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The Evaluation of Damage Caused by *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) on Cucumber Grown in Glass Greenhouse

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Abstract: The damage on cucumber (*Cucumis sativus* L., F_1 Kamaron) production caused by *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) was estimated in a glass greenhouse during the year 1999. Thirty two cucumber plants were separated in four groups; each group consisted of eight plants, which per two were covered with large cages made of muslin. 0, 5, 20 and 35 female adults of *F. occidentalis* were released correspondingly on every plant of these four groups. The thrips were released and grew up freely. The results of this research showed that, as the population of the thrips increased, it was observed an important decrease in the number of cucumbers per plant, the cucumber length, the cucumber mean weight and the total production per plant (kg). Initial thrips number consisted from one-day old adult females, resulted in linear correlated damages to all the production parameters studied.

Key words: *Frankliniella occidentalis*, damage, cucumber

Introduction

The polyphagous western flower thrips, *Frankliniella occidentalis* (Pergande), is an introduced greenhouse pest for Europe (Strassen, 1986). In Greece, *F. occidentalis* was first found in a sweet pepper's greenhouse in Ierapetra, Crete (1988), where it caused a great damage (Roditakis, 1991). The establishment of thrips in Greece (1988-1999) resulted to be one of the most serious enemies of a large number of plants in greenhouse and in field crops.

Cucumber (*Cucumis sativus* L.) is a well-established cultivation in Greece, especially in Crete, useful in salads. Additionally, the use of cucumber as a host plant is well documented in literature. The presence of the thrips, *F. occidentalis* and *Thrips palmi* Karny in cucumber cultivation, can harm leaves, stems, flowers and fruits. Thrips feeding on immature cucumbers generate silvery, web or streak like scarring, which may be accompanied by cucumber malformation. Either scarring or cucumber malformation may result in the downgrading of cucumber at harvest (Rosenheim *et al*., 1990). Kirk (1987) reports that besides the potential significance of thrips aggregation in flowers to fruit scarring, pollen feeding by thrips may sometimes deplete pollen stores and therefore depress fruit set. Also, feeding on flowers, petals (Haq, 1961), stamens (Bournier and Kochbav, 1963; Ananthakrishnan, 1955), or pistil, may be attacked separately, or often the whole flower withers. Moreover, thrips are virus vectors, infecting many cultivations with TSWV, causing great damages (Smith, 1957; Sakimura, 1969; Allen and Matteoni, 1988; Cho *et al*., 1989).

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Since cucumber is considered an important cultivation in Greece, this study was conducted to evaluate the damage caused by *F. occidentalis* in cucumber production under greenhouse's conditions. Four production parameters were estimated under different initial thrips populations: the number of cucumbers per plant, the cucumber length, the mean weight of fruits and the total production per plant.

Materials and Methods

The study was conducted in a 60 m^2 glass greenhouse, from February to July 1999. Cucumber plants (*Cucumis sativus* L., F_1 Kamaron) were used, which were first grown in little pots (12 x 10 cm) covered by plastic cylindrical cages (11 x 40 cm). There were little openings on the top and the sides of these cages, which were covered by a dense cloth made of muslin (0.06 mm opening) for ventilation. In order to create suitable growing conditions for the cucumber plants, the soil was enriched with 50 kg of substrate Humosoil 801.

At the 20/2/1999, 32 cucumber plants were transplanted and were treated with fungicides (Ridomyl MZ 63,5 WP and Benlate 50 WP) for the protection of the plants from mycological diseases. These plants were separated in four groups, with eight plants per group. The plants were covered with cages made of dense cloth of muslin (0.06 mm opening) sized 0.6 x 1.1 x 2.6 m. There were 16 cages in total (two plants/cage). There was an opening on each cage, which could close with a slide fastener for the inspection of the plants. The iron frame was embedded in the soil. The plants were attached to a horizontal wire with a thread. The distance between cages of different groups, as well as the distance between the cages of the same group was 0.4 m. The distance between plants was one m. The environmental conditions of the greenhouse were recorded by a thermohydrograph. Water and fertilization with Complesal fertilizer (12-4-6) were added at the same time according to the plant needs. Also, to prevent diseases (downy mildew, powder mildew) Antracol-Bayleton 67 WP fungicide (200 g/100 L) was used.

