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Seasonal fluctuation of the citrus bud mite population with an improved spraying programme for lemon trees in view

Abstract - The monthly fluctuations of *Aceria sheldoni* population were studied on different citrus varieties at Eleonas in the Aegeon area. Growth cycles of the trees and the seasonal climatic conditions affecting population size. The periods of highest contraction of the population inside the buds and of dispersal are determined as well as the appropriate time to check the growth of the population by intervention. Predator mites, including Phytoseiidae seem little effective in controlling *A. sheldoni*.

Riassunto - *Fluttuazione stagionale di popolazioni di* Aceria sheldoni *(Ewing) in conseguenza di programmi di lotta.*

Si riferiscono notizie sulla fluttuazione stagionale di popolazioni di *Aceria sheldoni* che risultano da una indagine biennale in un agrumeto con diverse cultivar; nella regione di Eleonas presso Aegeon (Grecia). I fattori che determinano la grandezza della popolazione dell'acaro nelle gemme sono i cicli vegetativi degli alberi e le condizioni climatiche; sono stati valutati i periodi di massimo livello di densitá della popolazione dell'eriofide e la sua dispersione. Inoltre è stato stabilito il periodo piú idoneo, per arrestare l'evoluzione della popolazione. Gli acari predatori, specialmente i Phytoseiidae, risultano poco efficaci nel caso di *Aceria sheldoni*.

Key words: citrus, *Aceria sheldoni*, fluctuation population, Greece.

INTRODUCTION

In addition to the phytophagous mites *Tetranychus urticae* Koch and *Panonychus citri* (McGregor), also *Aceria (Eriophyes) sheldoni* (Ewing) and *Aculops pelekassi* (Keifer), (Eriophyidae), have over the last years become of alarming concern for the citrus culture in Greece.

The citrus bud mite *A. sheldoni* is considered one of the most important citrus pests in the Mediterranean area (Sternlicht, 1970; Martin, 1972; Attiah *et al.*, 1973; Mijuskovic, 1973; Gerini, 1975; Di Martino, 1985; Vacante & Nucifora, 1985;

Zumreoglu, 1986). Until the eighties its occurrence in Greece was limited and considered incidental. Today it causes significant damage in most citrus growing areas and especially in monocultures of lemon. Infestation by this mite causes severe decline of the vegetative force of the plant while the level of phenolic compounds in the bud is raised. The infested buds (leaves and flowers) sprout poorly, resulting in new shoots with the well known short internodes and in malformation of leaves and fruit (Ishaaya & Sternlicht, 1969). In comparison to other phytophagous mites, records on its biology and behaviour in the field are very limited. Its very small body size (0.120 - 0.185 mm) and the fact that it lives most of the time under the scales of the buds, seem to make it a very difficult object to study (Sternlicht, 1969a, 1970; Mijuskovic, 1973, 1981; Jeppson, 1978; Beattie & Gellatley, 1983; Sale, 1988).

In Greece the species has merely been recorded (Papaioannou-Souliotis, 1985a, 1985b; Papaioannou-Souliotis *et al.,* 1994), but so far no data were available on its bioethology. In the present survey *A. sheldoni* was monitored on the two main lemon varieties cultivated in Greece as well as on an orange, a mandarin and on grape-fruit in order to verify any host preference of the species. Data are presented on its population fluctuation and phenology. With the control of *A. sheldoni* in view natural enemies (mites and insects) are recorded and evaluated and the time for intervention is determined.

