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DEMOGRAPHIC PARAMETERS OF *TETRANYCHUS URTICAE* (ACARI: TETRANYCHIDAE) ON FOUR *ROSA* SP. CULTIVARS

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Abstract

The goal of this work was to determine the life parameters of *Tetranychus urticae* Koch on leaves of 4 rose (*Rosa* sp.) cultivars. To conduct this experiment a colony of *T. urticae* collected from ornamentals grown at Saltillo, Coahuila, Mexico, was established on bean (*Phaseouls vulgaris* L.) seedlings inside a Biotronette chamber at 25 ± 2 °C, 60-70 RH and 12:12 h L:D. According to the experimental design, 100 one-day old recently mated and fertilized females were transferred to 2.5 cm diam rose (*Rosa* sp. L.) leaf discs from 'Emma', 'Luna', 'Gran Gala' and 'Virginia' cultivars in such a way that every experimental unit included 1 female per disc. The latter were maintained at the above temperature, RH and photoperiod conditions. Demographic parameters in this experiment showed greater growth potential of this pest on the 'Luna' and 'Gran Gala' cultivars than on 'Virginia' and 'Emma'.

Key Words: rose cultivars, demographic parameters, two-spotted spider mite, r_m

Resumen

Se determinaron parámetros de vida de *Tetranychus urticae* Koch en hojas de las variedades de rosal Luna, Gran Gala, Virginia y Emma. Se estableció una colonia de *T. urticae* en recolectas de cultivos ornamentales de Saltillo, Coahuila, México, en plántulas de frijol (*Phaseolus vulgaris* L.) en una cámara ambiental Biotronette® con condiciones de 25 ± 2 °C, 60-70 HR y fotoperiodo 12:12 horas luz oscuridad. Para el desarrollo del experimento se seleccionaron 100 hembras de un día de edad recién apareadas y fecundadas, se colocaron en forma individual en discos de hojas de 2.5 cm de diámetro de rosal, de tal forma que cada unidad experimental consistió en una hembra por disco y se mantuvieron a las mismas condiciones de temperatura, humedad y fotoperiodo. Los parámetros poblacionales muestran de manera general un mayor potencial de crecimiento en las variedades 'Luna', 'Gran Gala' seguidas de 'Virginia' y 'Emma'.

Palabras Clave: variedades de rosas, parámetros poblacionales, arañita de dos manchas, r_m

The two-spotted spider mite *Tetranychus urticae* Koch (Trombidiformes: Tetranychidae) is the main pest of greenhouse roses (*Rosa* sp. L.; Rosales: Rosaceae) (Van de Vrie 1985), a highly significant crop in Mexico. The detrimental effects of this pest include significant reductions in photosynthesis, stomatal conductance, transpiration and chlorophyll content (Fikru & Higley 2003; Jeppson et al. 1975). Population densities of 10 to 50 mites per leaf cause a 6 to 10% reduction in length of flower buds, compared with the control (Landeros et al. 2004). At present *T. urticae* on ornamental crops is primarily controlled by chemicals (Takematsu et al. 1994), but such control is becoming progressively more difficult because of rapidly developing miticide-resistance (Stumpf & Nauen 2002). *Tetranychus urticae* resistance to pesticides has been globally demonstrated with over 200 reported cases (Konanz & Nauen 2004). A tool for the control of pests is the use of resistant cultivars, and this tool is being used effectively in protecting many crop species (Flexner et al. 1995). Pest-resistant cultivars are a good way to improve production, minimize plant damage, improve crop quality, apply less pesticides, and decrease costs (Bustamante & Patiño 2001). Plant resistance to pests can be caused by antixenosis, antibiosis, tolerance or some combinations of these mechanisms (Smith 2005). Antibiosis has a direct influence on the life history of a pest, and thus comparison of biological parameters of a pest species reproducing and developing on different plants of a given species can be used to select resistant varieties to a pest (Li et al. 2004). The goal of this study was to assess the demographic parameters of the two-spotted spider mite, *T. ur-*

ticae, on 4 rose cultivars, i:e., 'Gran Gala', 'Luna', 'Virginia' and 'Emma' in order to determine the extent to which each of these cultivars fosters the development of this pest.

