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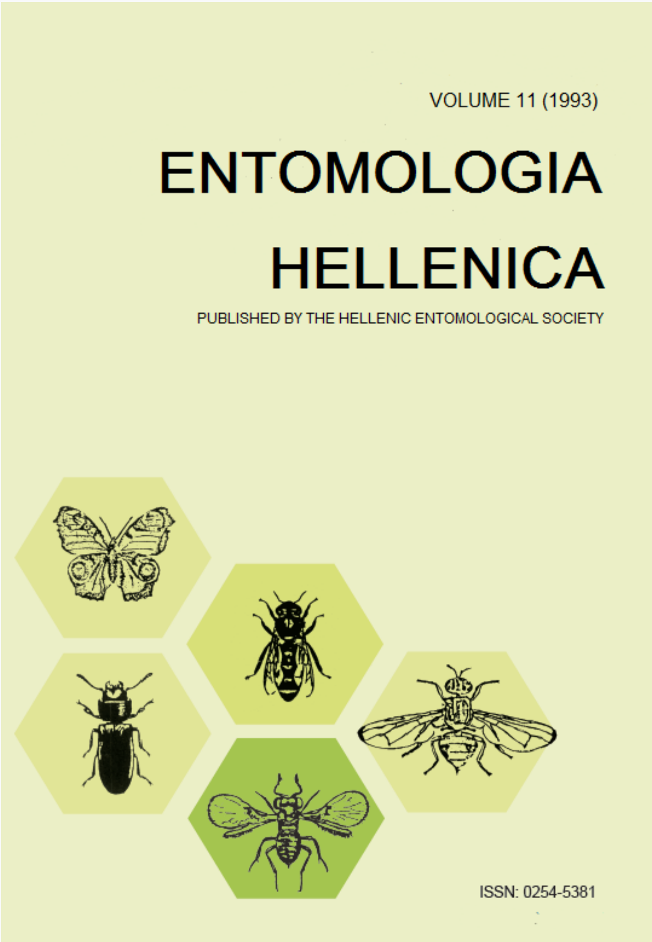

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Comparisons Between Alate Aphids Caught in Yellow Water Traps and Aphid Populations on Tomato Plants[1]

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ABSTRACT

Aphid monitoring was conducted by means of yellow Moericke water traps placed in tomato fields in two different localities in Co Boiotia during the growing seasons in 1992 and 1993. Additionally, aphid population densities were estimated by plant sampling. *Macrosiphum euphorbiae* (Thomas) and *Myzus persicae* (Sulzer) were the only species which developed populations on plants. Regression analysis between the number of alates from traps with either the number of alates or the total aphid population on plants showed that there was no correlation in the case of *M. persicae* for both localities and years. However, there were significant relationships between the number of alates in traps and either the number of alates on plants (r^2=0.83) or the total aphid population on plants (r^2=0.69) for *M. euphorbiae* in 1992. In 1993, such significant relationships were not found for the latter species, most probably due to extremely low trap catches. Significant relationships were also found between alates in traps, during their immigration period, with either alates on plants (r^2=0.93) or the total population on plants (r^2=0.80) in *M. euphorbiae* in 1992.

Introduction

Aphids are important as virus vectors in many crops, especially in the Solanaceae and Cucurbitaceae families. Tomato is attacked by about 200 insect species but only a few of them are considered as serious pests (Lange and Bronson 1981). Among them whiteflies, aphids, leafminers and some lepidopteran species are of particular importance. Aphids can damage tomato plants either directly or indirectly. In indirect injuries, sooty molds develop on aphid excretions and are deposited on fruits. The transmission of viruses such as CMV and PVY in particular, are important. In Greece high losses in yield of field tomatoes due mainly to CMV have occurred during recent years.

