Pest Status of the Leafhopper *Empoasca dolichi* Paoli on Groundnut (*Arachis hypogaea* L.) in the Zaria Area of Northern Nigeria

Elizabeth Agbenu EGWURUBE, Michael Ogunleke OGUNLANA, Michael Chidozie DIKE and Isa ONU

Department of Crop Protection, Faculty of Agriculture, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria

Abstract

Egwurube E.A., Ogunlana M. O., Dike M. C., Onu I. (2005): **Pest status of the leafhopper** *Empoasca dolichi* Paoli **on groundnut (***Arachis hypogaea* L.) **in the Zaria area of northern Nigeria**. Plant Protect. Sci., **41**: 158–164.

Population studies and tests on the relationship between density and damage were conducted in 1999 to 2001 to determine the pest status of *Empoasca dolichi* on groundnut (*Arachis hypogaea* L.) in the Zaria area of northern Nigeria. Analyses showed that *Empoasca* numbers varied significantly from one year to another, and within each year the numbers of leafhoppers observed at the different growth stages of the plant were significantly different ($P = 0.01$). There was an inverse and highly significant relationship between the mean kernel yield and the *Empoasca* damage at the different growth stages of the plant. When natural population densities were plotted against economic injury level (EIL), the densities did not reach the EIL throughout the groundnut growing seasons. The insect was thus not an economic pest on groundnut in Zaria during the period of the study.

Keywords: pest status; *Empoasca dolichi* Paoli; groundnut; *Arachis hypogaea* L.

Empoasca dolichi Paoli has long been recognised as an economic pest of groundnut and several other crops in different parts of the world (Paoli 1936; Caswell 1962; McDonald & Raheja 1980; Metcalf 1968; Parh 1979; Amin & Mohammed 1980; Lynch *et al.* 1985; Sithanantham *et al.* 1994). Although the species has been found in notable numbers on groundnut in northern Nigeria (Egwurube *et al.* 2003), its pest status has been unknown. In this study the densities of natural populations of *E. dolichi* on groundnut in the Zaria region of northern Nigeria were determined and it was evaluated whether the densities reached levels that caused economic damage.

MATERIALS AND METHODS

Sampling of farmers' fields to determine the population trend of Empoasca species on groundnut. Three farmers' fields were selected to monitor the population trends of *E. dolichi* on groundnut during the rainy season (June–October) of 1999 to 2001 in the Zaria area (latitude 11°11'N, longitude 7°38'E and altitude 686 m) of northern Nigeria. Each field about (100 m^2) was divided into ten sample sites. Five plants were randomly selected per sample site. As much as possible, one plant was sampled at a time. A D-vac suction sampler hose cone was allowed to vacuum pump each site for

one minute. Samples were taken once a week from 3 weeks after emergence (R_1) up to maturity (R_9) when the plants had no leafhoppers left on them. *Empoasca* catches including adults and nymphs were based on numbers caught per 50 suction samples of D-vac (i.e. 10 sites by 5 plants). The average number of leafhoppers caught per plant was obtained by dividing the number per sample by 50. The number of leafhoppers caught per plant were transformed by $\log_e (x + 1)$, where x was the number of insects counted per 50 suction samples. The mean number of *E. dolichi* obtained was subjected to an analysis of variance test. Groundnut growth stages and their respective characteristics are shown in Table 1.

Density/damage relationships tests. Tests were conducted in the rainy seasons of 2000 and 2001 at the Institute for Agricultural Research, Ahmadu Bello University Farm, Samaru, Zaria. Plot areas were fertilised according to soil test recommendations prior to planting with single superphosphate at the recommended rate of 300 kg/ha before ridging. Groundnut variety RRB was sown on 75 cm ridges. Each plot consisted of a single ridge measuring 1 m × 0.75 m and carried five stands of groundnut plants. Metal frames (1 m long, 0.75 m wide and 1.2 m high), covered with netting material were placed over the plots shortly after emergence. These cages were firmly secured to the ground to prevent leafhopper escape. Cages were placed approximately 3 m apart, and intervening plants were removed to avoid competition and to permit uniform lighting. Adult *E. dolichi* from colony cages maintained in the screen house were transferred to the field cages by means of a mouth aspirator. This infestation was done at three groundnut growth stages, i.e. R_1 (groundnuts beginning bloom), R_4 (full pod development) and R_7 (groundnut beginning maturity). Treatments included three infestation levels and an uninfested check replicated three times in a randomised block design. The infestation levels per plant were as follows: growth stage R_1 – 0, 5, 10 and 15 leafhoppers; stage R_4 – 0, 30, 60 and 90; and stage R_7 – 0, 50, 100 and 150. The infestation dates for stages 1, 4 and 7 are shown in Table 2. Fourteen