At 21/3/1999, 0, 5, 20 and 35, one day old female adults of *F. occidentalis* were released correspondingly in every of the four groups on every plant. The thrips were collected from a rearing and they were released to grow without any further interference. At 14/5/99, the greenhouse was covered with a slacked lime coating [$Ca(OH)_2$] in order to reduce temperature. The harvest began at 14/4/99 and took place every four days until 27/7/99. During the research, the number of cucumbers per plant, mean cucumber length (cm), mean cucumber weight (g) and the total cucumber production (Kg) per plant, were estimated. ANOVA was based on standard factorial analysis described by Snedecor and Cochran (1980).

Results

In Table 1 are presented the greenhouse's environmental conditions (temperature°C, relative humidity %) under which the damage on cucumber production caused by the *F. occidentalis,* took place (measurements every 15 days). Maximum temperatures (40°C) were found at the last two weeks of May (with an average at 27°C), while the minimum values were found during March (17°C). Relative humidity had not fluctuated significantly, except for minimum values (between 37 and 45%).

Table 1: Variability of the average temperatures (°C) per 15 days and relative humidity (%), maximum, mean and minimum values (max, mean, min) in the greenhouse from 1/3/99 until 31/7/99

	Temperatures (°C)			Relative humidity (%)		
Dates	max	mean	min	max	mean	min
1/3-15/3	30	23	17	86	57	45
16/3-31/3	32	24	17	86	57	41
1/4-15/4	35	25	18	86	56	43
16/4-30/4	36	26	19	86	56	48
1/5-15/5	36	26	20	87	55	42
16/5-31/5	40	27	19	86	52	35
1/6-15/6	38	26	19	89	52	36
16/6-30/6	35	26	21	85	54	37
1/7-15/7	36	25	22	89	59	37
16/7-31/7	36	26	22	83	59	37

Table 2: The effect of *F. occidentalis* on the number of cucumbers per plant, the mean cucumbers' length (cm), the mean fruit weight (g) and the production per plant (Kg) from 21/3/99 until 27/7/99

No. of female adults	No. of cucumbers per plant	Mean cucumber length (cm)	Mean fruit weight (g)	Mean production per plant (kg)
0	10.25±0.36 a	33.67±0.05 a	414.76±1.37 a	4.25±0.15 a
5	9.75±0.31 ab	33.16±0.05 b	384.38±1.52 b	3.74±0.11 b
20	8.62±0.46 b	32.27±0.05 c	312.13±1.38 c	2.69±0.14 c
35	6.5±0.42 c	31.41±0.08 d	251.84±0.95 d	1.63±0.10 d

Means followed by the same letter do not differ significantly ($p<0.05$)

The main results of this research presented in Table 2, specify the level of damage that *F. occidentalis* can cause on cucumbers. This damage was related to the initial number of the female thrips adults (0, 5, 20 and 35) that were at first released.

The analysis of results (Table 2) and the general testing of the F for every parameter studied, showed that there was a statistically significant impact of the thrips population on the number of cucumbers per plant ($F = 17.82$, $p<0.0001$), on the mean cucumber length ($F = 262.24$, $p<0.0001$), on the mean fruit weight ($F = 2517.9$, $p<0.0001$) and on the total production per plant ($F = 77.33$, $p<0.0001$).

There was also a linear relationship between the initial population of thrips and the damage that they can cause, as demonstrated by the correlation coefficients between initial thrips population and (a) the mean number of cucumbers per plant ($r = -0.989$), (b) the mean cucumber length ($r = -0.996$), © the mean cucumber weight ($r = -0.998$) and (d) the total production per cucumber plant ($r = -0.999$). The equations describing the relation between initial thrips number (x) consisted of one-day old adult females and the damage on the four production parameters (y) were respectively: (a) $y = -0.1042x +10.343$, (b) $y = -0.0628x +33.57$, © $y = -4.6237x +410.13$ and (d) $y = -0.0735x +4.1795$. This verification indicates that, as the initial population of *F. occidentalis* increases, the damage (Table 2) on cucumber also increases linearly.