Aphid species which may develop populations on tomato plants are *Myzus persicae* (Sulzer), *Aulacorthum solani* (Kaltenbach), *Macrosiphum euphorbiae* (Thomas), *Aphis craccivora* Koch, *Aphis fabae* Scopoli, *Aphis gossypii* Glover, *Smynthurodes betae* Westwood and *Rhopalosiphum* sp. (Imenes et al. 1984, Blackman and Eastop 1985). In the area of Boiotia, *M. euphorbiae* and *M. persicae* were the only species which reproduced on tomato plants in 1992 (Lykouressis et al. in press).

Several types of traps have been devised for monitoring alate aphids. These include yellow water traps, suction traps and various sticky traps (cylindrical, horizontal and vertical) (Moericke 1951, Taylor and Palmer 1972, Robert and Rouze - Jouan 1978). Each kind of trap has

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advantages and disadvantages. As Heathcote (1957) reported, only suction traps are non - selective and indicate the number of aphids per unit volume of air. However, they need an electric power supply for their operation. Sticky traps catch fewer aphids than Moericke traps but they do not require frequent inspection compared with Moericke traps. Trumble et al. (1982) found that cylindrical sticky traps were more effective than water traps in capturing *M. persicae*, *Hyadaphis erysimi* (Kaltenbach) and *Brevicoryne brassicae* (L.) in a study of aphid monitoring in broccoli. However, Heathcote (1957) reported that yellow water traps collected more aphids than cylindrical or flat traps when wind speed was low, and they were as effective as suction traps for aphid species attracted to yellow colour.

Relationships between the number of alates caught in various traps and the number found on plants have been sought in several studies (Zettler 1967, Zettler et al. 1967, Heathcote et al. 1969, Elliot 1980, Trumble et al. 1982) and various results obtained.

The goal of this work was the development of a model by which aphid population densities on plants could be estimated from alate catches in yellow water traps. That could lead to the avoidance of plant sampling which is necessary at present, and to a more rational control of aphids or aphid transmitted viruses.

Materials and Methods

This work was conducted in a 2 ha processing tomato (cv H30) field in the area of Vaghia in 1992 and 1993, and in a 0.3 ha edible tomato (cv Galli) field located in Akraiphnio in 1993, both in the Co of Boiotia.

To estimate aphid population densities on plants in the Vaghia field, samples were taken from a plot of 0.2 ha at weekly intervals in both years. On the first three samplings, when plants were still small, 100 seedlings were sampled. Then, 100 young and 100 mature leaves were taken until the end of the growing season. Sampling commenced on June 26 and lasted until September 29 and on May 20 until September 30 in 1992 and 1993, respectively. In Akraiphnio, samples were taken from a plot of 0.1 ha. Fifty young leaves were sampled at weekly intervals from May 27 until October 1. Aphids from leaf samples were collected and stored in glass vials of appropriate size in preservation fluid consisting of 2 volumes ethyl alcohol 90-95% and 1 volume lactic acid 75% w/w (Eastop and van Emden 1972). Then, aphids were sorted into species and instars.

Additionally, for alate aphid monitoring, yellow water traps (Moericke 1951) were used. These were steel trays (60 x 60 x 10 cm) painted yellow inside (580 nm reflectance) similar to those used by Robert and Rouze - Jouan (1978) and placed on a iron base at a height of 60 cm.

In Vaghia, 6 traps were set up in the plot from June 26 until September 29 in 1992 and 3 in the following year from May 3 until October 7. In

TABLE 1. Relationship between weekly catches of alates in yellow water traps and weekly counts of aphid population on tomato plants (either alates or total population).