Table 1. Growth stages of groundnut (*Arachis hypogaea* L.)

No.	Designation	Description
Vegetative stages		
VE	emergence	cotyledons near the soil surface with the seedling showing some part of the plant visible
VO		cotyledons are flat and open at or below the soil surface
V-1 V-(N)	first tetrafoliate to N^{th} tetrafoliate	one to N developed nodes on the main axis (a node is counted when its tetrafoliate is unfolded and its leaflets are flat)
Reproductive stages		
R_1	beginning bloom	one open flower at any node on the plant
R_2	beginning peg	one elongated peg (gynophore)
R_3	beginning pod	one peg in the soil with turned swollen ovary at least twice the width of the peg
R_4	full pod	one fully-expanded pod, to dimensions characteristics of the cultivar
R_5	beginning seed	one fully-expanded pod in which seed cotyledon growth is visible when the fruit is cut in cross-section with a razor blade (past the liquid endosperm phase)
R_6	full seed	one pod with cavity apparently filled by the seeds when fresh
R_7	beginning maturity	one pod showing visible natural coloration or blotching of inner pericarp or testa
R_8	harvest maturity	two-thirds to three fourths of all developed pods have testa or pericarp coloration. Fraction is cultivar dependent
R_9	over-mature pod	one damaged pod showing orange tan coloration of the testa and or natural peg deterioration

Source: Boote (1982)

days after planting, the plants were sprayed with 30 g a.i./ha of Benlate and 125 g a.i./ha of Dithane M45 to control leaf spot diseases of groundnuts before caging. The cages were placed over the plots after emergence and removed at harvest. The plants were harvested on October 18, 2000, and October 24, 2001, respectively. Caged plots were harvested by hand and threshed in the field. Weights were taken after all samples had dried in the laboratory for two weeks. Data from the tests were subjected to a regression analysis with the objectives of determining (1) the dependence of yield on leafhopper density, (2) the degree of this dependence, and (3) the accuracy with which yield can be predicted from leafhopper numbers.

***Determination of the pest status of** Empoasca dolichi **on groundnut**.* To determine the pest status of the leafhoppers on groundnuts, the population densities of the leafhoppers obtained from the farmers' field were compared with the economic injury levels (EIL's) at the different plant stages.

RESULTS AND DISCUSSION

Population trend of *Empoasca dolichi* on groundnut

The population density of *E. dolichi* from three farmers' fields in 1999–2001 was generally low during the first 30 d (R_1–R_2) after planting. The population increased thereafter and reached a peak within 40–70 d (R_3–R_8) after emergence. After the peak, there was a sudden drop in the population. The highest peak occurred between August and October. In 1999, the highest peak (three leafhoppers per plant) occurred around August 20, when the plants were at stage R_5; in 2000, the peak (two leafhoppers per plant) occurred on September 18,

Table 2. Infestation of caged groundnut with *Empoasca dolichi*

Growth stages	Date of infestation	Infestation levels			
		I_0	I_1	I_2	I_3
1	July 7, 2000	0	5	10	15
4	August 9, 2000	0	30	60	90
7	August 31, 2000	0	50	100	150
1	July 3, 2001	0	5	10	15
4	August 4, 2001	0	30	60	90
7	August 27, 2001	0	50	100	150