Discussion

The different initial number of thrips adults of *F. occidentalis* which were released on the cucumber plants, permitted the examination of the relevant importance of thrips in the formation of scarring, fruit deformations, but also loss of small cucumbers, resulting to the decrease of production. Thrips may enhance the pollination through pollen transportation (Kirk, 1984), but the increase of damages in this study, resulted mainly from feeding and oviposition of *F. occidentalis* in increasing

densities. Especially, the increase of the infection, from 0 to 35 adult female thrips per cucumber plant, in each case, resulted in a respective reduction of the examined parameters (number of cucumbers per plant, length and weight of cucumbers) and therefore the reduction of total production. Commercial size (length) of cucumbers is considered to be between 30 and 36 cm (fruit market standards) and thus, cucumbers less than 30 cm without proper development were considered harmed by thrips and included in damage level.

The progressive reduction of the total production depended on the increasing density of thrips population per plant during the experimentation but also to the habit of *F. occidentalis* to emigrate in flowers, a fact that increases the damage. The attractiveness of flowers to *F. occidentalis* has been noted for various host plants (Bryan and Smith, 1956; Yudin *et al*., 1986; Pickett *et al*., 1988; Yudin *et al*., 1988; Salguero Navas *et al*., 1991). Also, pollen provides a vital source of nutrition (proteins) for many thrips species, increases the fecundity, improves the longevity, lowers the time from egg to adult, affects oviposition rate, developmental rate and larval growth (Kirk, 1984, 1985; Bournier *et al*., 1979; Murai and Ishii, 1982; Trichilo and Leigh, 1988). Feeding and oviposition may cause respectively direct and indirect damages to tissues below epidermis, in a way that greater oviposition rates may cause greater damage and subsequently new generations of thrips in increased numbers, may increase damage by feeding on host plants. According to Deligeorgidis *et al*. (2005), the biological cycle of *F. occidentalis* on cucumber ranged from 33.99 days at 15°C to 11.99 days at 30°C, while that of *T. tabaci* ranged from 32.76 to 11.78 days at respective temperatures. The duration of each developmental stage for both thrips species was reduced with temperature increase. Total female longevity of *F. occidentalis* decreased when temperature increased from 15 to 30°C, while the longevity of *T. tabaci* was lower and also decreased from 15 to 30°C. For *F. occidentalis* the maximum reproduction dynamic and reproduction rate was found at 20°C and minimum at 15°C. Cucumber found to be a suitable host plant for survival and reproduction of both thrips species. Temperature may affect thrips population, especially when measurements are out of normal temperature range, resulting in increased populations. In such cases, the results based in initial thrips population may be biased (Deligeorgidis *et al*., 2005).

The possible concentration of *F. occidentalis* on cucumber flowers may cause fruit scarring, deformation and drop of small fruits. In addition, feeding of thrips with pollen, may cause an exhaustion of the pollen reservoirs and subsequently the blossom to drop and reduced numbers of fruit per plant (Kirk, 1987) and as a result the reduction of the production (both for quantity and quality). Damage, caused by oviposition of *F. occidentalis,* was also reported on grapes in California (Jensen, 1973; Stafford, 1974; Yokoyama, 1977) and apples in Arizona (Terry and Degrandi-Hoffman, 1988). Higgins (1992) reported that on cucumber plants, female western flower thrips were accumulated in flowers and thus are responsible for the majority of fruit damage. The intrusion into flowers resulted in various damages to the developing fruits, including deformations and loss of weight.

Steiner (1990) did not found significant correlation between western flower thrips density on plants and the amount of fruit damage. Sometimes there were high numbers of thrips individuals and low amount of damage, but other times there were few thrips and severe fruit damage. This may be explained by examining the sex of thrips on traps and of course, the temperature conditions (Deligeorgidis *et al*., 2005). In our study, initial thrips number consisted from one-day old adult females, resulted in linear correlated damages to the mean number of cucumbers per plant, the cucumber length, the fruit weight and the total production per plant. The linear model found depends mainly on the initial number of female thrips individuals (despite the equal spaced intervals used in calculations). High temperatures in the glasshouse may enhance the damage impact, resulting in the linear models of damage described here.

