Effect of Density on Reproduction and Survival of Pea Aphid on Cool Season Food Legumes

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SHORT COMMUNICATION

Abstract

The effect of pea aphid, *Acyrthosiphon pisum* (Harris) (Homoptera: Aphididae) density per plant on reproduction and survival was studied on four cool season food-legumes, Faba bean, Field pea, Lentil and Grass pea in the greenhouse conditions. There was a general trend of decreasing survival with increasing aphid density though there was no significant difference in survival among four densities (2, 6, 10 and 14 nymphs/plant) on faba bean. While significantly ($P \leq 0.05$) higher survival was observed under the lower density (2/plant) on lentil. Progeny production declined with increasing aphid density per plant on the four crops. The highest mean progeny production (37.3 offspring/female) was observed at the lowest aphid density of 2/plant, among all the plant species tested. The number of nymphs produced per aphid was significantly lower on faba bean compared to the other host plants regardless of density, indicating that faba bean is less suitable for the pea aphid survival and reproduction.

Introduction

Ethiopia is a major producer of cool-season food legumes (Tilaye et al. 1994) that, includes faba bean (*Vicia faba*), field pea (*Pisum sativum*), lentil (*Lens culinaris*), grass pea (*Lathyrus sativus*) and chickpea (*Cicer arietinum*). Cool season food legumes take the largest share in area (86%) and total grain production (88%) among pulses in general (Beyene et al. 1994). The major zones of production include the central highlands of Shewa, the highlands of Gojam, Gondar, northern Wolo and parts of Tigray (NSIA 1999), while Welega, Arsi and Bale constitute the second major production zones (Tilaye et al. 1994).

The cool-season food legumes are attacked by over 20 species of insect pests, but only a few are of economic importance (Kemal & Habtewold 1994). The Pea aphid (*Acyrthosiphon pisum*), African bollworm (*Helicoverpa armigera*) and bean bruchid (*Callosobruchs chinensis*) have been the focus of research so far in Ethiopia. Crowe & Kemal (1983) stated that until the 1980s aphids have not been pests of economic importance in Ethiopia. However, the attack of field pea by pea aphid (*Acyrthosiphon pisum*) has become increasingly serious since 1983 (Kemal & Gebremedhin 1990, Kemal

& Habtewold 1994). A similar situation has also been observed on lentil and grass pea. The pea aphid is currently the key pest of peas, lentil and grass pea (Kemal & Habtewold 1994, Kemal 1997, Wale et al. 1998). The pea aphid also attacks faba bean, but with limited damage as compared to others (IAR 1987).

Although pea aphid is regarded as important pest of legumes in Ethiopia, studies have not been carried out on the effect of population density on reproduction and survival of the aphid. Therefore, the main objective of the study was to investigate the effect of different aphid density on reproduction and survival of the pea aphid.

Materials and Methods

Stock culture

Pea aphid stock cultures were established according to Briese (1988). Cultures of pea aphid originating from different host plants (legumes) collected from the field were allowed to develop unhindered for several generations on plants of respective hosts grown in pots in the greenhouse. Apterous aphids, destined to provide offspring for experimentation, were subcultured individually for several generations to avoid variability due to different maternal influences in aphid performance.

The host legume crops (faba bean, field pea, lentil and grass pea) were regularly planted in pots as a source of continuous food supply. Once a culture was established, clonal lineage from one isolated individual female was maintained throughout the whole study for each crop species. First instars nymphs were transferred from one leaf (plant) to another with moistened fine hairbrush. The large ones were picked up using a pair of fine, curved forceps and lifted from underneath rather than grasping it.

Effect of aphid density on reproductive capacity and survival

Reproductive capacity and survival of four levels of aphid density (2, 6, 10 and 14 nymphs/seedling) were tested on the four crop species. The test was arranged on a factorial experimental design with (4 x 4 = 16) treatment combinations and replicated three times. Each crop species had 12 pots with one seedling per pot, in which 2, 6, 10 or 14 adult aphids were introduced. The experiment was conducted following the method of Briese (1988). Seeds were sown in pots 10 days before the aphids were released. Soil used for seedling growth was black clay and sandy soil mixture for lentil and grass pea, and red soil and sandy soil mixture for faba bean and field pea. Seeds were sown in pots at the rate of one seed per pot. Seedlings emerged after six days and the aphids were released on the plants on day 12.

