APHIDS INFESTING CEREAL CROPS IN EGYPT WITH SPECIAL REFERENCE TO COMPETITION BETWEEN SPECIES.

S.I. BISHARA AND LOUISE S. SOURIAL

Plant Protection Research Institute, Agricultural Research Centre, Giza, Egypt.

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Abstract

Intra-specific as well as inter-specific competition between three cereal aphids Rhopalosiphum maidis (Fitch), Rhopalosiphum padi (L.) and Schizaphis graminum (Rond.) were studied under laboratory conditions. Intra-specific competition of the nymphal stages of the three aphids under study induced the appearance of winged forms. When nymphs were reared separately, no or few alatae were produced, but rearing them in groups caused remarkable increase in formation of winged adults. The percentage survival of these nymphs also noticeably decreased as the level of crowding increased. Crowding of mothers resulted in significant decrease in the mean total progeny per female as the level of crowding was increased from one to five to ten females per cage. Clear reduction in the mean total progeny of a single female was also achieved when the progeny were left to feed with their mother than when nymphs were removed daily.

Inter-specific competition between adults of any of the studied aphids did not show any appreciable reduction in the mean total progeny when reared together than when reared separately. These results indicate that intra-specific competition (without starvation was more effective on the mean total progeny than inter-specific competition.

INTRODUCTION

Cereal crops are liable to infestation with several aphid species that exist in mixed populations. The main objective of the present work is to reveal certain ecological phenomena that occur in the field through accurate laboratory experiments carried out under controlled conditions. As aphids feed on a common resource, the phloem sap, competition may have important consequences. In this connection, intra-specific competition as well as inter-specific competition between the main three aphid species infesting barley in Egypt namely *Rhopalosiphum maidis, Rhopalosiphum padi* and *Schizaphis graminum* were studied. Their biology have been extensively studied (e.g. Barbulescu 1969, El-Ibrashy *et al.* 1972, Kieckhefer and Gellner

1988), but it was only recently that Chongrattanameteekul *et al.* (1991) and Thirakhupt and Araya (1992) studied some intra-and inter-specific interactions of *R.padi* and *Sitobion avenae* reared separately or in mixed population.

Some studies have focused on the effect of intra-specific competition (crowding) on alate production and aphid dispersal (Dixon and Glen 1971; Watt and Dixon 1981; Walters and Dixon 1982), but competition may affect other aspects of the biology of aphids.

In greenhouse cultures both R.padi (L.) and the English grain aphid Sitobion avenae (F.), may be found on the same plant (Williams, 1987), although S.avenae prefers the upper leaves and later the emerged heads (Wratten, 1978), while R.padi prefers the lower leaves (Dean 1974; Leather and Dixon 1981).

MATERIALS AND METHODS

A standard colony was established separately for each species of the tested aphids in the laboratory on barley Hordeum vulgare L. variety Giza 121. Culture plants were grown in plastic pots 20 cm. in diameter and 16 cm. high containing a 3 : 1:1 mixture of soil, sand and peat moss (Starks and Burton, 1977). Artificial infestation was achieved by transferring a single newly emerged apterous female to young barley plants 6 days old; each species in a separate colony. Cylindrical glass cages 18 cm. in diameter were placed over plants to exclude extraneous insects and to confine the aphids. These colonies were raised under laboratory conditions held at 22±1°C and photoperiod of 10 L : 14 D.

From the stock colony 1, 10, 20 or 30 first instar nymphs were maintained in cages to determine the effect of crowding on wing formation and nymphal mortality (25 replicates for each treatment). Meanwhile, in another experiment 1,5 or 10 apterous newly emerged females of each species alone, were maintained in the previously described cages on 5 barley seedlings and left for 6 days. All progeny (adults and nymphs) were counted in each case to evaluate the effect of crowding on the whole progeny (25 replicates per treatment).