Year	Locality	Comparison	Regression equation	S.E. of b	T of b	r^2	P
			Myzus persicae				
1992	Vaghia	Al vs. Alp	Y=0.019+1.984X	1.831	1.083	0.09	0.30177
1992	Vaghia	Al vs. Total	Y=0.107+1.619X	9.745	1.662	0.20	0.12474
1993	Vaghia	Al vs. Alp	Y=0.430+8.173X	0.020	0.393	0.01	0.69830
1993	Vaghia	Al vs. Total	Y=4.866+0.237X	0.346	0.687	0.02	0.50078
1993	Akraiphnio	Al vs. Alp	Y=1.857+0.024X	0.017	1.439	0.14	0.17370
1993	Akraiphnio	Al vs. Total	Y=5.155+0.074X	0.041	1.825	0.20	0.09096
1992-1993	all	Al vs. Alp	Y=0.759+0.012X	7.631	1.645	0.06	0.10674
1992-1993	all	Al vs. Total	Y=4.566+0.031X	0.056	0.554	0.01	0.58224
			Macrosiphum euphorbiae				
1992	Vaghia	Al vs. Alp	Y=3.620+0.113X	0.015	7.33	0.83	0.00001
1992	Vaghia	Al vs. Total	Y=0.539+2.527X	0.501	5.038	0.69	0.00038
1993	Vaghia	Al vs. Alp	Y=0.526 – 0.526X	1.046	–0.503	0.01	0.62120
1993	Vaghia	Al vs. Total	Y=10.158+45.842X	19.596	2.339	0.23	0.03105
1993	Akraiphnio	Al vs. Alp	Y=1.717 – 0.051X	0.228	–0.224	0.01	0.82621
1993	Akraiphnio	Al vs. Total	Y=13.741+1.525X	1.447	1.054	0.08	0.31117
1992-1993	all	Al vs. Alp	Y=0.736+0.033X	0.142	0.232	0.00	0.81772
1992-1993	all	Al vs. Total	Y=9.667+1.791X	1.621	1.145	0.03	0.27497

Al = Alates in traps, Alp = Alates on plants, Total = Population on plants

TABLE 2. Relationship between weekly catches of alates in yellow water traps and weekly counts of aphid population on tomato plants (either alates or total population) during the immigration period of alates into the tomato crop.

Year	Locality	Comparison	Regression equation	S.E. of b	T of b	r^2	P
			Myzus persicae				
1992	Vaghia	Al vs. Total	Y=1.453−0.012X	0.052	0.225	0.02	0.837
1992*	Vaghia	Al vs. Total	Y=1.469+0.448X	0.885	0.506	0.08	0.648
1993	Akraiphnio	Al vs. Alp	Y=4.117+7.532X	1.982	3.800	0.74	0.013
1993*	Akraiphnio	Al vs. Alp	Y=0.459+1.456X	0.347	4.199	0.78	0.085
1993	Akraiphnio	Al vs. Total	Y=3.258+2.737X	1.273	2.149	0.48	0.084
1993*	Akraiphnio	Al vs. Total	Y=0.554+0.704X	0.486	1.448	0.29	0.207
			Macrosiphum euphorbiae				
1992	Vaghia	Al vs. Alp	Y= 0.272+0.246X	0.038	6.519	0.93	0.007
1992*	Vaghia	Al vs. Alp	Y=−0.307+0.671X	0.122	5.508	0.91	0.012
1992	Vaghia	Al vs. Total	Y= 0.992+0.037X	0.011	3.443	0.80	0.041
1992*	Vaghia	Al vs. Total	Y=−1.142+0.653X	0.115	5.677	0.92	0.011

Al = Alates in traps, Alp = Alates on plants, Total = Population on plants
* = transformed [log (n+1)].

Akraiphnio, 3 traps were placed in the plot on May 27 and remained until October 1.

Traps were filled with water adding a few drops of detergent. All insects captured were collected twice a week and stored in glass vials. Then, alates of *M. euphorbiae* and *M. persicae* were separated from the other insects and counted.

Results and Discussion

In both localities and both years only the aphid species *M. euphorbiae* and *M. persicae* developed populations on tomato plants. Although trap catches of *M. persicae* were much higher than those of *M. euphorbiae*, much lower populations of the former species were found on plants in both localities and years.

Regression analysis was done to look for relationships between the number of alates captured each week in traps and the number of alates on plants or the total aphid population on plants. The results are shown in Table 1. In the case of *M. persicae* no relationships were found on any dates or in any localities. For some reason aphid populations on plants did not follow the flight pattern as might be expected since tomato is a host of *M. persicae*. This is likely due to different degrees of aphid preference or antibiosis of various varieties and hybrids and/ or other factors. However, both varieties used in this work showed no relationships.