MATERIALS AND METHODS

The survey was carried out from May 1995 till October 1996 at Eleonas in the Aegeon area, one of the most important lemon growing areas of Greece (Fig.1). The experimental plot of 0.4 ha (ca 1 acre) has been planted in alternating rows with the

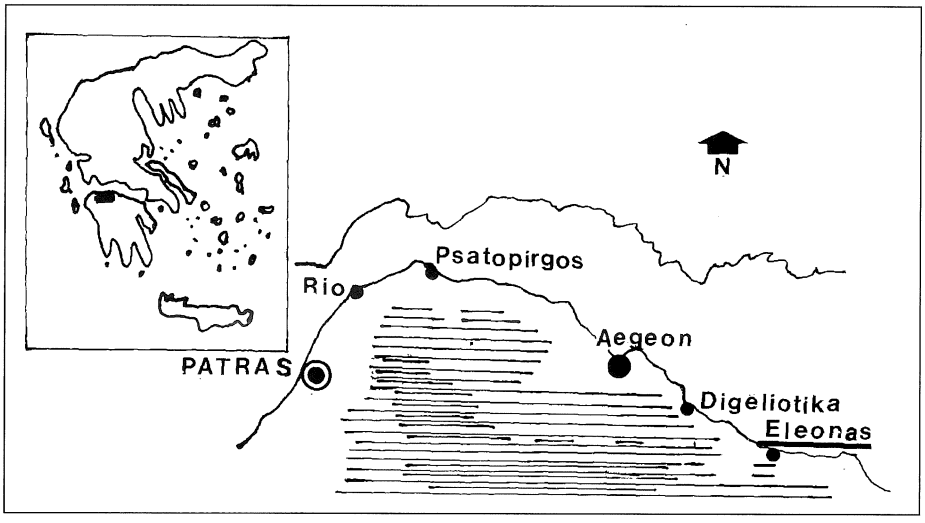

Fig. 1 - The area of Eleonas near Aegon, where the survey was conduced ovr the years 1995-1996.

two lemon varieties Maglini and Karistini, Satsuma mandarin and Merlin orange, while grape-fruit was planted interspersed over the orchard. At the time of the survey all trees were 20-25 years old and no pesticides had been used for at least four years. Three trees of each species and variety to be sampled were picked at random and samples were taken every fortnight (twice per month). With a few adaptations, that were considered necessary, the sampling method used in comparable work was applied (Sternlicht, 1969a; Di Martino & Benfatto, 1973). From each tree four (4) usually exterior young twigs of 10-20 cm were taken, one from each quarter of the tree at man's height (about the middle of the top of the tree). Subsequently each sample was put in a paper bag and all samples were transferred to the laboratory where the first six (6) buds (three top buds and three lateral buds) were examined under stereo-microscope (10x25), starting at the top of the twigs. The total number of buds examined was therefore 72 for each citrus species and variety. The moving forms of *A. sheldoni* were counted directly under stereo-microscope, while the predators of Phytoseiidae, Stigmaeidae, Tydeidae and others were collected and mounted after Nesbitt's clearing and Hoyer's sealing. They were then examined, using a phase-contrast microscope, for their identification as to species. The density of the predator populations was recorded over the whole duration of the survey.

RESULTS AND DISCUSSION

Evaluation of the collected data leads to the conclusion that in Greece *A. sheldoni* shows preference for lemon trees over other citrus species. This is in conformity with records from most Mediterranean countries like Italy, Yugoslavia (Montenegro area and Adriatic coast), Israel, Cyprus, Turkey and Egypt and also more generally from California, Brazil, Australia, New Zealand and South Africa (Sternlicht, 1969a, 1970; Celik & Urel, 1972; Attiah *et al.*, 1973; Gerini, 1975; Mijuskovic & Tomasevic, 1975; Bedford, 1979; Di Martino, 1985; Costilla *et al.*, 1987; Sale, 1988;). From all the specimens counted in this survey, 99.42% was collected on lemon (48,71 on Maglini and 50,71% on Karistini) and the remaining 0.58% on grape-fruit and Satsuma mandarin (0.5% and 0.08% respectively), when all these citrus species were planted interspersed in the same orchard. No *A. sheldoni* was collected on Merlin orange. Only in South Africa and California considerable damage on the orange varieties Navel and Valencia is reported (Sternlicht, 1969a; Jeppson *et al.*, 1958).

