

# WITHIN-TREE DISTRIBUTION OF SPIDER MITES (ACARI : TETRANYCHIDAE) IN SPRAYED APPLE TREES OF ORCHARDS IN BUENOS AIRES PROVINCE, ARGENTINA

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TETRANYCHIDAE  
*PANONYCHUS ULMI*  
*TETRANYCHUS URTICAE*  
WITHIN-TREE DISTRIBUTION  
APPLE ORCHARDS

**ABSTRACT :** The distribution of Tetranychid mite populations within three varieties of apple trees, and their preferences for the infestation of certain kinds of leaves were analyzed, in a chemically-treated commercial apple orchard, with terrestrial flood irrigation. The tetranychids do not present marked preferences for certain kinds of leaves in spring, but they preferably infest middle-sized leaves in summer. In this temperate climate apple orchard, the phytophages have an homogeneous distribution within-trees, in spite of variety, architecture and age of trees. There are no microclimatic ranges or favorable sections for the development of tetranychid mites, so sampling by random selection of leaves from any section of a tree could be carried out.

TETRANYCHIDAE  
*PANONYCHUS ULMI*  
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DISTRIBUTION DANS L'ARBRE  
VERGERS DE POMMIERS

**RÉSUMÉ :** La répartition des populations de tétranyques à l'intérieur du feuillage de 3 variétés de pommiers, ainsi que leur préférence pour certains types de feuilles, ont été analysées dans un verger commercial traité chimiquement et irrigué. Les tétranyques ne semblent pas sensibles au type de feuilles, au printemps, mais préfèrent les feuilles de taille moyenne en été.

Dans un tel verger irrigué et soumis à climat tempéré humide, les phytophages se répartissent de façon homogène dans le feuillage, indépendamment de la variété, de l'architecture ou de l'âge des arbres. Il n'y a pas de gradient microclimatique ou de section plus favorable au développement des tétranyques, si bien que l'échantillonnage des feuilles peut être pratiqué au hasard dans n'importe quelle section de l'arbre.

## INTRODUCTION

There are different agents that can affect the distribution of phytophages within host plants, such age of trees, their architecture, the microclimatic ranges inside them, and the irrigation system of the orchard. In spite of them, there has been no research in Argentina related to these subjects up to now; most of the studies being principally systematic (ROSSI DE SIMONS, 1961, 1966 and 1978).

In the present paper, our objective was to analyze

the distribution of phytophagous within three varieties of apple trees, as well as the preferences for infestation of certain kinds of leaves, in a chemically treated orchard with terrestrial flood irrigation.

## MATERIALS AND METHODS

Samples were taken from a chemically-treated apple orchard, infested by *Tetranychus urticae*

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| Var. | Season | Tree Section |              |              |              |              |
|------|--------|--------------|--------------|--------------|--------------|--------------|
|      |        | 1            | 2            | 3            | 4            | 5            |
| GS   | Spring | 1.28 ± 0.7*  | 1.72 ± 1.5   | 1.33 ± 0.7   | 1.00 ± 0     | 1.16 ± 0.4   |
|      | Summer | 3.83 ± 5.5*  | 2.71 ± 1.5   | 1.72 ± 0.8   | 1.55 ± 1     | 2.44 ± 2.7   |
| RD   | Spring | 1.67 ± 1.1*  | 1.59 ± 1.5   | 2.10 ± 1.5   | 3.76 ± 5.9   | 1.91 ± 1.1   |
|      | Summer | 4.06 ± 4.8*  | 4.28 ± 4.5   | 6.25 ± 8.4   | 6.83 ± 8.4   | 3.47 ± 3.5   |
| SP   | Spring | 1.87 ± 1.9*  | 1.61 ± 0.8   | 1.25 ± 0.4   | 2.13 ± 2.1   | 1.56 ± 0.7   |
|      | Summer | 16.27 ± 19*  | 14.81 ± 14.1 | 14.96 ± 16.1 | 14.36 ± 18.3 | 11.64 ± 15.1 |

TABLE 1 : Tetranychidae mean densities per leaf in each delimited section of 'Granny Smith' (GS), 'Red Delicious' (RD) and 'Spur Red Delicious' (SP) apple trees. Means with asterisk are not significantly different compared within a row (ANOVA ;  $p < 0.05$ ).

Koch and *Panonychus ulmi* (Koch). Five trees of each variety were chosen : 'Red Delicious' (RD), 'Spur Red Delicious' (SP) and 'Granny Smith' (GS). The phytosanitary treatment involved organophosphorus insecticides, carbamated acaricides, ftalamid and carbamated fungicides and helping substances.