Materials and Methods

Specimens of *T. urticae* were collected from ornamentals grown at Saltillo Coahuila, Mexico to establish a mother colony (stock colony) on bean (*Phaseolus vulgaris* L.; Fabales: Fabaceae) leaves inside a Biotronette environmental chamber at 25 ± 2 °C, 60-70 RH and 12:12 h L:D.

The Abbott-Setta & Childers (1987) technique was used to handle the biological material. This technique is also known as the arena-leaf technique. Thus female mites–after they had been collected by a suction tube from leaves of each rose cultivar–were transferred to circular leaf discs (2.5 cm diam) using a 000 camel's hair brush. The discs were placed up-side down on plastic trays lined with water-saturated cotton.

In order to determine the demographic parameters of *T. urticae*, 25 females were placed for egg laying on such leaf discs of the 4 cultivars during 24 h, then the females were separated, leaving the eggs behind. Eggs deposited on these discs were held in environmental chambers. After these eggs had hatched and the immature progeny had emerged as adults, 100 of the 1-day-old adult females, recently mated, were individually placed on a leaf disc of each rose cultivar. These mated females were kept under the same environmental conditions as the mother colony, and 1 female per disc was an experimental unit. Eggs deposited by these females were maintained on the same leaf disc until emergence of the larvae, which were then placed singly on another in leaf disc. From this point on daily survival and oviposition of adult females were recorded until the last female died. Demographic calculations based on Birch's model (1948) were made and the Jacknife method was used to estimate standard deviations with a confidence interval of 95%.

Results and Discussion

Survival and Fertility

Survival rates of *T. urticae* on the 4 rose cultivars (Fig. 1) were not significantly different from each other (log-rank test $P \leq 0.05$), and the range of live females in the 4 treatments ended in a similar way. However at 13-19 days of age, a larger fraction of *T. urticae* females remained alive on the 'Virginia' discs.

The fertility rate per specific age of *T. urticae* on 'Virginia' (Fig. 2) tended to be the lowest by far, followed by that on 'Emma', while those on 'Gran Gala' and especially 'Luna' produced much larger numbers of female offspring. According to Tukey's test, the differences were significant between 'Virginia' and the other 3 cultivars in terms numbers of daughters per mother.

Demographic Parameters

Regarding the gross reproductive rate (GRR) or total number of *T. urticae* females produced per mother at all ages, the highest value (78.33)

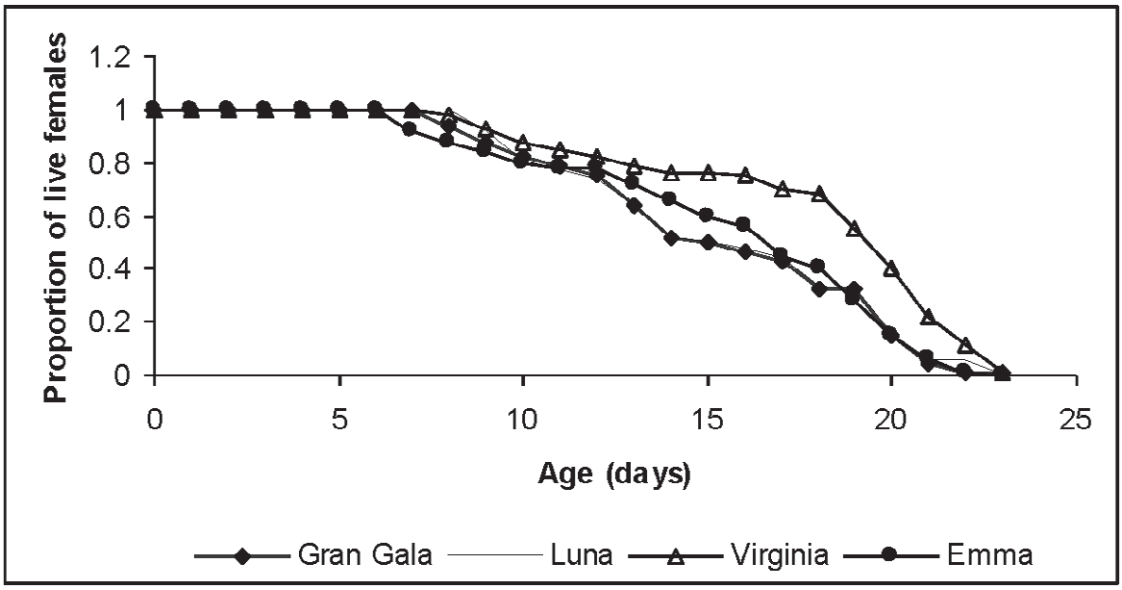

Fig. 1. Survivorship curves for *Tetranychus urticae* Koch on four rose (*Rosa* sp.) cultivars, i:e., 'Gran Gala', 'Luna', 'Virginia' and 'Emma'.