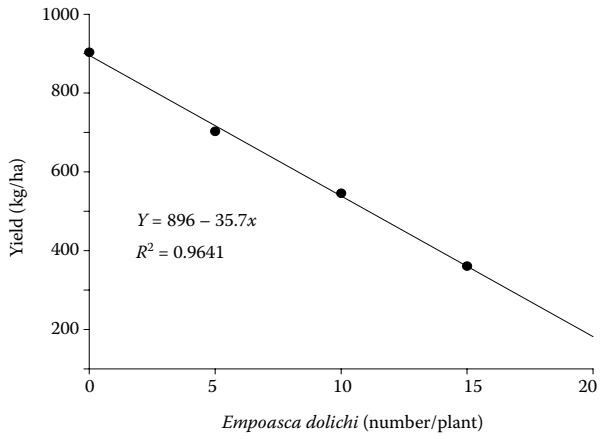

Figure 1. Regresssion of groundnut yield on number of *E. dolichi* per plant at stage R_1

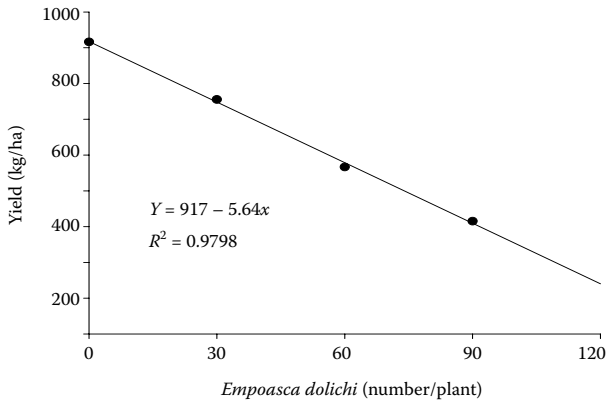

Figure 2. Regression of groundnut yield on number of *E. dolichi* per plant at stage R_4

Table 3. Mean number of adults and nymphs of *E. dolichi* caught (100 m^2) in three farmers fields in 1999, 2000 and 2001

	Groundnut growth stages	Leafhoppers (number/plant)			Total	Mean	Transformed mean $\log_e (x + 1)$
		I	II	III			
1999	R_1	0.0	0.2	0.4	0.60	0.20	0.83
	R_2	0.6	0.4	0.6	1.60	0.53	1.02
	R_3	1.4	0.4	1.8	3.60	1.20	1.28
	R_4	6.2	0.4	5.4	12.00	4.00	2.00
	R_5	0.8	0.8	14.6	23.40	7.80	2.65
	R_6	4.4	0.1	6.2	11.60	3.90	2.01
	R_7	2.6	0.3	6.8	12.40	4.13	2.11
	R_8	2.4	3.8	3.4	9.60	3.20	1.92
	R_9	0.0	3.4	0.0	3.40	1.13	1.13
	Mean					2.90	1.66
	MSE					7.04	0.41
	LSD					4.39	1.10
2000	R_1	0.0	0.4	0.4	0.80	0.27	0.87
	R_2	1.4	0.6	1.0	3.00	1.00	1.22
	R_3	2.2	1.0	1.0	4.20	1.40	1.36
	R_4	2.4	2.8	1.8	7.00	2.33	1.68
	R_5	3.8	4.6	2.2	10.60	3.53	1.99
	R_6	3.8	5.2	4.2	13.20	4.40	2.21
	R_7	4.6	4.0	5.2	13.80	4.60	2.26
	R_8	2.2	2.0	8.0	12.2	4.07	2.05
	R_9	0.6	0.0	4.6	5.2	1.73	1.34
	Mean					2.59	1.66
	MSE					2.38	0.17
	LSD					2.67	0.71
2001	R_1	0.0	0.4	0.4	0.80	0.27	0.87
	R_2	0.6	1.0	1.2	2.80	0.93	1.19
	R_3	1.2	1.4	3.8	6.40	2.13	1.59
	R_4	5.0	0.6	3.8	9.40	3.13	1.82
	R_5	9.2	4.2	3.6	17.00	5.66	2.44
	R_6	9.2	3.4	7.0	19.60	6.53	2.61
	R_7	9.6	2.8	7.4	19.80	6.60	2.60
	R_8	20.4	4.4	1.2	36.8	12.27	3.44
	R_9	0.0	0.0	0.0	0.0	0.00	0.70
	Mean					4.17	1.92
	MSE					7.91	0.25
	LSD					4.87	0.86

when the plants were at stage R_7; and in 2001, the highest peak (three leafhoppers per plant) occurred on October 1, when the plants were at stage R_8. This infers that the peak populations of *E. dolichi* differ for each year. The analysis of variance test showed that there were significant differences in leafhop-

per number from one year to another. Within each year, the numbers of leafhoppers observed at the different developmental stages of the plants were significantly different (F values = 13.38 at 8 df, $Pr > F = 0.001$) (Table 3).

