse Gebremedhin (1990) have reported its status as a minor pest in earlier surveys in the country. However, since 1983/84, *A. pisum* has become an important pest on legumes in Ethiopia (Kemal Ali and Tadesse Gebremedhin, 1990). Since then it is increasing both on other crops and wider geographical areas.

In Ethiopia, the pea aphid (*A. pisum*) has a holocyclic life cycle (*i.e*., it reproduces parthenogenetically without producing sexual forms) which is typical of tropical and subtropical species (Cardona *et al*., 1984; Kemal Ali and Tadesse Gebremedhin, 1990). Viviparity permits rapid exploitation of the host plant as its parthenogenetic multiplication rate, without fertilization, is potentially enormous. In temperate areas, pea aphids reproduce both sexually (via

eggs) during the winter and parthenogenetically during the summer (Davidson and Lyon, 1987).

To date, total (100%) crop failure has become common experience in many areas in Ethiopia (Andarge and Birhan, 1998). Farmers in Zema Valley of West Gojam, for example, have totally stopped field pea cultivation due to pea aphids and have shifted towards haricot bean production. The range of wild hosts of pea aphid and its mechanism of survival during the dry season is hardly known in Ethiopia and this experiment was carried out to fill the gap.

MATERIALS AND METHODS

Two sites in West Gojam, Ethiopia, (Adet and Wondata, about 40 km from each other) were selected for the study during the 1999–2000 season. Annual and perennial leguminous wild or volunteer plants encountered in the study areas were closely monitored for the presence of pea aphid. Annual plants were sampled using 0.5 x 0.5 m^2 quadrate, which were selected randomly. A total of 40 and 31 quadrates at Adet and Wondata were taken, respectively. Branches, leaves and pods of perennial legume trees were also sampled. At Adet and Wondata, 52 and 39 trees of pigeon pea were sampled.

The legume plant density was visually estimated to be in one of the categories of high (more than 50%), medium (25–50%) or low (less than 25%). The nature of the field was recorded whether it was a field margin, a crop field, a forage field, a natural pasture, a grassland or protected grazing land or not. This assessment was repeated about 3 times during the season (from September to January). For the annual legumes, the number of aphids was counted and recorded on a random sample of 10 plants per quadrate. In the case of leguminous perennial trees, the number of aphids per leaf and or (pod) was counted and recorded. Additional data recorded were the date when assessment was made, location, habitat and soil type. Soil type was determined visually by colour as black and red. At the same time, on each quadrate, the name of the host plant species carrying the aphid was recorded. Variation in aphid population among sampling sites and the plant species carrying them were statistically tested for significance using Chi-square (χ^2) distribution according to the method stated by Service (1984). Similarly, the number of plants harbouring aphids and those, which did not, were analysed using χ^2 test. For testing the significance of the difference between two sample proportions, the following short chi-square test formula was used.

$$\chi^2 = N(AD-BC)^2 / (A+B)(C+D)(A+C)(B+D)$$

where A and B are the number of aphids that satisfy certain criteria, C and D those which do not, respectively. N denotes total sample size. Similarly, for comparing more than two sample proportions, the chi-square statistic used was:

$$x^2 = \sum \left[(o-e)^2 \,/\, e \right]$$

where *o* and *e* are the observed and expected frequencies, respectively.

RESULTS

Levels of infestation on different plant species

In the case of annual plants, pea aphid infested vetch (*Vicia* spp) and clover (*Trifolium ruepellainum* Fresen) significantly (χ^2 = 245.69, p = 0.005). This was not found to be the case on lupine (*Lupinus* spp) and alfalfa (*Medicago sativa* L.) (Table 1). Aphids infested flowers of clover, flowers, leaves and stems of vetch. Despite the search for its existence on many perennial leguminous trees, pea aphid was consistently found only on perennial pigeon pea (*Cajanus cajan*) plants throughout the year.

Table 1. Plant species infested by pea aphid at Adet and Wondata, Ethiopia, in 1999/2000.

Number of plants	Host plant species				Total
	Vetch	Clover	Lupine	Alfalfa	
Infested plants with pea aphid	57	57	0	0	114
Healthy	7	10	100	78	195
Total	64	67	100	78	309

χ^2 = 245.69, p = 0.005, df = 3.