Following AMANO and CHANT (1990), each tree was divided in sections, along a vertical cross section from southwest to northeast. We divided the trees in 5 sections, four lateral and one central (Fig. 1). Samples consisted of fifteen apples leaves collected from each tree section. They were taken monthly from September 1991 to April 1992. Direct counting method was used to determine tetranychid abundances (SABELIS, 1985).

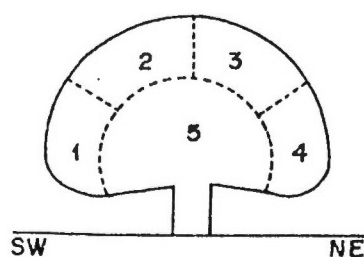


FIG. 1 : Delimited sections in the studied apple trees.

The area of infested leaves was measured by means of a polar planimeter. Subsequently, they were grouped in three types : small sized, type 1 (0-25 cm<sup>2</sup>), medium sized, type 2 (25-50 cm<sup>2</sup>) and large sized, type 3 (50-75 cm<sup>2</sup>).

In order to specify the availability of leaves, 10 branches of 30-40 cm were collected throughout

spring and summer, and the leaf areas measured and grouped in the same way as the infested leaves.

ANOVA was used to determine within-tree distribution of phytophages, by means of the BMDP program (ENGELMAN *et al.*, 1979).

## RESULTS

Average densities of Tetranychidae per leaf were always higher in summer than in spring. However, the densities remained homogeneous between sections.

ANOVA between the five delimited sections showed that there were no significant differences in densities of phytophages between them. This is true not only for spring ( $F_{RD} = 1.34$ ,  $df = 70$  ;  $F_{SP} = 1.16$ ,  $df = 93$ ), but also for summer ( $F_{RD} = 1.29$ ,  $df = 133$  ;  $F_{SP} = 1.0$ ,  $df = 524$  ;  $F_{GS} = 1.05$ ,  $df = 44$  ;  $p < 0.05$ ). Although the differences in GS were significant, they were not considered because of the low number of observations ( $F_{GS} = 3.71$ ,  $df = 41$ ) (Table I).

Infested leaf areas were analyzed for spring and summer (Table 2). Comparing the average densities of Tetranychidae in the spring between type 1 sized leaves and type 2 sized leaves, there were no significant differences ( $t_{RD} = 0.52$ ,  $df = 73$  ;  $t_{SP} = 1.31$ ,  $df = 98$  ;  $t_{GS} = 1.01$ ,  $df = 47$  ;  $p < 0.05$ ). Infested leaves of type 1 were more common, and type 3 leaves did not appear (Fig. 2).

However, in summer the differences between average tetranychid densities on 1 and 2 leaves types were significant ( $RD F = 10.81$ ,  $df = 134$  ;  $F_{SP} = 5.20$ ,  $df = 529$  ;  $p < 0.05$ ). These results