Relevant damages of *Frankliniella bispinosa* (Morgan) (Thysanoptera: Thripidae) in flowers (on the pistil or petals) of navel orange and developing buds and oviposition in all floral parts has been reported (Lima *et al*., 1980). However, this does not mean that occurs economic loss, because of a high percentage of citrus flowers and small fruitlets that abort naturally (Lima *et al*., 1980; 1981). The natural loss happens mainly on citrus fruits and sometimes may exceed 95% (Childers and Achor, 1991), while this kind of damage does not happen on cucumber cultivations. Rosenheim *et al*. (1990) reported that the tolerable economic loss level for *F. occidentalis* is 8 thrips/200 cm^{-2} of cucumber leaves. The rising from 8 to 20 thrips/200 cm^{-2} of leave surface can increase the scarring on cucumbers for about 10%.

It is obvious that, *F. occidentalis* in large populations can cause great damages in greenhouse cultivars and the spreading of this thrips species around the world may become a great problem for the farmers.

References

Allen, W.R. and J.A. Matteoni, 1988. Cyclamen ringspot. Epidemics in Ontario greenhouses caused by the tomato spotted wilt virus. Can. J. Plant Pathol., 10: 41-46.

Ananthakrishnan, T.N., 1955. Miscellaneous note. 28. Notes on *Thrips palmi* Karny, attaching *Sesamum indicum*. J. Bombay Nat. Hist. Soc., 52: 951-952.

Bournier, A. and A. Kochbav, 1963. Action stérilisante d' un Thysanoptére sur les fleurs de luzerne. Bull. Soc. Ent. Fr., 68: 28-30.

Bournier, A., A. Lacasa and Y. Pivot, 1979. Régime alimentaire d'un prédateur *Aeolothrips intermedius* (Thysanoptera: Aeolothripidae). Entomophaga, 24: 353-361.

Bryan, D.E. and R.F. Smith, 1956. The *Frankliniella occidentalis* (Pergande) complex in California (Thysanoptera: Thripidae). Univ. Calif. Publ. Entomol., 10: 359-410.

Childers, C.C. and D.S. Achor, 1991. Feeding and oviposition injury to flowers and developing floral buds of "Navel' orange by *Frankliniella bispinosa* (Thysanoptera: Thripidae) in Florida. Ann. Entomol. Soc. Am., 84: 272-282.

Cho, J.J., R.F.L. Mau, T.L. German, R.W. Hartmann, L.S. Yudin, D. Gonsalves and R. Provvidenti, 1989. A multidisciplinary approach to management of Tomato Spotted Wilt Virus in Hawaii. Plant Disease, 73: 375-383.

Deligeorgidis, P.N., L. Giakalis, G. Sidiropoulos, M. Vaiopoulou, G. Kaltsoudas and C.G. Ipsilandis, 2005. Longevity and reproduction of *Frankliniella occidentalis* and *Thrips tabaci* on cucumber under controlled conditions. J. Entomol., (In Press).

Haq, A., 1961. A note on the broad bean thrips, *Taeniothrips lefroyi* Bagnall. Indian J. Entomol., 22: 132-133.

Higgins, C.J., 1992. Western flower thrips (Thysanoptera: Thripidae) in Greenhouses: Population dynamics, distribution on plants, and associations with predators. J. Econ. Entomol., 85: 1891-1903.

Jensen, F., 1973. Flower thrips damage to table grapes in San Joaquin Valley: (1) timing of halo spotting by flower thrips on tomato grapes. Calif. Agric., 27: 6-8.

Kirk, W.D.J., 1984. Ecological studies on *Thrips imaginis* Bagnall (Thysanoptera) in flowers of *Echium plantagineus* L. in Australia. Aust. J. Ecol., 9: 9-18.

