EFFECT OF TOMATO PUBESCENCE ON DEVELOPMENT, SURVIVAL AND FECUNDITY OF *TETRANYCHUS URTICAE* KOCH AND *NEOSEIULUS CALIFORNICUS* (MCGREGOR) [ACARI: TETRANYCHIDAE: PHYTOSEIIDAE]

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TETRANYCHUS URTICAE, *NEOSEIULUS CALIFORNICUS*, PUBESCENCE, TOMATO, FECUNDITY, SURVIVAL.

SUMMARY : The objective of this study was to determine whether differences in tomato hairiness affect the developmental time, survival and fecundity of *Tetranychus urticae* Koch and *Neoseiulus californicus* (McGregor). Laboratory experiments were performed on two tomato hybrids with different density of glandular hairs. There were no significant differences in developmental time of immature stages and total preadult time of *T. urticae* and *N. californicus,* between hybrids. Survival of both immatures and adults *T. urticae* was not affected by tomato hairiness, but fecundity, although low in both hybrids, was significantly lower in the most pubescent hybrid. *Neoseiulus californicus* did not show any difference among hybrids in none of the life history traits studied. However, there was a trend towards reduced cohort survival when hairiness increased. Tomato plant seems to be a very poor resource for the performance of *T. urticae* and *N. californicus* compared to other horticultural crops. An antibiosis process due to glandular hairs could be, at least in part, the cause of this detrimental effect. Implications of these observations in the control of *T. urticae* on tomato are discussed.

Commercially grown tomato in the surrounding area of La Plata (Buenos Aires Province, Argentina) is subject to attack from numerous pests. The two-spotted spider mite, *Tetranychus urticae (*Koch), is the most serious one and it induces the frequent use of miticides, which do not provide an effective control. Spider mite biological control using predaceous mites such as *Phytoseiulus persimilis* Athias-Henriot*, Neoseiulus fallacis (Garman)* and *Neoseiulus californicus* (McGregor) has been investigated in many countries. Presently, this biological control is successfully implemented on several orchards and vegetable crops in greenhouses, especially with *P. persimilis,* in many places of the world (HELLE & SABELIS, 1985; SCOPES, 1985, NYROP *et al.*, 1998). The predator, *N. californicus*, is distributed in subtropical and temperate regions of South America, Southern California, Southern Europe, and Northern Africa. In La Plata area, it is the most widespread phytoseiid mite associated with spider mites. Studies carried out in strawberry (GRECO *et al.*, 1999) and apple orchards (MONETTI, 1994) indicate that this predator seems to be a promising natural enemy for controlling the two-spotted mite and red spider mite, respectively.

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However, the effectiveness of this natural enemy in tomato remains poorly understood.

Host plants can affect biological attributes of both, phytophagous and natural enemies, through direct and multitrophic effects (PRICE *et al.* 1980; WALDE, 1995; Barbosa & Letourneau, 1998) In this sense, the colonization of the host plant, fitness and effectiveness of natural enemies used in biological control can be positively or negatively influenced by the host plant of the target pest (OBRYCKI & TAUBER, 1984; FARRAR & KENNEDY, 1987; KAUFFMAN & KENNEDY, 1989; EIGENBRODE *et al.*, 1996; JOHNSON, 1997; BOTTRELL *et al.*, 1998). Tomato plant has a variety and quantity of hairs and glandular trichomes that secrete sticky substances (LUCKWILL, 1943). This kind of hairs and trichomes reduce the effectiveness of predators by inhibiting movement and disturbing the prey-predator interactions (PRICE *et al.*, 1980; KHAN *et al.*, 1986; COLL & RIDWAY, 1995; CORTESERO *et al.*, 2000; HADDAD & HICKZ, 2000; CLOYD & SADOF, 2000). BELCHER & THURSTON (1982) and OBRYCKI & TAUBER (1984) registered this effect in the coccinellid lady beetle on tobacco and in *Chrysopa* and several coccinellid species on potato, respectively. Previous studies on tomato indicated that hairiness prevents *N. californicus* from exhibiting a strong numerical response and the functional response is much lower than on other host plants and than for other phytoseiid species (CÉDOLA *et al.*, 2001).