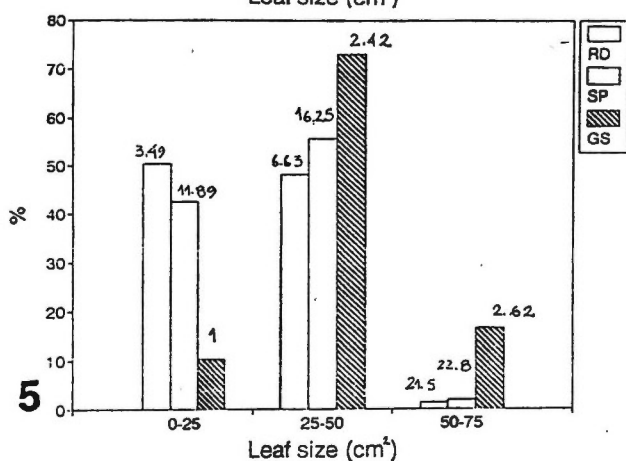
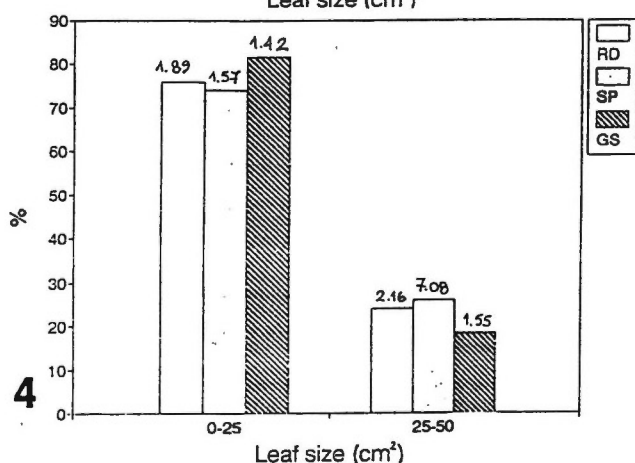
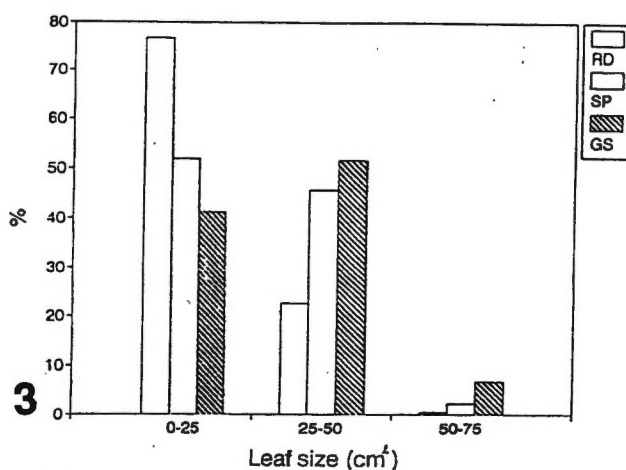
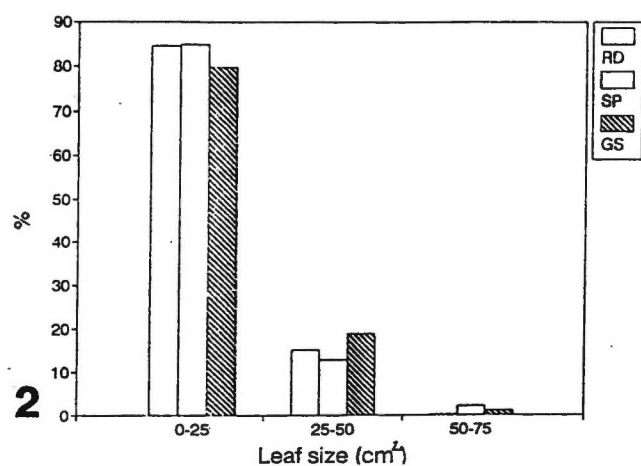


FIG. 2 : Percentage of infested leaves in each leaf-size category, during spring.

FIG. 3 : Percentage of infested leaves in each leaf-size category, during summer.

FIG. 4 : Percentage of available apple leaves in each leaf-size category, during spring.

FIG. 5 : Percentage of available apple leaves in each leaf-size category, during summer.

| Variety | Season | Leaf Size                 |                            |                            |
|---------|--------|---------------------------|----------------------------|----------------------------|
|         |        | 1<br>0-25 cm <sup>2</sup> | 2<br>25-50 cm <sup>2</sup> | 3<br>50-75 cm <sup>2</sup> |
| GS      | Spring | 1.42 ± 0.9 a              | 1.55 ± 0.5 a               | —                          |
|         | Summer | 1.00 ± 0 a                | 2.42 ± 1.6 a               | —                          |
| RD      | Spring | 1.89 ± 1.7 a              | 2.16 ± 5.4 a               | —                          |
|         | Summer | 3.49 ± 4.1 a              | 6.63 ± 7.5 b               | 21.5 ± 21.9 c              |
| SP      | Spring | 1.56 ± 1.2 a              | 2.08 ± 1.8 a               | —                          |
|         | Summer | 11.80 ± 12.7 a            | 16.25 ± 18.8 b             | 22.80 ± 22.4 b             |

TABLE 2 : Tetranychidae mean densities ( $\pm \sigma$ ) per leaf for three kinds of leaves from 'Granny Smith' (GS), 'Red Delicious' (RD) and 'Spur Red Delicious' (SP) apple trees. Means with a different letter are significantly different (ANOVA;  $p < 0.05$ ). involve RD and SP varieties, but it is not true for GS ( $F = 0.8$ ,  $df = 45$ ;  $p < 0.05$ ).

During summer, leaves of types 1 and 2 were equally infested in RD trees, while there was a higher number of type 2 leaves infested in SP trees. On the other hand most of the GS leaves were of type 2. GS also showed an important number of type 3 leaves (Fig. 3).

Figs. 4 and 5 show variations in leaf availability throughout the seasons studied. During spring, the small leaves were remarkably more abundant in the three varieties. During summer, however, the numbers tend to be equally distributed between type 1 and 2. The larger leaves were scarce.