To study the effect of competition between species, 5 barley seeds were planted in a plastic pot. Apterous adult aphids from the stock cultures were used for infesting each pot according to the following treatments :

(a) 5 *Rhopalosiphum maidis* alone

(b) 5 *Rhopalosiphum padi* alone

(c) 5 *Schizaphis graminum* alone

(d) 5 *Rhopalosiphum maidis* + 5 *Rhopalosiphum padi*

(e) 5 *Rhopalosiphum maidis* + 5 *Schizaphis graminum*

(f) 5 *Rhopalosiphum padi* + 5 *Schizaphis graminum*

Each pot was covered with the glass cage and after 6 days the progeny in each cage was counted to evaluate the effect of competition between species on the overall population (25 replicates for each treatment).

RESULTS

1. Intra-specific competition

Two aspects of intra-specific competition (crowding) of the three aphid species were studied. The first is the effect of crowding of the nymphal stages on their survival and form of adults produced. The second aspect deals with the effect of crowding of the newly emerged adults on the mean total progeny produced after 6 days.

1.1 Effect of intra-specific competition of nymphal stages

Intra-specific competition (crowding of the nymphal stages) has been considered as a prime factor in the production of winged forms among aphids and the proportion of alatae differed with aphid species and the level of crowding. Table 1 clearly shows that crowding of the nymphal stage induced the appearance of winged forms in the three tested aphid species.

No alatae were produced by R.padi when the nymphs were reared singly on barley seedlings under laboratory conditions of 22±1°C and 10 hours photophase (being the favourable conditions), while few of S.graminum (2.5%) and *R.maidis* (7.5%) were winged.

However, more winged forms were obtained when nymphs were crowded together in groups of ten nymphs/seedling (R.maidis 20%, S.graminum 26.5% and R.padi 33.5%).

A remarkable increase in alatae production was observed when nymphs were crowded to 20 nymphs/seedling being 36, 41 and 49.5% for R.maidis, S.graminum and R.padi, respectively.

Again, more alatae were formed when nymphs were crowded at the level of 30 nymphs/seedling, R.padi gave the highest proportion of alatae 63% followed by *S.graminum* 61.5% and finally by *R.maidis* 57.5%.

Table 1. The effect of the degree of nymphal crowding on the proportion of alatae development and % mortality.

Aphid species	No of nymphs reared/cage	% Alatae	% Mortality
R.Maidis	1	7.5	2.0
	10	20.0	10.5
	20	36.0	23.0
	30	57.5	29.5
R.papdi	1	0	0
	10	33.5	18.5
	20	49.5	21.5
	30	63.0	23.0
S.graminum	1	2.5	6.0
	10	26.5	8.5
	20	41.0	11.0
	30	61.5	19.5

The percentage survival of these nymphs was also effected by the level of nymphal crowding as shown in Table 1. It was 2.0, 10.5 23.0 and 29.5% at levels of 1,10,20 and 30 nymphs/seedling for R.maidis, compared to 0.0, 18.5, 21.5 and 23.0 for *R.padi* and 6.0, 8.5, 11.0 and 19.5 for *S.graminum* at the same crowding levels, respectively.

1.2. Effect of intra-specific competition of the newly emerged adults on the progeny produced

The role of crowding on the overall progeny by one female is shown in Table 2.

Table 2. Effect of crowding of newly emerged females on the progeny produced.

Aphid species		Number of newly emerged females reared/cage/6 days			L.S.D. at 0.05
		1 female	5 female	10 female	
R.Maidis	mean progeny/ 1 female /6 days ±SE (range)	21.60±1.88 (25-45)	14.03±1.04 (11.0-18.2)	7.48±0.63 (5.3-9.6)	1.8598
R.papdi	mean progeny/ 1 female /6 days ±SE (range)	14.40±1.81 (9-20)	11.80±0.67 (10.2-14.2)	3.36±0.25 (2.3-4.1)	0.8080
S.graminum	mean progeny/ 1 female /6 days ±SE (range)	22.40±2.02 (16-28)	21.50±0.97 (18.8-23.6)	3.43±0.25 (2.6-4.2)	1.7424

Apterous newly emerged females were reared at different population densities of 1,5 and 10 females, and the corresponding mean total progeny per female was compared. Crowding caused a significant decrease in the total progeny of the three studied aphids. The mean total progeny was 21.60 ± 1.88 aphids/6 days, when a female of R.maidis was reared singly (with its progeny) and decreased to 14.03 ± 1.04 aphids when 5 females were caged together and reached 7.48 ± 0.63 aphids when reared in groups of 10 females.