The objective of this study was to determine the effect of tomato plant pubescence on developmental time, survival and fecundity of *T. urticae* and *N. californicus.*

MATERIAL & METHODS

Tetranychus urticae and *N. californicus* were collected in commercial strawberry greenhouses from La Plata area, in September 1998, and reared on tomato plants for several generations in an experimental greenhouse at CEPAVE. Developmental time, survival and fecundity of both species were estimated on two tomato hybrids with different density of glandular hairs: Parador (24 ± 4.8 hairs/20 mm^2) and Fortaleza (48 ± 8.2 hairs/20 mm^2). The number of glandular hairs /area was calculated by counting the number of hairs in the visual field of a stereo microscope (40X). The surface of the visual field is p r^2, where r was equal to 2.523 mm. The trials were conducted at 25 ± 1° C, 50 -75% RH, and 14:10 (L:D) h.

To determine the developmental time of immature stages of *T. urticae* and adult stages of *N. californicus*, two cohorts of 81 and 85 eggs of *T. urticae* and two of 65 and 60 eggs of *N. californicus* were placed (one egg/leaflet) on leaflets of Parador and Fortaleza, respectively. Change of developmental stages were determined through daily observations of moults to adult's emergence.

The effect of tomato pubescence on survival and fecundity was determined by placing 16 and 17 couples of *T. urticae* on leaflets of Parador and Fortaleza, respectively. For *N. californicus*, 16 couples were placed on leaflets of each hybrid with spider mites «*ad libitum*». Daily survival, oviposition rate, duration of preoviposition and oviposition periods, cohort longevity and total mean fecundity per female were computed. Food supply (tomato leaflets and spider mites) was provided when necessary.

Differences in developmental times, daily oviposition rates and total fecundity between hybrids, were examined using analysis of variance (ANOVA). Differences in survival curves between hybrids were compared with G test (SOKAL & ROHLF, 1995). In all statistical analysis significance level was set at P = 0.05.

RESULTS

Developmental time of immature and adult stages of *T. urticae* and *N. californicus* on both hybrids are summarized in TABLE 1. There were no significant differences in developmental time of immature and adult stages of *T. urticae* between hybrids. Duration of adult stage registered in the present study was similar to that reported by MESA *et al.* (1987).

Survival and duration of preoviposition and oviposition periods (TABLE 2) of *T. urticae* were not affected by differences in tomato pubescence (G= 2.28, df = 28, χ^2 = 41.34). The mean preoviposition period was 1.66 and 1.80 days on Parador and Fortaleza, respectively, and was similar to 1.16 days recor-

STAGE	*Parador*	*n*	*Fortaleza*	*n*	*F*	*df*	*P*
T. urticae							
Egg	*4.40 ± 0.51*	*81*	*4.40 ± 0.50*	*85*	*0.55*	*1,164*	*0.66*
Larva	1.05 ± 0.22	80	1.04 ± 0.21	83	0.49	1,161	0.58
Protochrysalis	0.9 ± 0.31	80	0.86 ± 0.33	83	1.22	1,161	0.35
Protonymph	1.95 ± 0.22	80	1.47 ± 0.50	83	2.13	1,161	0.13
Deutochrysalis	0.95 ± 0.22	80	1.04 ± 0.21	83	1.58	1,161	0.43
Deutonymph	1.4 ± 0.50	80	1.69 ± 0.47	83	0.98	1,161	0.88
Teliochrysalis	1.2 ± 0.41	80	1.13 ± 0.34	83	1.08	1,161	0.95
Total preadult	11.9 ± 0.64	11.8	± 0.72	0.65	1,161	0.76	0.76
Adult	20.6 ± 3.9	16	21.05 ± 4.1	17	0.49	1, 31	0.48
N. californicus							
Egg	1.96 ± 0.18	65	2.04 ± 0.2	60	1.13	1,123	0.62
Larva	0.92 ± 0.27	64	0.53 ± 0.5	53	12.56	1,115	0.26
Protonymph	1.23 ± 0.42	63	1.47 ± 0.51	48	2.87	1,109	0.47
Deutonymph	1.0	54	1.0	34			
Total preadult	5.11		5.04		1.26		0.54
Adult	14.00 ± 3.4	16	14.00 ± 3.4	16			

TABLE 1. Developmental time (mean ± SD) in days of immature and adult stages of *T. urticae* and *N. californicus* on Parador and Fortaleza hybrids.

ded by HELLE & SABELIS (1985) on cotton. Daily oviposition rates were significantly lower on the most hairy hybrid, Fortaleza (F=4.59, df=1,30, P=0.04) (FIG. 1a -1b) and the oviposition period was 2 days shorter than on Parador. The mean total fecundity per female was 23.3 ± 3.4 and 15.67 ± 2.3 eggs/female, on Parador and Fortaleza, respectively, and were also different between hybrids (F= 5.26, df= 1,30, P= 0.038). Cohort longevity was 28 days in both hybrids.