Seasonal changes in infestation

Clover plants were infested more in October when the plant flowered and set pods as compared to other times (Table 2). From December onwards, these plants almost disappeared except in very wet conditions such as near tap water, irrigation channels and streams. Although a few of them existed until January and February, many did not support the high proportion of aphids per plant as they did in October. Vetch plants were highly infested in September (Table 4); pigeon pea in September, October and November (χ^2 = 57.78, p = 0.005, df = 2) (Table 3).

Table 2. Seasonal changes in pea aphid infestation on clover at Adet in 1999/2000.

Number of plants	Months				Total
	Sept	Oct	Nov	Jan	
Infested by pea aphids	11	8	6	7	32
Healthy	50	13	40	57	160
Total	61	21	46	64	192

$\chi^2 = 8.978$, p = 0.05, df = 3.

Table 3. Seasonal changes in pea aphid infestation on pigeon pea at Adet in 1999/2000.

Number of leaves/pods	Months			Total
	Oct	Nov	Jan	
Carrying aphids	36	23	3	62
Without aphids	9	6	40	55
Total	45	29	43	117

$\chi^2 = 57.78$, p = 0.005, df = 2

Table 4. Seasonal changes in pea aphid infestation on vetch at Adet in 1999/2000.

Number of plants	Months			Total
	Sept	Nov	Jan	
Infested with aphids	61	6	6	77
Healthy	12	40	70	151
Total	73	46	76	228

$\chi^2 = 119.44$, p = 0.005, df =2.

Pea aphid load

Vetch plants were found carrying significantly more aphid load per plant than clover in all the survey areas (Table 5). Furthermore, vetch plants in the forage field were carrying more aphid load than vetch plants in a crop field margin (Table 6).

Table 5. Pea aphid load by plant species at Adet in 1999/2000.

Number of plants	Vetch	Clover	Total
With more than 5 aphids/ plant	35	18	53
Less than 5 aphids/ plant	22	39	61
Total	57	57	114

$\chi^2 = 10.2$, p = 0.005, df = 1

Table6. Effect of nature of field on pea aphid load on vetch at Adet in 1999/2000.

Number of plants	Vetch	Clover	Total
With more than 5 aphids/ plant	35	22	57
Less than 5 aphids/ plant	22	80	102
Total	57	102	159

$\chi^2 = 25.23$, p = 0.005, df = 1

Effect of location and plant density on level of infestion

Vetch plants had higher plant density at Adet and carried more pea aphid load than lower density of plant at Wondata (Table 7).

Table 7. Level of pea aphid infestation on vetch at different locations in September/ October 1999/2000.

Number of plants	Location		Total
	Wondata	Adet	
Carrying pea aphids	5	46	51
Not carrying pea aphids	21	6	27
Total	26	52	78

$\chi^2 = 36.71$, p = 0.005, df = 1

DISCUSSION

The present study indicated that some legumes are best hosts of pea aphid while others are not. Similar studies indicate that termis (*Lupinus termis*) does not support pea aphid and is largely resistant to pea aphid infestation (Mansour *et al*., 1982). Subsequent biochemical analysis showed that it was coumarin in termis that acted as a deterrent. Studies in Poland have shown that it is the alkaloids in the phloem sap of lupine plants that determine their resistance to attack by pea aphid (Wegorek and Krzymanska, 1971; 1975). In other countries, both lupine and alfalfa (Davidson and Lyon, 1987) and cowpea (*Vigna unguiculata*) and even cereal rye (*Secale cereale*) (Kaakeh and Dutcher, 1993) are some of the hosts of pea aphids. This indicates that secondary plant metabolites (*e.g*., alkaloid content) of some plant species could be variable when grown in different places and render some varieties to be resistant. The pea aphid biotype or biotypes that exist today on cultivated food legumes (faba bean, field pea, lentil, grass pea), forage legumes (vetch and pigeon pea), and wild legumes (clover) in Ethiopia might have evolved as a result of continuos adaptation only to these plants. Clover (*Trifolium ruepellanium*) is common weed in the cool highlands of Ethiopia (Stroud and Parker, 1989). However, we have as yet no information whether or not all pea aphid populations established on a certain plant species in Ethiopia do attack the other plant species equally. The population collected from field pea may not attack vetch or clover equally well. Such variation may indicate the presence of biotypes.