As far as the population fluctuation of the bud mite is concerned, an important factor in most citrus species is known to be the growth cycles of the trees. Flushes of new growth occur usually twice per year in August-September and February-April and sometimes also in June-July. Additional factors are climate, weather conditions and cultural measures. From research carried out on lemon at Bet Dagan in Israel (Sternlicht, 1969a) and at Fillmore and Escondido in California (Jeppson *et al.*, 1958) concluded that intensity and type of the wind (dry, moist, warm) affect the bud mite especially in the period that it migrates from the old buds to the younger ones.

The density of *A. sheldoni* on the two lemon varieties does not differ significantly. Furthermore, its population fluctuation follow the same course on both varieties without

great deviations (Fig. 2). The highest density of *A. sheldoni* in the buds was noted in September 1995 with 44.98 individuals per bud on the variety Maglini and 42.66 on Karistini. In both years a peak was noted in July. In March, April and August the mite migrates from older buds to young ones. This dispersal was more pronounced during spring (beginning March till mid-April) than in summer (mid-July till mid-August) (Fig. 2), probably because of the weather, that in spring is often rainy and windy. It has to be mentioned here, that the two lemon varieties in the survey, Maglini and Karistini, are not of the perennially bearing type. Thus in the periods from mid-May till mid-July and from mid-August till mid-September the bud mite shows a rapid multiplication

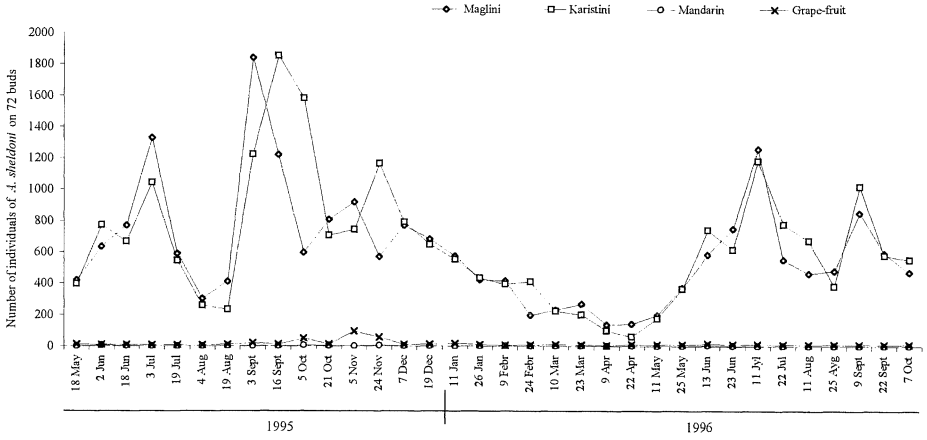

Fig. 2 - Population fluctuation of *A. sheldoni* on the lemon varieties Maglini and Karistini, Satsuma mandarin and grape-fruit, in the area of Eleonas during 1995-1996.

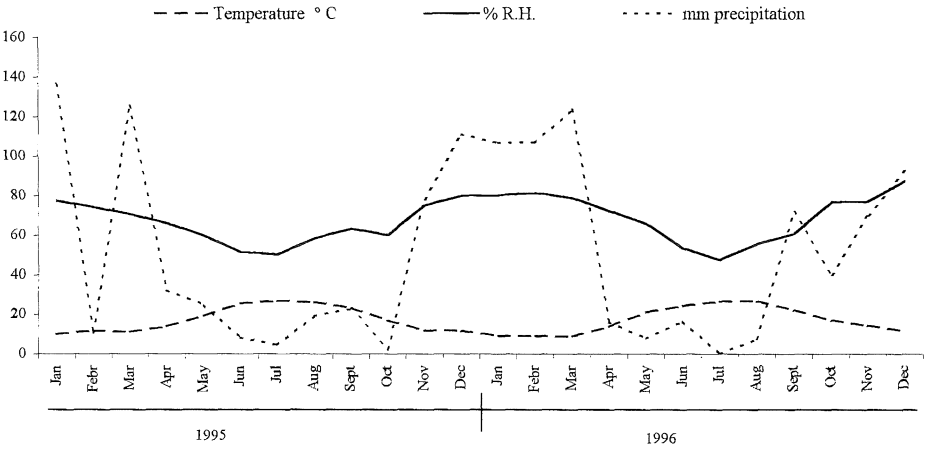

Fig. 3 - Meteorological data for 1995 and 1996 for the area of Aegeon.