Period	Parador	Fortaleza	F	df	P
T. urticae					
Preoviposition	1.66 ± 0.5	1.8 ± 0.5	1.21	1,31	0.28
Oviposition	5.60 ± 3.2	5.3 ± 2.5	2.99	1,31	0.09
N. californicus					
Preoviposition	0.53 ± 0.5	0.31 ± 0.5	1.56	1,31	0.22
Oviposition	6.64 ± 1.17	6.73 ± 1.75	0.03	1,31	0.87

TABLE 2. Duration of preoviposition and oviposition periods of *T. urticae* and *N. californicus* on Parador and Fortaleza hybrids.

Developmental time of immature and adult stages of predator did not show any difference (TABLE 1) and were similar to those reported by MA & LAING (1973).

Although survival was not significantly different between hybrids (G=3.48, df=18, χ^2 =28.8), cohort survival exhibited a noticeable trend to decrease when hairiness increase (56% of the cohort reached the adult stage on Fortaleza compared to 82% on Parador). Duration of adult stages was approximately 14 ± 3.4 days on both hybrids. Preoviposition and oviposition period were not affected by hybrid pubescence and was shorter than that registered on other host plants (MA & LAING, 1973; HELLE & SABELIS, 1985). Daily oviposition rates of *N. californicus* were not different among hybrids (F= 0.031, df=1,15, P =0.22), the mean fecundity was 15.83 ± 2.1 and 14.65 ± 1.8 eggs/female, on Parador and Fortaleza, respectively and were not different (F=0.42, df= 1,15, P=0.67) (FIG.2 a -2 b). Cohort longevity was 19 days on both hybrids.

DISCUSSION

Tomato plant seems to be a very poor resource for the performance of both prey and predator. Fecundity was much lower than that registered by other authors in different crops (VAN DE VRIE *et al.,* 1972; HELLE & SABELIS, 1985). HELLE & SABELIS (1985) found that *T. urticae* females laid a total number of 103.3 eggs/female on cotyledons of cotton and VAN DE VRIE *et al.* (1972) found a range of 67 -111 eggs/

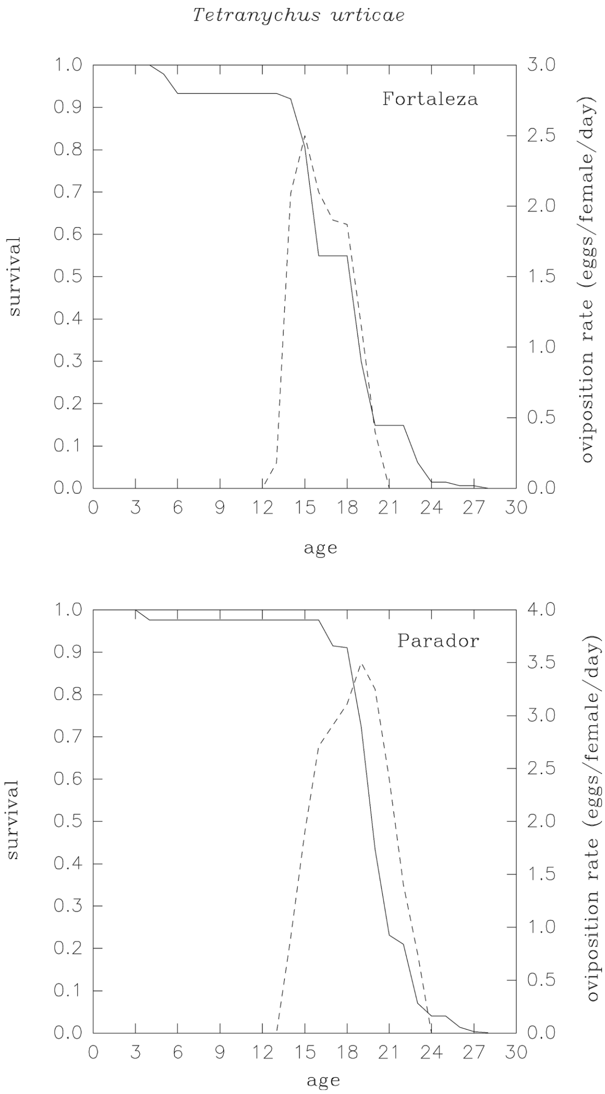

FIG. 1. — Survival and oviposition rate of *T. urticae* on the tomato hybrids Fortaleza (48 ± 8.2 hairs/20 mm^2) and Parador (24 ± 4.8 hairs/20 mm^2) Survival (——), oviposition rate (- - -)