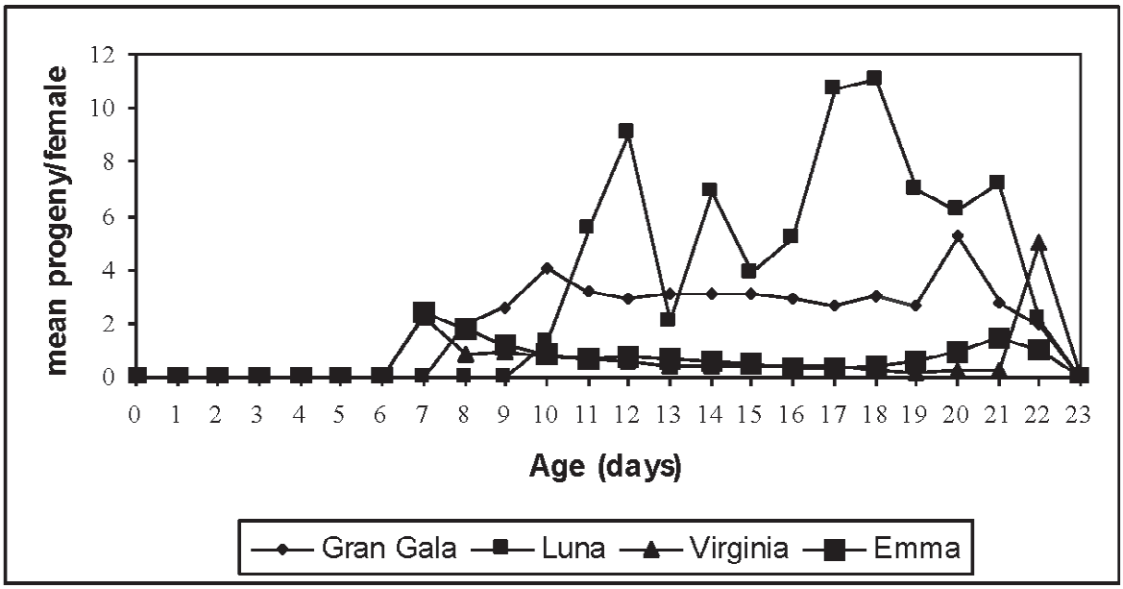

Fig. 2. Age-specific fecundity of *Tetranychus urticae* Koch on four rose (*Rosa* sp.) cultivars, i:e., 'Gran Gala', 'Luna', 'Virginia' and 'Emma'.

was recorded on 'Luna' followed by those on 'Gran Gala' (45.43),' Emma' (18.64) and 'Virginia' (10.44) (Table 1). The GRR values of *T. urticae* obtained from the present research work clearly indicate differences in reproductive performance of *T. urticae* on the 4 rose cultivars, but these values were lower than that reported by Maggi & Leight (1983) with a GRR of 91.26 on cotton (*Gossypium hirsutum* L.; Malvales: Malvaceae) leaves. On the other hand, Flores et al. (2000) reported a GRR of 218.22 on bean leaf discs, while Sáenz de Cabezón et al. (2006) reported a GRR of 85.88 for *T. urticae* also on bean leaf discs.

