Population Growth of Tomato Russet Mite, *Aculops lycopersici* (Acari: Eriophyidae) and Its Injury Effect on the Growth of Tomato Plants

Mohd. Mainul HAQUE and Akira KAWAI

*National Institute of Vegetables and Tea Science, National Agricultural Research Organization, Ano, Mie 514–2392, Japan*

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**ABSTRACT**

The population growth of the tomato russet mite, *Aculops lycopersici* (Massee), and its effect on tomato plants were studied in glasshouses. The population increased exponentially for six weeks after infestation. The intrinsic rate of natural increase was estimated to be 0.175 per day. At seven weeks after infestation, the predator, *Homeopronematus anconai* (Baker) (Acari: Tydeidae), appeared on several plants. The population of *A. lycopersici* decreased rapidly on plants where the predator appeared, due to predation. But it decreased gradually on plants where the predator did not appear, because of the damage to the host plant caused by the mites. More than 70% of the population infested the leaves. *A. lycopersici* first reproduced on the released leaves then moved upward. The infestation caused great injury to the plants, with a large number of leaves turning brown and then drying up. The number of leaves, the plant height and the diameter of the main stem of the plants all decreased.

Key words: *Aculops lycopersici*, population growth, tomato, injury, *Homeopronematus anconai*, natural enemy

**INTRODUCTION**

The tomato russet mite, *Aculops lycopersici* (Massee) is an important pest of tomato, *Lycopersicon esculentum* Mill., first described by Massee (1937) in Australia but now cosmopolitan (Perring and Farrar, 1986). It was first found in Japan in 1986 (Nemoto, 1991) where it has since become a serious pest (Nemoto, 2000).

Ramalho (1978) observed that the *A. lycopersici* population increased gradually, peaked when the plants were 82 days old, and declined thereafter in an open field. He also stated that mites were distributed all over the plant. But a detailed study on the population growth and distribution of *A. lycopersici* on tomato plants is lacking.

*A. lycopersici* causes great damage to tomato plants. It destroys the epidermal cells of the leaflet, resulting in a curling of the leaflet edges, a rusting of damaged tissue, desiccation, and plant death (Keifer et al., 1982; Royalty and Perring, 1988). However, the effect of this pest in relation to its population growth is as yet unclear.

The present study was designed to examine the population growth of *A. lycopersici* on tomatoes in glasshouses and its injury effect on the growth of the plants.

**MATERIALS AND METHODS**

*Tomato Plants.* Seven-week-old tomato seedlings (cultivar ‘House Momotaro’) were

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1Present address: Department of Zoology, Rajshahi University, Rajshahi 6205, Bangladesh
transplanted on 23 May 2000 in two glasshouses of the National Institute of Vegetables and Tea Science (NIVTS), Ano, Mie, Japan. Forty seedlings were planted in two ridges in each glasshouse (9.75 m$^2$). Each ridge had two rows separated by a distance of 50 cm and the seedlings were planted at intervals of 35 cm along each row. All lateral buds and flowers of the plants were removed.

The plants were cultivated without heating. The side windows and top ventilator were covered with stainless steel netting whose mesh was 1 mm, and opened automatically when the temperature in the glasshouse exceeded 25°C. The temperature and humidity in the glasshouse were not measured.

*Infestation.* At one week after transplantation (May 30), *A. lycopersici* were released onto the plants in one glasshouse. In the other glasshouse no infestation was made. The mites used were collected in Mie Pref. in November 1999 and then cultured on potted plants at 25±5°C in the laboratory of NIVTS. On each plant, a known number of mites (102.8±6.7 adults and 27.2±4.2 nymphs, x±S.D.) were released on the fourth and fifth leaves. The infestation was achieved by attaching an infested leaflet to the tomato leaf using fine adhesive tape.

*Counting.* Counts were made every week after the infestation. Counting for *A. lycopersici* was done only at the adult stage. When other insect pests and natural enemies were found, species names were recorded but the number was not. Five plants were removed every week for counting from both houses, but only four plants were obtained in the eighth week from the infested house due to the death of one plant. The total number of mites was counted until the second week after infestation. But from the third week, since the population became too high, a sampling method was adapted (Fig. 1). In the case of the leaflets, the second and third leaflets of each leaf were used for counting. The percentage of the population on the

![Fig. 1. Sampling method for the population on leaf. Only the population on black parts was counted and total population was estimated. Numerals show the leaflet position in leaf. See the text for the details.](image)
Population growth of *Aculops lycopersici* on tomato is definite (Kawai and Haque, unpublished). The mid-veins of leaves were divided into three parts and a 2-cm length of each part was used for counting. For stems, the sample was also cut into pieces taking three inter-nodes in each piece and the mite population was counted on a 2-cm length from each.