Similarly, the mean total progeny per female of R.padi was 14.40 ± 1.81, 11.80 ± 0.67 and 3.36 ± 0.25, and for *S.graminum* it was 22.40 ± 2.02, 21.50 ± 0.97 and 3.43 ± 0.25 at levels of 1,5 and 10 females, respectively.

When the mean progeny of a single newly emerged female reared on barley in a separate cage and left for 6 days with its progeny was compared with a single female left for the same period and nymphs removed daily, difference was highly significant in the mean total progeny for the three tested aphids being 21.60±1.88 and 34.75 ± 2.14 for R.maidis (t = 9.7086); 14.40 ± 1.81 and 41.10 ± 2.07 for R.padi (t = 15.2245) and 22.40 ± 2.02 and 30.5 ± 2.26 for S.graminum (t= 5.6157), respectively.

2. Inter-specific Competition

In order to explain certain phenomena that may happen in the field due to the existence of more than one species of aphids on the same cereal crop, competition experiments between the three aphid species under study when feeding on barley were carried out. The data included in Table 3, clearly show that the highest fecundity was achieved by S.graminum when reared separately, followed by R.maidis and finally R.padi; the mean total progeny produced by 5 females in 6 days being 107.50±4.78, 70.15 ± 2.49 and 59.00 ± 3.66, respectively.

When R.maidis and R.padi were reared together under the same conditions on the same plant, R.maidis progeny was 64.65 ± 3.57 aphids/5 females/6 days which increased significantly for the same aphid species when reared separately, the mean being 70.15 ± 2.49 aphids/5 females/6 days (t = 2.6560). On the other hand, R.padi increased in the mixed population (63.25 ± 4.24 aphids) than when reared separately (59.00 ± 3.66 aphids), but the difference was not significant (t = 1.5951). Meanwhile, no significant difference existed between the mean progeny of the species reared together (t = 0.5311).

However, when 5 R.maidis and 5 S.graminum females were caged together, significant difference existed in the mean number of progeny after 6 days with

R.maidis being 65.60 ± 3.23 aphids in mixed population and 70.15 ± 2.49 aphids reared separately (t = 2.3464) while no significant difference occurred with S.graminum being 111.00 ± 5.18 aphids in mixed population and 107.50 ± 4.78 aphids when reared separately (t = 1.0438). Meanwhile, the difference in the mean progeny of the two aphid species was highly significant (t = 15.6363).

Table 3. Inter-specific competition between the three cereal aphids when fed on barley.

Aphid species	Mean number of progeny/5 females/6 days			t
	R.maidis	*R.padi*	*S.graminum*	
5 R.maidis	70.15 ± 2.49	59.00±3.66	107.50 ± 4.78	
5 R.padi				
5 S.graminum				
5 R.maidis + 5 R.padi	64.65±3.23	63.25±4.24		0.5311*
5 R.maidis + 5 S.graminum	65.60±3.23		111.00 ± 5.18	15.6363**
5 R.padi + 5 S.graminum		61.05 ± 3.73	95.65±3.27	14.6667**

* Significant at 0.05 Level.

** highly significant at 0.01 level.

Furthermore, S.graminum was affected to a certain degree by inter-specific competition with R.padi when reared together. The mean number of progeny of S.graminum females was 95.65 ± 3.27 aphids/6 days when reared together with R.padi and increased significantly to 107.50 ± 4.78 when reared separately (t = 4.2988). Although the mean number of progeny of R.padi was 59.00 ± 3.66 aphids/6 days when reared separately and increased to 61.05 ± 3.73 aphids when reared mixed with S.graminum, the difference was not significant (t = 0.8247) indicating that R.padi was affected by the presence of S.graminum. However, the difference in the progeny between the two aphids R.padi and S.graminum reared together was highly significant (t = 4.6667).