inside the buds with peaks in July and September. The population size seems not to be affected by the low relative humidity and the high temperatures prevailing from the spring (April-May) till the beginning of autumn (September) in Greece, especially in the area of Aegeon (Fig. 3). On the other hand, at Fillmore and Escondido in California and at Bet Dagan in Israel, a decrease in mite population on lemon trees was noted in the months of low relative humidity. In California the low relative humidity occurs in autumn and winter and in Israel occurs in spring (April-May) and autumn (Sternlicht, 1969a; Jeppson, *et al.*, 1958). Furthermore it has to be mentioned that during spring (mid-April till mid-May) and shortly before the buds burst open, the mites are found in groups on the outer scales thereof. When the buds open, free at last, the mites settle at the under surface usually of very young leaves, not exceeding 3 mm. in length, where they stay till new lateral buds are formed in which they subsequently invade and settle.

During autumn a gradual drop of population in the buds is observed (Fig. 2), yet the density of individuals/bud continues to remain at fairly high levels till as late as December (Table 1). This is probably more due to the bioethological habits of *A. sheldoni* than to the seasonal climatic conditions.

Table 1 - Total number of A. sheldoni *individuals per bud on the lemon varieties Maglini and Karistini, on mandarin (var. Satsuma) and on grape-fruit, from May 1995 till October 1996 in the area of Eleonas, recorded per month.*

	MAGLINI				KARISTINI				GRAPE-FRUIT				MANDARIN			
	1st,2nd,3rd	4th	5th	6th	1st,2nd,3rd	4th	5th	6th	1st,2nd,3rd	4th	5th	6th	1st,2nd,3rd	4th	5th	6th
May	215	73	96	36	98	79	65	54	7	3	2	0	0	0	0	0
June	699	258	217	226	727	224	295	91	0	0	0	0	2	5	0	0
July	832	341	475	269	911	257	171	244	5	1	0	0	0	2	0	0
August	366	157	88	101	256	88	73	72	0	0	0	0	0	0	0	0
September	1249	661	645	684	2185	326	293	268	8	3	0	0	0	2	0	1
October	754	193	253	201	1379	288	326	291	20	11	6	3	6	2	0	0
November	876	194	216	200	1257	233	241	175	107	17	2	4	3	0	0	1
December	867	133	208	244	985	172	156	123	1	0	0	0	0	0	0	0
January	531	132	215	117	481	149	197	160	6	0	0	0	0	0	0	0
February	293	134	104	80	514	95	108	88	0	0	0	0	0	0	0	0
March	238	84	73	101	200	81	54	87	0	0	0	0	0	0	0	0
April	175	59	17	27	46	26	34	51	0	0	0	0	0	0	0	0
May	264	102	136	66	190	108	181	61	0	0	0	0	0	0	0	0
June	651	233	222	224	660	255	198	240	2	1	2	2	0	3	2	5
July	792	322	375	315	1081	262	247	363	0	0	0	0	0	0	0	0
August	608	129	93	109	601	218	128	103	0	0	0	0	0	0	0	0
Septembe	792	265	204	178	851	290	233	221	0	0	0	0	0	0	0	0
October	247	112	49	62	279	110	102	58	0	0	0	0	0	0	0	0

In the current survey the population density measured during winter was indeed very low, as has been reported for *A. sheldoni* from Israel and California (Jeppson *et al.*, 1958; Sternlicht, 1969a), (Table 1 and Fig. 2). Nevertheless, in this period all biological stages of the mite could be found inside the buds. Eggs were glued, singly or in clusters, to the inner, meristematic scales of the bud.

From the above data the time considered intervention to be most effective is in the period of May-begin June and mid August-begin September, when the mites are usually found on the outer scales of the bud where they are more vulnerable to a spray with the proper compound. At the same time their reproduction rate, which tends to grow in that period, will also be checked.