The total population on the whole leaf is estimated as

\[ N_t = \sum_{n=1}^{3} \left( N_n \times L_n / 2 \right) + (N_{L2} + N_{L3}) / a \]

where \( N_t \) is the total population on the whole leaf, \( N_n \) is the number on the central two cm of each piece of petiole, \( L_n \) is the length of each piece of petiole, \( N_{L2} \) and \( N_{L3} \) are the numbers on the second and third leaflets and \( a \) is the percentage of mites on the second and the third leaflets relative to the number on all leaflets (0.470 for adult and 0.465 for nymph) (Kawai and Haque, unpublished).

**Chemicals.** When any *A. lycopersici* population was observed in uninfested plants (at one and five weeks after infestation) acaricide (Chinomethionat, ×2000) was sprayed. No other chemical was applied during the seedling and experimental period.

**Physical characteristics of tomato plants.** The total number of leaves, the height and the diameter of the stem of infested and uninfested plants were measured every week starting from May 29. Diameter was measured at three places, viz., at the fifth, tenth and 15th inter-nodes. The number of brown leaves (when five leaflets of a leaf turned brown, the leaf was considered brown) and dried leaves (when the leaflets were about to fall off, it was considered a dried leaf) were also recorded. The data of plants on which predators appeared was excluded from the calculation.

**RESULTS**

The population fluctuation in the adult *A. lycopersici* is shown in Fig. 2. The population increased exponentially and peaked (187,286 per plant) at six weeks after infestation, then started to decrease. The change in population density during the six weeks after infestation fitted well to the equation \( N_t = 0.175t + 0.495 \) (\( r = 0.964, P < 0.01 \)) (\( t \): days after release, \( N_t \): population density at day \( t \)). A tendency toward an increase was shown by the equation of exponential growth (\( N_t = No \times e^{rt} \), \( e \): base of natural logarithm, \( r \): intrinsic rate of natural increase, \( No \): population density at day 0) and the intrinsic rate of natural increase per day was estimated as 0.175. The greenhouse whitefly, *Trialeulodes vaporariorum* (Westwood) and the green peach aphid, *Myzus persicae* (Sulzter) were found from the second to fourth week but the density is very low. From the seventh week, the predator, *Homeoprnonematus anconai* (Baker) (Acari: Tydeidae) naturally appeared on several plants. In the seventh and eighth weeks, it appeared on three of the five plants and two of the four plants, respectively. The population density of *H. anconai* was not measured exactly, but more than 2,000 individuals were found on the leaf with the highest number in the eighth week. The population of *A. lycopersici* on the plants without predators decreased gradually because of the damage to the host plant caused by the attack. It decreased rapidly in the plants where predators appeared. At one and two weeks after the appearance of the predator, the densities of *A. lycopersici* were 5.3% and 1.7% of that without predators, respectively. Few other natural enemies were found during the experimental period.
The number of adult *A. lycopersici* on the stem as a percentage of the total population on the plant is shown in Fig. 3. It increased gradually until the fourth week and then decreased, and was always less than 30%. The greater part of the population always infested the leaves.

The vertical distribution of adult *A. lycopersici* on leaves and stems is shown in Fig. 4. On
leaves (Fig. 4A), until two weeks after infestation, more than 80% of the population were found on the fourth and fifth leaves, where the mites were released. At three weeks after infestation, the percentage was highest on the fifth leaf, but that on the fourth and fifth leaves was only 36%. At four weeks after infestation, the population was greatest on the seventh to tenth leaves. Then the part with the highest percentage moved up the plant. At six and eight weeks after infestation, the population was greatest on the 13th to 19th and the 24th to 29th leaves, respectively. *A. lycopersici* first reproduced on the infested leaf and then moved upward. The leaves with the highest density were in the middle part of the plant and the leaves in the apical parts had a low density population. On the stem (Fig. 4B), at one week after infestation, about half of the population was found 10 to 20 cm from the bottom and this position was near where the mites were released. Until four weeks after infestation, the position with the largest population moved upward and the distribution tended to be

![Vertical distribution of adult *A. lycopersici* infested on leaves (A) and on stems (B). Arrows indicate the released leaves. Values for all plants were calculated collectively.](image)

Fig. 4.
uniform. From five to seven weeks after infestation, the population on the apical part of the stem increased. At eight weeks after infestation, *A. lycopersici* were again distributed from the middle to the apical part of the stem.

The physical characteristics of infested and uninfested plants are compared in Fig. 5. From one week after infestation, the plant height was significantly shorter than that of uninfested one and the difference became larger as the *A. lycopersici* population increased (Fig. 5A). The total number of leaves on infested plants was smaller and differed significantly at one and two weeks after release and again at six and seven weeks after release (Fig. 5B). Large populations of *A. lycopersici* also affected the thickness of the main stem. At the fifth inter-node, the thickness of the stem differed significantly at only two and three weeks after infestation (Fig. 5C). But at the tenth inter-node, it differed significantly at two weeks and again at seven and eight weeks after infestation (Fig. 5D). At the 15th inter-node, it differed significantly at three weeks and again from six to eight weeks after infestation (Fig. 5E).