In the case of *M. euphorbiae* a significant linear relationship between the number of alates in traps and alates on plants was found in 1992 with 83% and 69% variance accounted between the number of alates in traps with either the number of alates in plants or the total aphid population on plants, respectively (Table 1). In the other two cases no relationships were found. In Vaghia in 1993, there were no relationships because of the very low number of alates captured in traps (only 2 individuals during the sampling period). Again, no relationships were found in Akraiphnio because of the very low nymber of alates (16 individuals during the whole sampling period). When all data, from both years, were incorporated in one regression equation, they resulted in no relationship between alates from traps with either alates on plants or the total population on plants. The existence of a good relationship in the case of *M. euphorbiae* between trap catches and aphids on plants is quite encouraging and it is very likely that a better relationship could be obtained if the number of alates in traps had been higher during 1993.

Regression analysis was also done with transformed values (log (n+1)) of the number of aphids. Again, in *M. euphorbiae*, significant linear relationships were found in 1992 between the number of alates in traps and alates on plants ($Y=0.011+0.441X$, $r^2=0.68$, $P=0.00049$) and between the number of alates in traps and the total aphid population on plants ($Y=-0.476 + 0.393X$, $r^2=0.81$, $P=0.00002$). These relationships are similar to those calculated by the untransformed values.

Furthermore, regression analysis was conducted between the number of alates caught in traps, during the immigration period at which their numbers were increasing, with either the number of alates on plants or the total aphid population on plants for both species, localities and years, with untransformed and transformed (log (n+1)) values (Table 2).