Kirk, W.D.J., 1987. How much pollen can thrips destroy. Ecol. Entomol., 12: 31-40.

Kirk, W.D.J., 1985. Aggregation and mating of thrips in flowers of *Calystegia sepium*. Ecol. Entomol., 10: 433-440.

Lima, J.E.O., F.S. Davies and A.H. Krezdorn, 1980. Factors associated with excessive fruit drop of navel orange. J. Am. Soc. Hortic. Sci., 105: 902-906.

Lima, J.E.O. and F.S. Davies, 1981. Fruit set and drop of Florida navel oranges. Proc. Fla. State Hortic. Soc., 94: 11-14.

Murai, T. and T. Ishii, 1982. Simple rearing method for flower thrips (Thysanoptera: Thripidae) on pollen (in Japanese). Jpn. J. Applied Entomol. Zool., 26: 149-154.

Pickett, C.H., L.T. Wilson and D. Gonzalez, 1988. Population dynamics and within-plant distribution of the western flower thrips (Thysanoptera: Thripidae), an early-season predator of spider mites infesting cotton. Environ. Entomol., 17: 551-559.

Roditakis, N.E., 1991. First record of *Frankliniella occidentalis* in Greece. Entomol. Hellenica, 9: 77-79.

Rosenheim, J.A., S.C. Welter, M.W. Johnson, R.F.L. Mau and L.R. Gusukuma-Minuto, 1990. Direct feeding damage on cucumber by mixed-species infestations of *Thrips palmi* and *Frankliniella occidentalis* (Thysanoptera: Thripidae). J. Econ. Entomol., 83: 1519-1525.

Sakimura, K., 1969. A comment on the color forms of *Frankliniella schultzei* (Thysanoptera: Thripidae) in relation to transmission of tomato-spotted wilt virus. Pacif. Insects, 11: 761-762.

Salguero Navas, V.E., J.E. Funderburk, R.J. Beshear, S.M. Olson and T.P. Mack, 1991. Seasonal patterns of *Frankliniella* spp. (Thysanoptera: Thripidae) in tomato flowers. J. Econ. Entomol., 84: 1818-1828.

Smith, K.M., 1957. A Text book of Plant Virus Diseases. 2nd Edn., Churchill, London, pp: 652.

Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Edn., The Iowa State Univ. Press, Ames, IA.

Stafford, E.M., 1974. Insect grape pests of northern California. Calif. Agric. Exp. Sta. Circ., pp: 566.

Steiner, M.Y., 1990. Determining population characteristics and sampling procedures for the western flower thrips (Thysanoptera: Thripidae) and the predatory mite *Amblyseius cucumeris* (Acari: Phytoseiidae) on greenhouse cucumber. Environ. Entomol., 19: 1605-1613.

Strassen, R.Z., 1986. [*Frankliniella occidentalis* (Pergande 1895), from North America as a new Thysanopterous inhabitant of European greenhouses]. Nachrichtenbl. Deutsch. Pflanzenschutzd (in German). 36: 86-88.

Terry, L.I. and G. Degrandi-Hoffman, 1988. Monitoring western flower thrips (Thysanoptera: Thripidae) in "Granny Smith" apple blossom clusters. Can. Entomol., 120: 1003-1016.

Trichilo, P.J. and T.F. Leigh, 1988. Influence of resource quality on the reproductive fitness of flower thrips (Thysanoptera: Thripidae). Ann. Entomol. Soc. Am., 81: 64-70.

Yokoyama, V.Y., 1977. *Frankliniella occidentalis* and scars on table grapes. Environ. Entomol., 6: 25-30.

Yudin, L.S., J.J. Cho and W.C. Mitchell, 1986. Host range of western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae), with special reference to *Leucaena glauca*. Environ. Entomol., 15: 1292-1295.

Yudin, L.S., B.E. Tabashnik, J.J. Cho and W.C. Mitchell, 1988. Colonization of weeds and lettuce by thrips (Thysanoptera: Thripidae). Environ. Entomol., 17: 522-526.