The changes in the numbers of healthy, brown and dried leaves are shown in Fig. 6. Browning and drying of leaves were observed from four and five weeks after release, respectively. At seven and eight weeks after release, 58 and 79% of the leaves were dried up in infested plants, respectively. But in the uninfested plants, only 3 and 4% of leaves turned brown and dried up due to aging in the same time frame. The number of healthy leaves on infested plants was smaller than that on uninfested plants, and the difference became larger as the *A. lycopersici* population on infested plants increased. At eight weeks after release, infested plants had only 4.8 healthy leaves, while uninfested ones had 34.8 healthy leaves.

**DISCUSSION**

The *A. lycopersici* population increased exponentially during the six weeks after infestation (Fig. 2). Ramalho (1978) also reported an exponential increase in *A. lycopersici* on tomatoes in an open field. The intrinsic rate of natural increase calculated from his data (0.175) was the same as the value obtained in this study, but the maximum density (3,400 per leaf) in the field was much lower than in the greenhouse. In the greenhouse, a smaller effect of physical and biological restrictions on the insect population, a more suitable temperature and humidity for insect reproduction, and the amount of food provided by rapid plant growth would explain the greater maximum density than in the field. The intrinsic rate of natural increase of *A. lycopersici* obtained in the greenhouse (0.175) is much higher than that of *T. vaporariorum* (0.048–0.092) (Naba et al., 1978; Yamada et al., 1979) or of *T. palmi* (0.05) (Kawai, 1983). From this rate, it is estimated that the population of *A. lycopersici* can increase 191 times in 30 days and 36,316 times in 60 days.

Bailey and Keifer (1943) observed that infestations of *A. lycopersici* in home grown tomatoes were reduced by predation of the mite, possibly by *Seiuls* sp. Osman and Zaki (1986) showed the voracity of *Agistemus exsertus* against *A. lycopersici* and suggested it to be a good bio-control agent. Hessein and Perring (1986) showed that the population density of *A. lycopersici* on potted tomato plants with *H. anconai* was significantly lower than that without *H. anconai*. In the present study, the population of *A. lycopersici* in the greenhouse was well controlled by *H. anconai*. The population density of *A. lycopersici* was less than
Fig. 5. Comparison of physical characteristics between infested (filled circle) and uninfested (open circle) plants. (A) plant height, (B) total number of leaves, and diameter of the main stem at the (C) fifth inter-node, (D) tenth inter-node, (E) 15th inter-node. *, significant difference at the 5% level by $t$ test; **, significant difference at the 1% level by $t$ test.
2% of the control value (Fig. 2). *H. anconai* is a possible biological agent against *A. lycopersici*. But before the application of this predator, more experiments on its efficiency are essential.

The number of adults on stems as a percentage of the total population increased until the fourth week and then decreased (Fig. 3). Since during the two weeks after infestation more than 80% of *A. lycopersici* reproduced on the released leaves (Fig. 4A), these leaves deteriorated because of the infestation of *A. lycopersici*. The increase in this percentage on the stems would be due to movement from the damaged leaves to the stem which is soft and fit for feeding and reproduction. As the plants grow older, the percentage on the stem decreases again. This would be due to the movement of *A. lycopersici* from the stem to the soft leaves at apical parts. This showed that *A. lycopersici* does not move unless the condition of the leaf is poor.

Fig. 6. Number of dried (filled box), brown (striped box) and healthy (open box) leaves on infested (A) and uninfested (B) plants.
A heavy infestation of *A. lycopersici* affects plant height, the number of leaves and the diameter of the stem in plants (Fig. 5). For several weeks after infestation, the growth of the plant would be suppressed by the damage to released leaves. However, when most of *A. lycopersici* moved to the stem, the upper leaves grew vigorously and no significant difference in physical character could be found between infested and uninfested plants. From six weeks after infestation, since *A. lycopersici* reproduced on upper leaves and the population density per plant was high, the growth of plant would again be suppressed by the injury.

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REFERENCES


摘　要

トマトにおけるトマトサビダニ *Aculops lycopersici* の個体群増殖とトマトへの被害 Mohd. Mainul HAQUE・河合 章（野菜茶業研究所）

トマトサビダニの個体群増殖とトマトに及ぼす被害を施設トマトで調べた。放飼 6 週間にわたり個体数は指数的に増加し、内的自然増加率は日当たり 0.175 と推定された。放飼 7 週間後に一部の株で捕食性ダニ *Homeopronematus anconai* が見いだされ、捕食性ダニの見られなかった株では個体数は急激に減少した。これに対し、捕食性ダニの見られなかった株では寄生による株の劣化により、個体数は徐々に減少した。全個体数の 70%以上は葉に寄生していた。トマトサビダニは始めは放飼葉で増殖し、その後株の上部へ移動した。寄生により多くの葉が褐変・枯死するとともに、葉数・草丈・茎径が有意に減少した。