Emerging nymphs were counted, recorded and discarded daily. Counting was done late in the afternoon, to be able to count all nymphs produced both in the morning and afternoon. Survival of adults was recorded daily.

Data were subjected to statistical analysis using MSTATC software (Freed, 1989). Fecundity was compared with two-way analysis of variance (ANOVA) at $\alpha = 0.05$ significance level. When significant differences were detected, multiple comparisons were made among the means using Duncan's Multiple Range Test (DMRT) procedure. Daily adult aphid survival and reproduction were

graphically plotted against age on each test crop and aphid density.

Results

Effect of density on progeny reproduction

The number of nymphs produced by one individual aphid decreased with increasing aphid density (Table 1). At the lowest density of 2 aphids/plant, they produced significantly more nymphs per aphid (37.33) than at 6, 10, or 14 aphids/plant. The number of nymphs produced per aphid was significantly lower on faba bean while it remained on par among the other crops (Table 1).

Table 1. Number of nymphs produced per aphid on four cool season food legumes.

Aphid density (number/plant)	Number of nymphs/aphid				
	Faba bean	Field pea	Lentil	Grass pea	Mean
2	29.67 a	32.00 b	47.00 a	40.67 a	37.33 a
6	21.33 bc	40.33 a	24.33 c	36.00 a	30.50 b
10	24.67 b	29.67 b	30.33 b	29.33 b	28.50 b
14	17.67 c	23.00 c	22.33 c	22.67 c	21.42 c
Mean*	23.33 y	31.25 z	31.00 z	32.17 z	29.44 z

*Means followed by different letters within a column are significantly different from each other, DMRT, $p \leq 0.05$; *Grand means of each crop species followed by different letters (y and z) within the last row are significantly different from each other, DMRT, $p \leq 0.05$.*

Effect of density on survival

There was no significant difference ($P > 0.05$) in aphid survival among densities on faba bean (Fig 1a). Aphids in the high-density treatment (14 aphids/ plant) survived less on field pea. The general trend was of decreasing survival with increasing aphid density (Fig. 1b). Similar trend was observed on lentil for densities of 14 and 10, while 6 aphids/ plant survived less on lentil (Fig. 1c). However, survival of aphids for the density of 2 aphids/plant remained high throughout. On grass pea, all the different densities showed similar survival to each other (Fig. 1d).

Effect of aphid density on daily reproduction

On faba bean, 2 aphids/plant had the highest daily reproduction, while 14 aphids/plant had the lowest (Fig. 2a). Reproduction declined with increasing aphid density on all the four host plants (Fig. 2 a-d). For all densities, reproduction started to decline when the adults were 8, 6, 6 and 8 days old on faba bean, field pea, lentil and grass pea, respectively.