Effects of the damage of *E. dolichi* on groundnuts

During 2000 and 2001, yields of groundnut plants infested at stages R_1, R_4 and R_7 with various densities of *E. dolichi* showed a consistent decrease with increase in leafhoppers (Table 4). The early infestation (at growth stage R_1) had the most pronounced effect on yield as clearly shown in Figure 1. At 15 leafhoppers per plant, the pest population reduced yield by ca. 50%. There were significant but less pronounced difference between the yields if infestation occurred at growth stages R_4 and R_7. The regression of yield on leafhopper numbers was negative and linear. This indicated that the appropriate regression model for the yield – leafhopper relationship was $Y = a + bx$, where Y = the expected yield, a = the Y intercept, a constant representing the average yield of uninfested plots, b = the slope of the regression line, and × represents the number of leafhoppers present per plant. There was an inverse and highly significant relationship between the mean kernel yield and the *Empoasca* damage at the different growth stages of the plant. Thus at the different growth stages, increasing numbers of *E. dolichi* per plant resulted in decreasing yields. The regression lines derived are shown in (Figures 2 and 3). The slope, b, tends to be steeper with younger plants than with the older ones. 35.7× for the stage R_1 infestation, 5.64× for the stage R_4 infestation and 2.56× for the stage R_7 infestation.

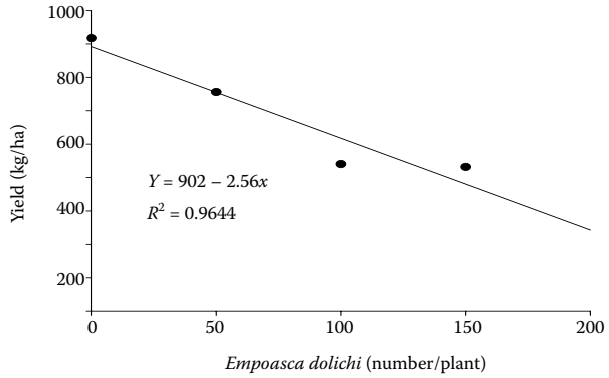

Figure 3. Regression of groundnut yield on number of *E. dolichi* per plant at stage R_7

Calculation of economic injury levels (EIL)

A. Cost of control with Cypermethrin (Sherpa plus) at l/ha = ₦ 800

For spraying twice = ₦ 800 × 2
= ₦ 1600

Application cost of 4 labourers/2 applications/ha at ₦ 100/labour
= ₦ 100 × 4
= ₦ 400
= ₦ 1600 + 400
= ₦ 2000

Price of groundnut (₦/kg)

In 2000, the market price of groundnut was ₦ 120 per tiya (a tiya is a local measure which weighs 2.5 kg). In 2001, the market price was ₦ 180.00 per tiya. A grand mean of ₦ 150.00 per tiya was obtained for these years. Therefore, the market price of groundnut per kg = ₦ 150 divide by 2.5 = ₦ 60. The amount of yield loss that constitutes economic damage is referred to as 'gain threshold' (Stone & Pedigo 1972). The following formula is used to calculate gain threshold:

$$\text{Gain treshold (kg/ha)} = \frac{\text{Cost of pest control (₦/ha)}}{\text{Market price of crop (₦/kg)}}$$

In this particular case, the gain threshold
= (₦ 2000/ha) ÷ (₦ 60.00/kg) = (₦ 2000/ha) × (kg/60)
= (₦ 2000/ha) × (kg/₦ 60)
= (33.33/ha) × kg
= 33.3 kg/ha