DISCUSSION

One of the major factors that influence the size of aphid population under field

conditions is competition between individuals existing in the same feeding sites. Crowding of nymphs of the same species caused remarkable increase in percentage of alate formation in the three species under study. This phenomenon was accompanied by noticeable increase in nymphal mortality, most probably due to poor nutrition as mentioned by Dixon and Glen (1971).

The present results also revealed clear reduction in the mean total progeny of a single female after 6 days when the progeny were left to feed with their mother than when removed daily. Crowding of adults, on the other hand, resulted in significant decrease in the total progeny per female at different crowding levels of 1,5 and 10 females per 5 seedlings per 6 days. This may be due to interaction between aphids themselves and are not caused by starvation, the relevant sense was probably that of touch, while visual, olfactory and exchange of pheromones were excluded (Lees, 1967).

Inter-specific competition between adults of any two species in the present work, did not show any appreciable reduction in the mean total progeny of each species than when reared separately. This phenomenon might be attributed to difference in species behavior, which show preference for certain feeding sites of the plant.

It might be concluded that intra-specific competition caused more pronounced effect on aphid reproduction than inter-specific competition. Similar observations were achieved by Wetzel *et al.* (1983) who studied the effect of combined infestation of wheat by Sitobion avenae, R.padi and Oulema melanopus on population development and found that intra-specific competition has more adverse effect on population increase than inter-specific competition.

Chongrattanameteekul *et al.* (1991) studied the longevity and fecundity of R.padi and S.avenae at various densities and found that R.padi responded to intra-specific competition by having a significantly shorter life and lower fecundity. Thirakhupt and Araya (1992) also found that the survivorship curves obtained for R.padi and S.avenae in single or mixed colonies were similar to the general survivorship curve. However, these results may be of value in further studies of population dynamics for single and mixed colonies of cereal aphids.

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دراسات عن بعض أنواع المن التى تصيب محاصيل الحبوب فى مصر مع اهتمام خاص بالتنافس بين الأنواع

صادق إبراهيم بشارة ، لوئيس صليب سوريال

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقى .

تم فى هذا البحث دراسة التنافس بين أفراد النوع الواحد والمن وكذلك بين أفراد ثلاثة أنواع من المن هى Rhopalosiphum maidis (L.), Rhopalosiphum padi (L.) and Schizaphis graminum (Rond.) تحت ٨٨ الظروف المعملية . أدى تنافس حوريات النوع الواحد للمن إلى إنتاج أفراد مجنحة لأنواع المن الثلاثة المدروسة. فعندما ربيت الحوريات منفردة لم تظهر أفراد مجنحة ولكن عندما ربيت فى تزاحم تسبب ذلك فى زيادة (معنوية) لنسبة تكوين الإناث المجنحة. كذلك قلت بوضوح نسبه البقاء فى الطور الحورى عندما زاد معدل التزاحم للأفراد. وقد أدى تزاحم الأمهات إلى انخفاض معنوى فى المتوسط الكلى لإنتاج الحوريات لكل أنثى عندما زاد مستوى التزاحم للأنثى من واحد إلى خمسه ثم إلى عشرة إناث. عندما تركت الحوريات مع الأمهات فى تزاحم أدى ذلك إلى نقص واضح فى المتوسط الكلى لإنتاج الحوريات لكل أنثى بالمقارنة بترك الأمهات تتغذى وحدها وذلك بأبعاد الحوريات الناتجة يوميا.

لم يؤدى التنافس بين إناث أى نوعين من الأنواع المدروسة إلى ظهور نقص معنوى فى المتوسط الكلى لإنتاج الحوريات عند تربيتهما معا.

وقد دلت النتائج على أن التنافس بين حوريات أو أمهات النوع الواحد (بدون تجويع) له تأثير أقوى على معدل الإنتاج الكلى للحوريات لكل أنثى من التنافس بين الأنواع المختلفة المدروسة.