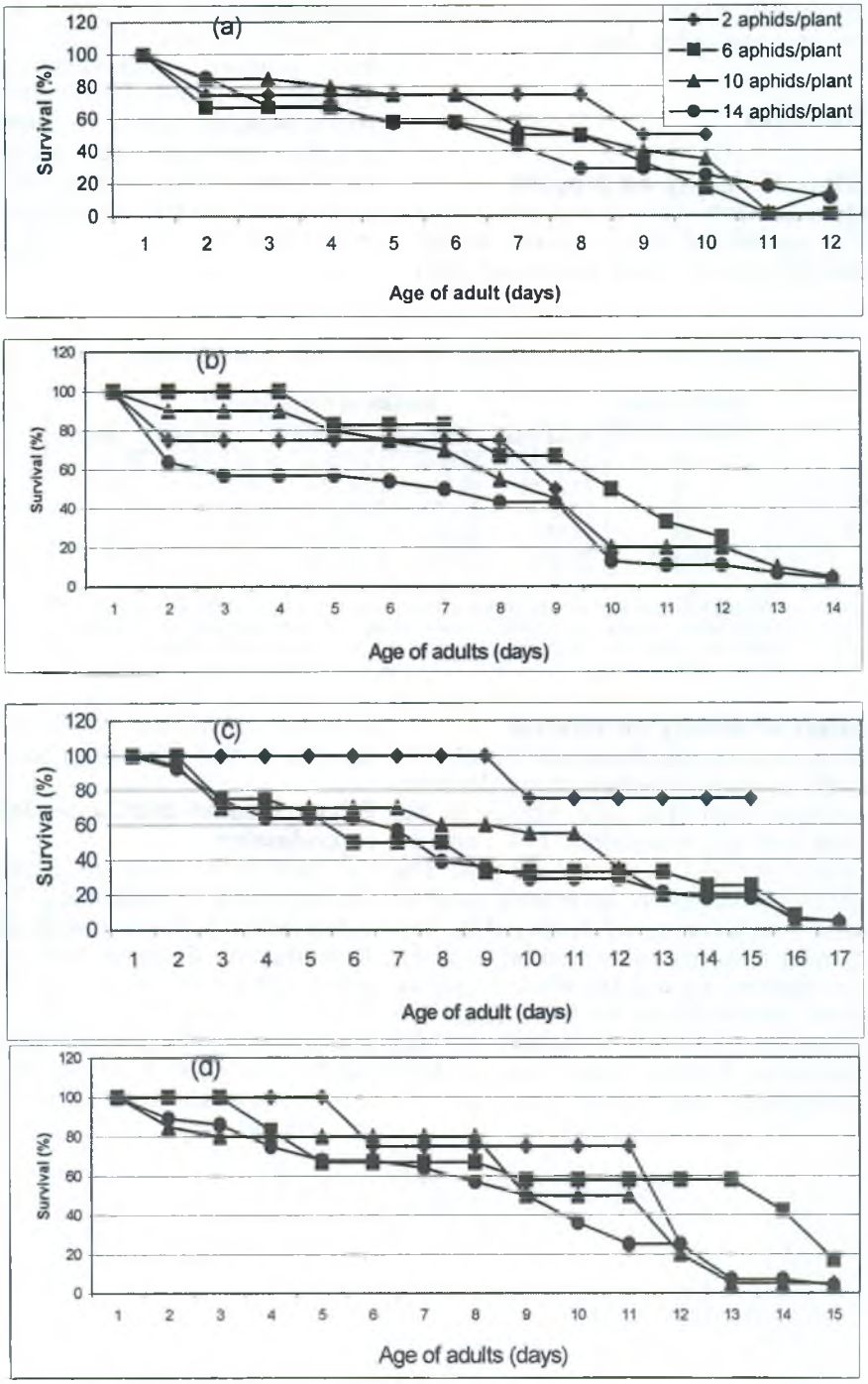

Figure 1. Survival of *A. pisum* at four densities on (a) faba bean, (b) field pea, (c) lentil and (d) grass pea.