The EIL for a given stage is the number of infesting leafhoppers that would reduce the yield by 33.3 kg per ha. Because $Y = a + bx$, it follows that $bx = y - a = (a - y)$. But $a - y$ is the reduction (the intercept minus the expected yield). Therefore $x = 33.3$. For the stage R_1 infestation $bx = 35.7x = 33.3$. Therefore, $x = 33.3 \div 35.7 = 0.95$ ca 1. Consequently, the EIL for the stage R_1 infestation of one leafhopper per plant at groundnut stage R_1 is economically significant. For the stage R_4 infestation $bx = 5.64x = 33.3$. Therefore, $x = 33.3 \div 5.64 = 5.90$ ca 6, i.e. the EIL for the stage R_4 of groundnut is six leafhoppers/plant. For the stage R_7 infestation $bx = 2.56x = 33.3$. Therefore, $x = 33.3 \div 2.55 = 13.06$ ca 13, i.e. the EIL for the stage R_7 groundnut is 13 leafhoppers/plant (Egwurube *et al.* 2004).

Pest status of *Empoasca dolichi* on groundnut

When population densities of *E. dolichi* obtained from the three farmers' fields in 1999, 2000, and

Table 4. Kernel yield of groundnut infested at growth stages R_1, R_4 and R_7 by *E. dolichi*

Treatment levels	Leafhoppers (number/plant)			Kernel yield (kg/ha)		
	R_1	R_4	R_7	R_1	R_4	R_7
T_1	0	0	0	903.33a*	916.41a*	917.31a*
T_2	5	30	50	702.59b	755.37b	755.87b
T_3	10	60	100	545.57c	566.58c	640.02c
T_4	15	90	150	360.56d	415.19d	531.72d
Mean				628.01	663.39	711.23
MSE				± 35.93	± 16.32	± 30.66
CV (%)				5.72	2.46	4.31
SE				± 14.67	± 6.66	± 2.52

*treatments followed by the same letter were not significantly different at $P > 0.001$

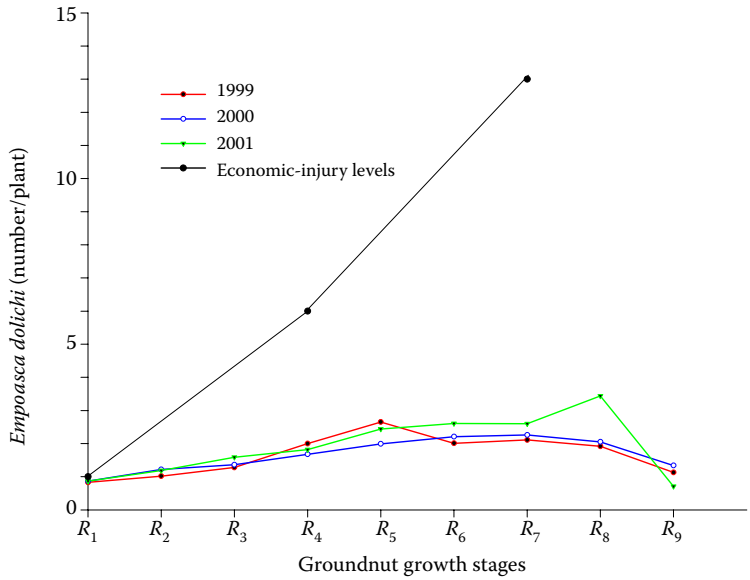

Figure 4. Economic-injury levels and population trends of *E. dolichi* on groundnut in Zaria, Nigeria

2001 were compared with the EIL's at the different plant stages (Figure 4), *E. dolichi* numbers failed to reach the EIL's throughout the growing season in 1999, 2000 and 200. The insect did not prove to be an economic pest on groundnut in Zaria during the period of this work. However, a continual monitoring of natural populations is desirable, because the populations showed significant differences among years. The groundnut plants are capable of withstanding high levels of damage by the leafhopper if the damage commences when the plants are between the R_4 and R_7 stages of growth. An early infestation (stage R_1), however, had a most pronounced effect on yield. At 15 leafhoppers per plant the pest populations reduced yield by approximately 50%. Therefore, it appears important to minimise serious *Empoasca* feeding damage to groundnut when the plants are in the early vegetative stage. This can be done by monitoring the insect populations at that stage and applying appropriate control measures as soon as injurious population levels per plant are attained.