The alfalfa races in Ethiopia may be the resistant types based on the present experiment, which showed their immunity and the development of completely resistant varieties of alfalfa by (Kugler and Radcliffe, 1983). Further studies in a wider scale should be carried out on

alfalfa, lupine and other potential hosts to verify these findings. Pea aphids generally feed on leguminous plants, trees or annual herbs. They feed mostly on nitrogen rich food sources to be able to reproduce in great numbers in a short time. Plants of low protein-sugar ratio are resistant to pea aphid (Maltais and Auclair, 1957; Wegorek and Krzymanska, 1973; Nielsen and Lehman, 1980). There is negative relationship between reproductive rate of pea aphid and the ratio of sugars to amino acids (Febvay *et al*., 1988).

In the case of perennial plants, pea aphid was consistently found only on perennial pigeon pea plants throughout most of the year. Earlier, Tsedeke Abate (1991) reported pea aphids attacking pigeon pea in the Upper Awash, Ethiopia. Pigeon pea is grown for livestock feed and soil conservation (gully stabilization). Despite its value, it is being a reservoir host plant of pea aphids. Sesbania (*Sesbania exaltata*) is also reported to host pea aphids (Kaakeh and Dutcher, 1993). However, pea aphids were not observed attacking sesbania (*Sesbania sesban*) at our study area.

The observation of more pea aphid load on vetch at Adet could possibly be attributed to higher density of the plant per unit area. Vetch plants at Wondata are grown mixed with other field crops such as maize or other naturally occurring grasses and herbs (weeds) which might have a diluting effect on aphid population as well as become home for natural enemies that prey on aphids. This observation is in line with the reports of Wnuk and Wiech (1996) who indicated increasing spacing between plants significantly reduced pea aphid numbers per plant.

The present study on seasonal changes of infestation showed that infestation levels were variable with time. In Japan clover plant sown in late April, aphids were found in late May and peaked in early July (Honda, 1989). In temperate areas, aphids in general including pea aphids, over-winter during winter at the egg stage (sexual forms); the winter eggs hatching in April to May when daily temperatures average 9 to 17^{o}c (Abdulmadzhid, 1972). However, in New Zealand, only asexual forms (virginoparae) are found on lucerne throughout winter (Archibald, 1979). This is similar to our condition in Ethiopia where reproduction of aphids is always asexual (parthenogenetic) which continues all year round as long as food is available (Kemal Ali and Tadesse Gebremedhin, 1990). This shows that Ethiopia and New Zealand are more tropical than places where pea aphids pass the winter as eggs or full-fed nymphs under the remains of perennial leguminous plants (Abdulmadzhid, 1972).

The all-year-round breeding of the pea aphid, as long as a host is available, in Ethiopia indicates that they survive adverse conditions on a wide variety of alternate hosts, domestic or wild. During the main crop-growing season, they can survive on cultivated plants and forage legumes. They depend on field pea, faba bean, vetch and clover in the main season (June to October); on lentil, grass pea, vetch, clover and pigeon pea in the off-season (August to March). The inoculums remains throughout the dry season of April to May on perennial legumes such as pigeon pea and possibly other unidentified hosts. They can also continue breeding without break in places where small rains exist or irrigation schemes are practiced. Some of the food-legumes can easily grow in few numbers in the backyard during the dry season with some moisture. Aphids can breed on these plants. Further study is recommended to determine the real situation occurring all year round in a wider geographical area.

ACKNOWLEDGEMENTS

We extend our gratitude to the technical staff of Adet Research Centre, Entomology Section, especially Dereje Andarge, Mola Nigatu, Yihenew Awoke, Gebre Alamir and Birhane Assayehegne for their assistance in field studies. We are indebted to Fantahun Mengistu, Manager of Adet Centre, and Adet Centre as a whole, who provided transport for fieldwork. Department of Biology, Faculty of Science, Addis Ababa University, provided financial support for the study.

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