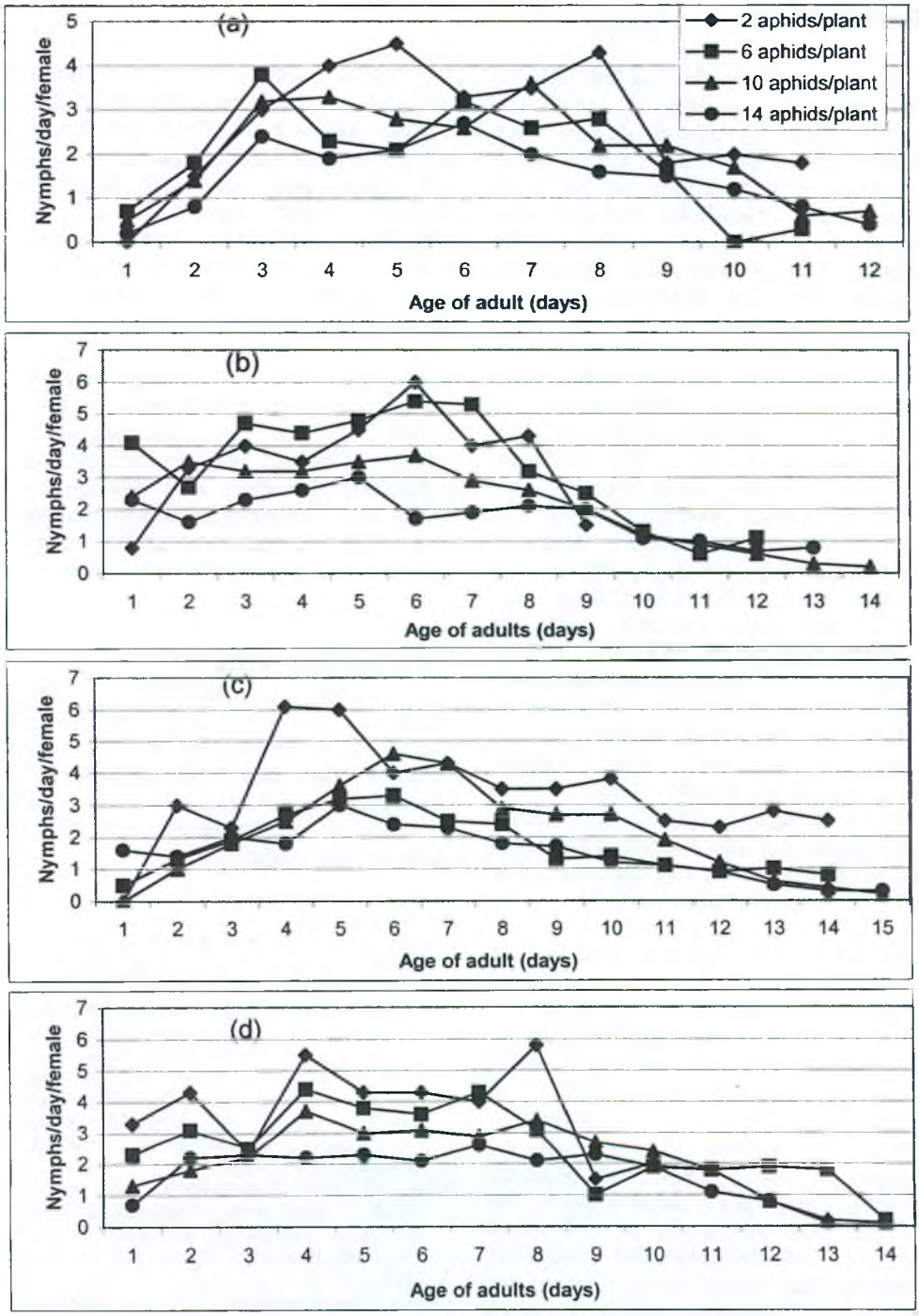

Figure 2. Reproduction of adult pea aphids at four densities on (a) faba bean, (b) field pea, (c) lentil and (d) grass pea.

Discussion

The present study showed that rate of reproduction was affected significantly by aphid density per plant. However, such effect was observed to vary among the different hosts tested. Similarly, survival was observed to decline as the aphid density increased per plant, though the magnitude of the effect was variable among host plants.

There have been similar studies with respect to the relationship of reproduction and aphids density. The reproduction of *Aphis chloris* Koch decreased with increasing density. (Briese 1988). Similar studies on *Acyrthosiphon pisum* had indicated that increasing aphid density caused more alates to form and these had potentially less intrinsic rate of increase (Tsuji & Kawada 1989). Regardless of aphid density per plant, host plant variation was observed to have significant effect on survival and development of pea aphid. Accordingly, Richter and Balde (1993) observed aphids to undergo prolonged developmental time and lower reproduction rate on unsuitable plants than on suitable ones.

Pea aphids are known to feed mostly on nitrogen rich food sources to be able to reproduce in great numbers in a short time and plants of low protein-sugar ratio are resistant to pea aphid (Nielsen & Lehman 1980). The reproductive rate of pea aphid is negatively related to the ratio of sugars to amino acids (Febvay et al. 1988). Considering these reports, the effects observed in the present study on rate of reproduction and survival of aphids, may have been affected by change in the nutritional condition of the host plant as affected by the density of the aphids.

Pea aphid biotype that may have survived on different cultivated food legumes (faba bean, field pea, lentil and grass pea), forage legumes (vetch and pigeon pea), and wild legumes (clover) might have evolved a different reproduction and survival behavior as it has been observed for other species of aphids (Stroud & Parker 1989).

The pea aphid is causing serious damage to cultivated legumes, in this country. To curb such damage such research findings, which focused on population dynamics and biology of aphid, have paramount importance to design control measures and time of application of the control measures.

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