Collecting the individuals from each bud separately, allowed also for the evaluation of possible habitat preference of the mite for any of the six buds examined. No preference of *A. sheldoni* was shown for any part (Table 1).

As far as the predator mites are concerned that connect to *A. sheldoni* and the role

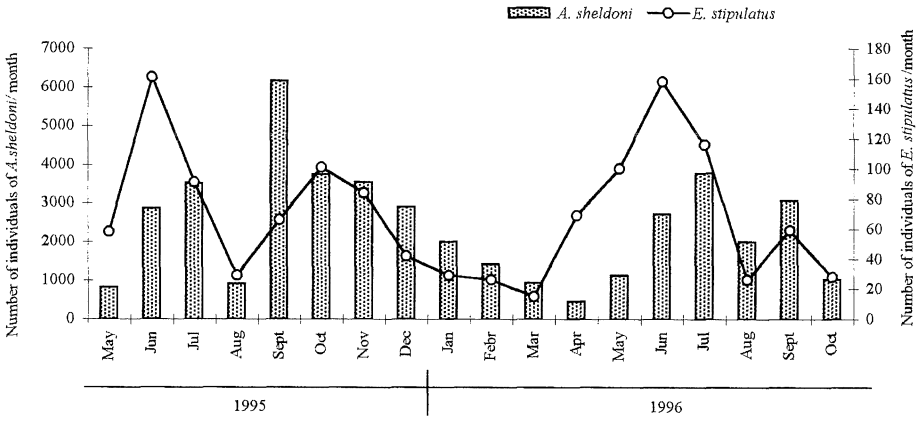

Fig. 4 - Population fluctuation of the predator *E. stipulatus* in relation to the population size of *A. sheldoni,* in the area of Eleonas during 1995-1996.

these might play in its control, the species that were collected on infested and non-infested buds belong to five families: Phytoseiidae 8.3%, Tydeidae 76.3%, Stigmaeidae 6%, Tarsonemidae 8.3% and Cheyletidae1.1%, of which the family Phytoseiidae is the most important. The following Phytoseiidae species were found on the buds: *Euseius stipulatus* Athias-Henriot, and very few individuals of *Paraseiulus talbii* (Athias-Henriot) and *Typhlodromus athenas* Swirski & Ragusa. Past research revealed *E. stipulatus* to be the pre-eminent predator of phytophagous mites *T. urticae* and *P. citri* on all citrus in Greece (Papaioannou-Souliotis *et al.*, 1994). In the case of *A. sheldoni*, however, its frequency is rather limited, as is demonstrated also by the low relative frequency (8.3%) of all Phytoseiidae species recorded on the buds. Figure 4 clearly shows the low numbers of *E. stipulatus* even when *A. sheldoni* is abundant, proving its limited predatory action on the bud mite. Furthermore, during the whole

period of the survey individuals of *E. stipulatus* were never seen hunting after mobile forms of *A. sheldoni* and only very few larvae were found between the first scales of the infested buds.

The relative frequency of the Stigmaeidae did not exceed 6%. However, the species *Zetzelia graeciana* Gonzales and *Zetzelia* sp. were very often seen feeding on eggs and mobile forms of *A. sheldoni* especially in the period that the buds are swollen and ready to burst open.

The few individuals of the Cheyletidae that were collected have not yet been identified. These were found along the twigs and not on the buds.

CONCLUSIONS

The above data lead to conclusion that the growth cycles of the trees is the factor that has the greatest impact on the population size of *A. sheldoni* and therefore also on the infestation rate of the buds. Climate and the weather conditions play an important role mainly in the period of migration of the mites.

From mid-May and mid-August the mite shows a rapid population growth in the buds which peaks mid-July and mid-September respectively. In autumn a gradual drop of the population is observed which during the winter months, due to the frequent changes of weather, is rendered even smaller. The low population densities begin-March-mid-April are due to the dispersal of the mites which is less pronounced during summer (mid-July-mid-August) and coincides with the migration of *A. sheldoni* from the older to the new buds.

The most appropriate time for intervention has to be when populations of *A. sheldoni* have not yet moved into the very interior of the buds.

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