With regards to the net reproduction rate (Ro) (average number of daughters that a female produces during her lifetime), the largest number of *T. urticae* daughters/mother in one generation were registered on 'Luna' (33.46), followed by 'Gran Gala' (22.57), 'Emma' (8.78) and 'Virginia' (7.60). These values represent reductions in Ro of *T. urticae* of 32.54, 73.75 and 77.26% on these 3 cultivars, respectively, versus the 'Luna' cultivar (Table 1). Thus, 'Emma' and 'Virginia' allowed much slower *T. urticae* population development than 'Luna' and 'Gran Gala'; and these results show that 'Luna' is the most susceptible cultivar. Also for *T. urticae* Marcic (2007) reported a Ro value of 28.92 on bean leaf discs, Grissa-Lebdi et al. (2002) registered a Ro value of 19.2 on apple (*Malus domestica* Borkh.; Rosales: Rosaceae) leaf discs and Bounfour & Tanigoshi (2001) found a Ro value of 54.86 at 25 °C on raspberry (*Rubus idaeus* L.; Rosales: Rosaceae) leaves.

TABLE 1. POPULATION PARAMETERS OF *TETRANYCHUS URTICAE* ON LEAF DISCS OF FOUR ROSE CULTIVARS: 'LUNA', 'GRAN GALA', 'VIRGINIA' AND 'EMMA'.

	Cultivars			
Population Parameter	'Luna'	'Gran Gala'	'Virginia'	'Emma'
Gross Reproductive Rate (GRR)	78.33	45.43	10.44	18.64
Net Reproductive Rate (R_o)	33.46 ± 15.72*	22.57 ± 8.34*	7.60 ± 4.02*	8.78 ± 4.51*
Intrinsic Growth Rate (r_m)	0.255 ± 0.058*	0.272 ± 0.061*	0.216 ± 0.112*	0.234 ± 0.108*
Finite Growth Rate (λ)	1.292	1.313	1.241	1.263
Cohort Duration (days) (T_C)	14.74	12.75	10.43	10.415
Growth Capacity (r_c)	0.238	0.224	0.194	0.205
Generation Time (days) (T_G)	13.72	11.45	9.39	9.29
Population Doubling Time (days) (T_2)	2.71	2.55	3.21	2.29

* Standard error by the Jacknife method at a confidence interval of 95%

Values of the reproductive capacity of the *T. urticae* population (intrinsic growth rate, rm), i.e., rate at which the population increases in the absence of density-dependent forces (Table 1) indicated that 'Gran Gala' (0.272) allowed the greatest population increase rate of *T. urticae* and is most susceptible to this pest, followed by the intrinsic growth rate on 'Luna', (0.2550), 'Emma' (0.2338) and 'Virginia' (0.2160). Even though there is no statistical difference between these values (Tukey's $P = 0.05$), these values represent a reduction in the multiplying capacity of *T. urticae* by 6.32, 14.11 and 20.65% on these respective cultivars in comparison to 'Gran Gala'. These results coincide with values ranging from 0.220 to 0.340 commonly reported by Sabelis (1991). Skorupska (1998) reported the rm values of 2 *Tetranychus* species on 5 apple cultivars, which ranged from 0.084 to 0.113, while Kheradpir et al. (2007) reported rm values of *T. urticae* on 5 different cultivars of *Cucumis sativus* L. (Cucurbitales: Cucurbitaceae) ranging from 0.254 to 0.313. These authors stated that different rm values depended mainly on the host and the temperature. This last factor is important; Bountour & Tanigoshi (2001) recorded rm values on *T. urticae* rm values of 0.084 at 15 °C, and 0.321 at 30 °C.

Regarding the mean time between generations (T_G), a higher value of 13.72 days—with a daily population increase of 1.29—was recorded for 'Luna', followed by progressively shorter times on 'Gran Gala', 'Virginia' and 'Emma' (Table 1). These results imply a greater damage potential in 'Luna' cultivar, as compared with the other 3 cultivars. These results are lower than to those reported by Grissa-Labdi et al. (2002) on apple leaves. These workers recorded a T_G of 19.7 days and a daily growth factor of 1.16, whereas Wermelinger et al. (1991) recorded a generation time of 15.4 days. Lastly, the doubling times (T2) of *T. urticae* population in 'Virginia', 'Emma', 'Luna' and 'Gran Gala' were 3.20, 2.29, 2.70 and 2.54 days, respectively (Table 1). These results represent reductions of 28.4, 15.6 and 20.6 % in time needed by *T. urticae* develop on 'Emma', 'Luna', and 'Gran Gala', as compared with 'Virginia'. 'Virginia' presented greatest resistance to the demographic development of *T. urticae*, followed by 'Emma', 'Gran Gala' and 'Luna'.

Endnote

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