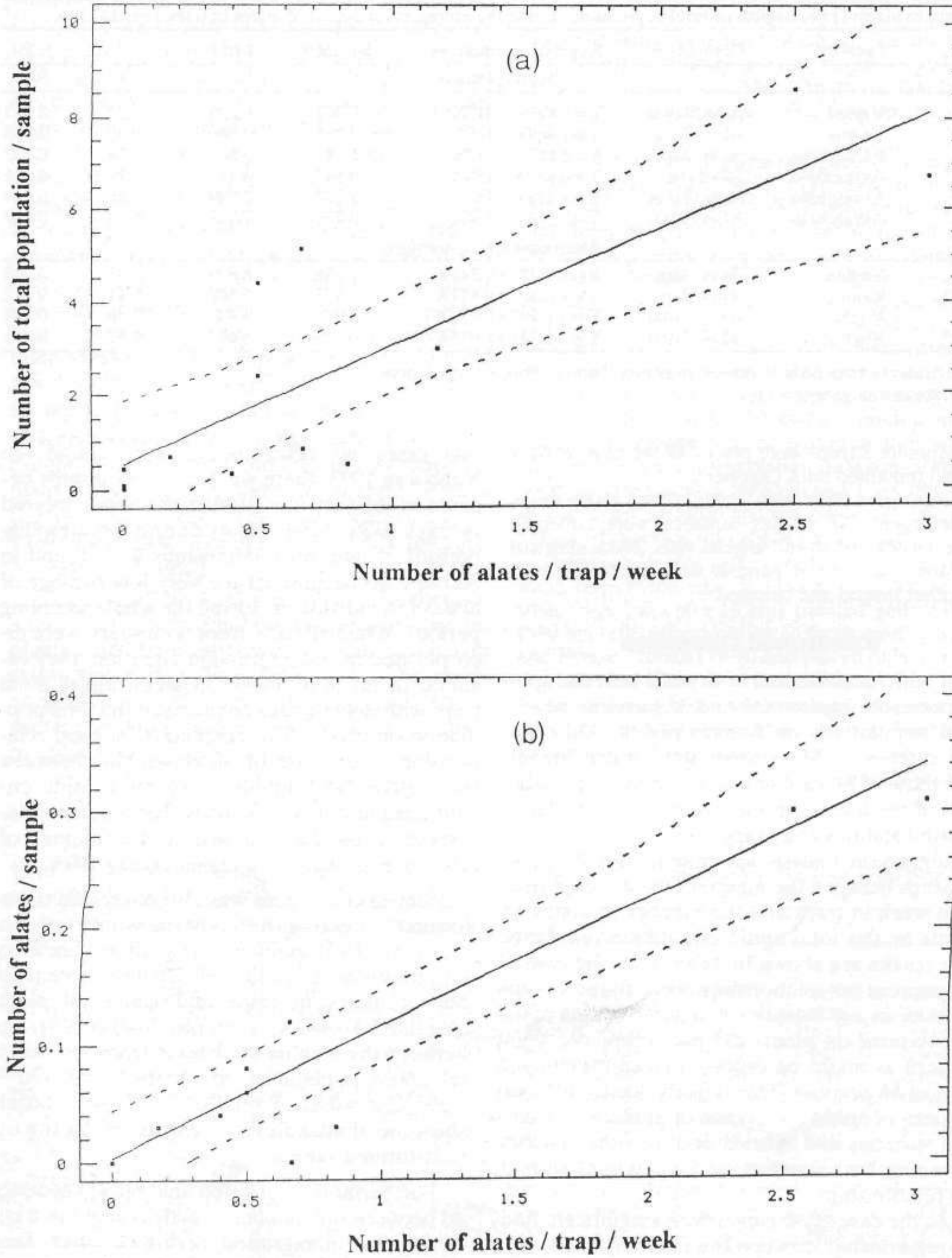

FIG. 1. Relationship between the number of alates, caught in yellow water traps, either with the number of total aphid population (a) (Regression line Y=0.539+2.527X, r^2=0.69) or alates on tomato plants (b) (Regression line Y=3.620+0.113X, r^2=0.83) in *M. euphorbiae.*

In *M. persicae*, a significant relationship was found only between alates in traps and alates on plants ($r^2=0.74$), in 1993. In *M. euphorbiae*, however, better significant relationships were found between alates in traps with either alates on plants or the total aphid population on plants, in 1992 ($r^2=0.93$ and $r^2=0.80$ respectively) (Table 2). The latter relationship could be of importance for short term predictions of the aphid population on plants from trap catches during the immigration phase of *M. euphorbiae* alates into a tomato crop. A similar possibility does not seem to exist in the case of *M. persicae*.

Few researchers have attempted to relate the number of alates cought in different traps with the number of aphids on plants. Heathcote et al. (1957) stated that the 40 ft suction trap and the yellow cylindrical sticky trap at 5 ft were more effective at recording the first seasonal immigration of *M. persicae* and *A. fabae* than the inspection scheme adopted by the British Sugar Corporation. Zettler (1967) reported that counts from sticky traps were «in agreement» with the number of aphids on bean leaves, although he did not give any statistical relationships between them. Elliot (1971) found a significant relationship between the transformed counts from a suction trap with those on Brussels sprouts plants for *M. persicae*. Elliot (1980), again, found positive correlations between suction trap catches and counts of alates on plant traps (tomatoes) for *M. euphorbiae*.

In another study (Trumble et al. 1982), yellow trap catches of *H. erysimi* were correlated with numbers of aphids on foliage of broccoli but no significant correlations occurred between alates of *M. persicae* or *B. brassicae* from traps with those on broccoli plants. They concluded that counts of alates in yellow water traps may be only marginally useful for estimation of aphid population densities on plants. However, the use of traps for aphid monitoring to determine the incidence of virus outbreaks as has been suggested by various authors may be their most important contribution.

Nevertheless, since some significant relationships between the number of alates in traps and that on plants have been found already in other studies and in the present one, research on this aspect should be continued because such relationships, where they can be found, are very useful elements for integrated pest management programmes.