It is worth noting that, in summer, although the number of available RD and SP leaves tend to be similar, type 1 was more infested in RD.

## DISCUSSION

Previous studies on within-host plant distribution of Two-spotted Spider Mites were mainly carried out in annual plants, such as cotton (CAREY, 1982), corn (BARRON and MARGOLIES, 1991) and cantaloupe (PERRING *et al.*, 1987), and studies on fruit trees are scarce (HERBERT and BUTTLER, 1973; WILSON *et al.*, 1983 and 1984). The information from annual plants can not be compared to perennial trees, because, in the annuals, phytophages have a distribution which depends on the stem ramification.

Research carried out by HOYT (1969) on apple orchards in Washington, showed that *Tetranychus mcdanieli* remain in the central portions of trees at the beginning of summer, but infest the outer portions at the end of this season. In the case of *Panonychus ulmi*, the distribution is similar in the central and outer portions in June, but they are more abundant in the outer portions in August. Hoyt did not report the irrigation system used.

WILSON *et al.* (1984), working on almond trees in California, only found significant differences between infestation of delimited quadrants when the orchard was irrigated using fixed-point pivotal sprinklers. This is probably because the sprinklers were responsible for suppressing spider mites on the lower half of the trees, washing away the mites. When the orchards studied had terrestrial flood irrigation, the authors did not find differences between quadrants. As the orchard in the present study presents a flood irrigation system, our data agree with the results of the above mentioned authors. Also, our results show that, independent of seasonal variation, phytophage distribution remains homogeneous between sections of apple trees, since the higher infestations in summer do not influence Tetranychidae distribution.

The architecture of trees, the arrangement of branches and the canopy shape, is another aspect related to the within-tree distribution of mites. In general, young trees are not able to produce microclimatic ranges (WESTIGARD and CALVIN, 1971). In our case, this aspect is related to differences between varieties. Although they have different kinds of pruning, neither fan-shaped pruned

trees nor spherical-canopy trees influenced the distribution of Tetranychidae.

In relation to the age of trees, HERBERT and BUTTLER (1973), working on 25-year-old trees, found significant differences between numbers of *P. ulmi* among delimited levels. However, our data come from both young and old trees; those of SP are approximately 10 years old and those of RD and GS are more than 30 years old. Therefore, the age of the trees did not influence infestation distribution.

According to VAN DE VRIE *et al.* (1972), *Panonychus citri* (McGregor) lays more eggs on young leaves than on mature ones, and *T. urticae* also reproduces more quickly on young leaves. On the other hand, *Oligonychus pratensis* (Banks) reproduces more quickly on mature leaves and the population does not increase when the most of leaves are young (MCMURTRY and JOHNSON, 1966). Studies by HOYT (*op. cit.*) reveal that *P. ulmi* infest mature leaves when summer starts, but young leaves when it finishes. *T. mcdanieli* generally infest young leaves.

Our results regarding the infestation of different kinds of leaves show seasonal variations. The three varieties do not show differences between densities of Tetranychidae on small and middle-sized leaves. However, since small leaves are more abundant during spring, the phytophages are mainly distributed on this type of leaf. On the other hand, in summer, there are higher densities on middle-sized leaves, although SP and RD infested leaves of types 1 and 2 were equally abundant. It suggests higher clumping in leaves up to 50 cm<sup>2</sup>. The largest leaves (type 3) are always less common, but when they are present, the densities of Tetranychidae are similar to those the middle-sized leaves.

In GS trees, the number of infested leaves of middle size is higher than in the others, but their mite densities are similar to those of the small-sized leaves, so we can not establish any relation of preference.

Summarizing, the Tetranychidae found in this study do not generally show marked preferences for certain kinds of leaves in spring, but they do in summer. In summer the mites show a preference for middle-sized leaves, in RD as well as SP trees. We

can consider middle sized leaves as mature leaves. Since they are the most numerous in summer, a tendency to prefer type 2 leaves could be related to a higher available area for feeding and reproduction.

Data contributed in this paper indicated that for apple orchards of temperate-humid climatic regions with a terrestrial flood irrigation, the homogeneous distribution of mites within trees allows sampling by random selection of leaves, from any section of the tree. Kinds of pruning and the age of trees do not affect Tetranychidae distribution.

The lack of microclimatic ranges or favorable sections for the development of tetranychid mites is also demonstrated. This is true in spherical canopy trees as well as in fan-shaped trees.

Differences between varieties are marked in their differential Tetranychid densities, since SP trees are always more affected, but they do not reflect differences in distribution within host plants. No variety showed a preferred section of infestation.

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