Acknowledgements: We are grateful to Dr. S. G. Ado, Director, Institute for Agricultural Research, Samaru, Zaria, for providing the funds for the research. We are also grateful to Job James for his technical support during the study.

References

Amin P.W., Mohammed A.B. (1980): Groundnut pest research at ICRISAT. In: Proceedings of the International Workshops on Groundnuts, 13–17 October, 1980. ICRISAT Center, India, Patancheru: 158–166.

Boote K.J. (1982): Growth stages of peanut (*Arachis hypogaea* L.). Peanut Science, **9**: 317–340.

Caswell G.H. (1962): Agricultural Entomology in the Tropics. Edward Arnold, Ltd., London.

Egwurube E.A., Ogunlana M.O., Dike M.C., Onu I. (2003): Distribution, abundance and damage assessment of leafhoppers (*Empoasca* species) on groundnut (*Arachis hypogaea* L.) in the Savanna Ecological Zones of Nigeria. Nigerian Journal of Plant Protection, **20**: 111–122.

Egwurube E.A., Ogunlana M.O., Dike M.C., Onu I. (2004): Economic injury levels of *Empoasca dolichi* Paoli on groundnuts (*Arachis hypogaea* L.) in Zaria area. Nigeria Journal of Entomology, **21**: 126–136.

Lynch R.E., Ouedrago A.P., Dicko I. (1985): Insect damage to groundnut in semi-arid tropical Africa. In: Proceedings of the International Workshop on Agrometeorology of Groundnut, 21–26 August, 1985. ICRISAT Center, Niamey, Niger: 501–514.

McDonald D., Raheja A.K. (1980): Pests, diseases, resistance and crop protection in groundnuts. In: Summerfields R.J., Bunting A.H. (eds): Advances in Legume Science. Proceedings of the International Legume Conference, 24–29 July, 1978. Kew, Surrey, Vol. 1: 501–514.

Metcalf Z.P. (1968): General catalogue of the Homoptera. Fascicle VI, Part 17. D.A. Agricultural Research Service, Washington: 1513.

Paoli G. (1936): Descrizione di alcune nuone specie di *Empoasca* (Hemipt. Homopt). Observazioni su specie note – Memorie della Societa Entomologica Italiana, Genova, **15**: 5–24.

Parh I.A. (1979): Studies on the bionomics of *Empoasca* species (Hemiptera: Cicadellidae) associated with cowpea. [Ph.D. Thesis.] University of Ibadan, Nigeria.

Sithanantham S.J., Sohati P.H., Syamasonta B., Kannaiyan J. (1994): Identification of groundnut genotypes less susceptible to damage by leafhopper, *Empoasca dolichi* (Paoli) in Zambia. Insect Science and Application, **15**: 207–209.

Stone J.D., Pedigo L.P. (1972): Development and economic-injury level of green cloverworm on soyabean in Iowa. Journal of Economic Entomology, **65**: 197–201.

Received for publication September 29, 2004
Accepted after corrections December 9, 2004

Abstrakt

Egwurube E.A., Ogunlana M. O., Dike M. C., Onu I. (2005): **Význam pidikříska** (*Empoasca dolichi* Paoli) **jako škůdce na podzemnici olejné (***Arachis hypogaea* **L.) v oblasti Zaria (severní Nigérie)**. Plant Protect. Sci., **41**: 158–164.

V severní Nigérii byly po tři roky studován vliv hustoty populace a škodlivosti pidikříska na výnosy podzemnice olejné. Byla zjištěna statisticky významná proměnlivost výskytu škůdce v jednotlivých letech pozorování i na různých růstových fázích rostlin. Škodlivost pidikříska na podzemnici olejné nebyla ekonomicky významná.

Klíčová slova: výskyt škůdce; *Empoasca dolichi* Paoli; podzemnice olejná; *Arachis hypogaea* L.

Corresponding author:

Dr. Elizabeth Agbenu Egwurube, Institute for Agricultural Research, Faculty of Agriculture, Department of Crop Protection, Ahmadu Bello University, P.M.B. 1044, Zaria, Kaduna State, Nigeria
tel.: + 803 593 05 70, e-mail: eaegwurube@yahoo.com