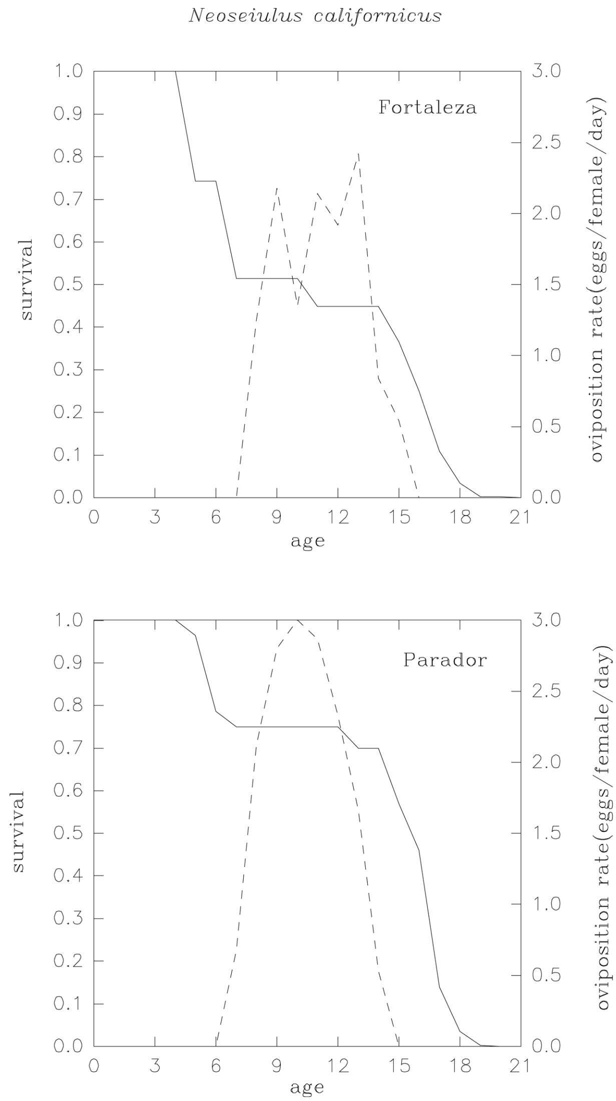

FIG. 2. — Survival and oviposition rate of *N. californicus* on the tomato hybrids Fortaleza (48 ± 8.2 hairs/20 mm^2) and Parador (24 ± 4.8 hairs/20 mm^2). Survival (———), oviposition rate (- - -)

female on different varieties of bean. In addition, MA & LAING (1973) found for *N. californicus* on artificial arenas, a mean fecundity of 43.3 eggs.

Positive effects of trichomes on the performance of phytoseiid mites have been reported by RODA *et al.* (2001). They found, under laboratory conditions, that apple leaves architecture influenced positively the behavior of *P. persimilis.* This predator oviposited more frequently on surfaces with trichomes, spider mites webbing or cotton fiber. In the present study, an antibiosis process due to glandular hairs could, at least in part, disturb the host plant utilization by the prey and limit prey feeding by the predator. Additional experiments showed that there is not an effective interaction between *T. urticae* and *N. californicus* in tomato (CÉDOLA *et al.*, 2001). Glandular trichomes secrete sticky substances that may inhibit movement or produce chemicals that are repellent or toxic to natural enemies (STONER *et al.*, 1969; RODRIGUEZ *et al.*, 1972; BOTTRELL *et al.,* 1998). Moreover, NIHOUL

(1993) found that abiotic factor such as light intensity, temperature and photoperiod affect the entrapment of mites on tomato glandular hairs.

The present study adds valuable information to the understanding of the life history of *T. urticae* and *N. californicus* in tomato and helps elucidate why phytoseiid mites have been successfully used to control *T. urticae* in other horticultural crops, but releases of phytoseiids have failed on tomatoes (SCOPES, 1985; GILLESPIE & QUIRING, 1994; MANZAROLI & BENUZZI, 1995).

Since pubescence is a characteristic that varies in commercial tomato hybrids, the use of more pubescent hybrids could be a cultural practice to diminish *T. urticae* damage. However, more information is needed to know how this trait could affect the effectiveness of natural enemies of other pests of this crop, such as *Tuta absoluta* (Meyrick) (Gelechiidae) and *Trialeurodes vaporariorum* (Westwood) (Aleyrodidae).

Tritrophic interactions often involve complex interactions that should be well understood before implementing pest control strategies**.**

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