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KEY WORDS: *Myzus persicae, Macrosiphum euphorbiae,* Aphididae, Tomato, Traps, Monitoring

Συγκρίσεις Μεταξύ των Πτερωτών Μορφών Αφίδων που Συνελήφθησαν σε Κίτρινες Παγίδες Moericke και των Πληθυσμών τους που Βρέθηκαν σε Φυτά Τομάτας

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ΠΕΡΙΛΗΨΗ

Η παρακολούθηση των πτερωτών των ειδών αφίδων *Myzus persicae* (Sulzer) και *Macrosiphum euphorbiae* (Thomas) έγινε με τη βοήθεια κίτρινων παγίδων νερού τύπου Moericke, οι οποίες είχαν εγκατασταθεί σε τοματοφυτείες στην περιοχή Βοιωτίας. Το 1992, 6 παγίδες τοποθετήθηκαν σε τεμάχιο έκτασης 2 στρεμμάτων σε καλλιέργεια βιομηχανικής τομάτας (cv H30) συνολικής έκτασης 20 στρεμμάτων στα Βάγια Βοιωτίας, από 26 Ιουνίου έως 29 Σεπτεμβρίου. Το 1993, 3 παγίδες τοποθετήθηκαν στον ίδιο αγρό όπως το 1992, από τις 3 Μαΐου έως 7 Οκτωβρίου. Το ίδιο έτος, επίσης, 3 παγίδες τοποθετήθηκαν σε αγρό επιτραπέζιας τομάτας (cv Galli) στο Ακραίφνιο Βοιωτίας από 27 Μαΐου έως 1 Οκτωβρίου. Για την εκτίμηση της πληθυσμιακής πυκνότητας των αφίδων επί των φυτών, δείγματα λαμβάνονταν εβδομαδιαίως από τα πειραματικά τεμάχια των φυτειών και κατά τα δύο έτη. Τα είδη τα οποία ανέπτυξαν πληθυσμούς επί των φυτών ήταν μόνο τα *M. persicae* και *M. euphorbiae.* Η ανάλυση της παλινδρόμησης έδειξε ότι δεν υπήρχε συσχέτιση μεταξύ των πτερωτών που συνελήφθησαν στις παγίδες Moericke είτε με τα πτερωτά είτε με το σύνολο του πληθυσμού επί των φυτών στη περίπτωση του *M. persicae*, σε αμφότερες τις περιοχές και κατά τα δύο έτη. Στην περίπτωση όμως του *M. euphorbiae*, η συσχέτιση μεταξύ των πτερωτών στις παγίδες και αυτών επί των φυτών ήταν σημαντική (r^2=0.83) καθώς επίσης και η συσχέτιση των πτερωτών στις παγίδες και του συνολικού πληθυσμού επί των φυτών (r^2=0.69) κατά το έτος 1992. Το 1993 δεν βρέθηκαν τέτοιες σημαντικές συσχετίσεις μεταξύ των ανωτέρω, λόγω των πολύ μικρών αριθμών πτερωτών που συνελήφθηκαν στις παγίδες. Αρκετά καλές συσχετίσεις βρέθηκαν, για το *M. euphorbiae,* μεταξύ των πτερωτών που συνελήφθησαν στις παγίδες, κατά την περίοδο μετανάστευσής των στην καλλιέργεια και μέχρι την πραγματοποίηση του μεγίστου, είτε με τα πτερωτά επί των φυτών (r^2=0.93) είτε με το συνολικό πληθυσμό επί των φυτών (r^2=0.80). Η τελευταία συσχέτιση θα μπορούσε να χρησιμοποιηθεί για τον υπολογισμο του πληθυσμού του *M. euphorbiae* επί των φυτών από τις συλλήψεις των πτερωτών στις παγίδες.

Η σημασία ύπαρξης τέτοιων σημαντικών συσχετίσεων μεταξύ αριθμού πτερωτών στις παγίδες και πληθυσμού των αφίδων επί των φυτών, όπως είναι προφανές, δύναται να αποβεί σε χρήσιμο «εργαλείο» στην ανάπτυξη και εφαρμογή προγραμμάτων ολοκληρωμένης αντιμετώπισης εντόμων - εχθρών της τομάτας.