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THE REPRODUCTIVE CAPACITY OF SPIDER MITES (*Acari: tetranychidae*) POPULATION IN SINGLE- AND MULTI-LEADER APPLE TREE CROWNS OF ELSTAR AND JONAGOLD CVS.

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Abstract. The present study aimed at finding techniques alternative to chemical control, capable of reducing spider mite density. The experiment was carried out in 7 single-leader and 3 multi-leader training systems. The pest density was compared across the systems and between apple cultivars Elstar and Jonagold showing variable crown densities and trichome cover of leaves. The spider mite mobile stages were more abundant in single-leaders crowns, whereas more eggs were laid in multi-leader crowns. Nevertheless, the egg and the youngest stages survival was reduced in multi-leader crowns probably by the more intensive solar radiation reducing the air RH. The lowest pest abundance was found in the crowns of the V-Güttingen system, and in the similar, stretched Tatura trellis 2-leader system. These types of crowns should be therefore recommended for integrated and organic apple production.

Key words: *Malus domestica*, tree architecture, *Panonychus ulmi*, *Tetranychus urticae*

INTRODUCTION

The spider mites commonly encountered in orchards make a classic example of secondary pest, as their economical importance had been increasingly growing in response to the intensification of the orchard technology, including the use of insecticides [Cuthbertson and Murchie 2005, Yanar and Ecevit 2008].

The chemical pest control in apple cultures is the most intensive one among all orchard crops. The average use of pesticides amounts to 9 kg of active ingredient per ha [Surawska and Kołodziejczyk 2006] which results in multi-residues in apple fruits [Nowacka et al. 2009]. During this day and age of integrated pest management it is therefore necessary to find alternative control techniques, that would make it possible to reduce pesticide input in fruit production.

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In the process of apple orchard training, tree architecture is one of the most important factors that strongly affects the yield mass and its quality. The tree architecture has been referred to as the combined result of the crown height, its width and shape. No less important is there the proportion between the spurs and vegetative shoots, their spatial arrangement, the extent of their branching, and the growth rate. Factors such as crown density that may be characterized by light interception by the crown [Williaume et al. 2004] are also taken into account in training system considerations. The planting density of trees and the row orientation relative to the cardinal directions are critically important too.

The impact of microhabitat factors in many different systems of crown training on the apple yield and its quality had been already investigated by many authors [Hampson et al. 2002, Szewczuk and Gudarowska 2004, Sosna 2004, Willaume et al. 2004, Licznar-Małańczuk 2006, Buler and Mika 2006, Rutkowski et al. 2009]. Contrary to that, the way in which the crown type affects the development rate of the phytophagous arthropods has not been recognized yet. Only Simon et al. [2006] discuss the issue relative to the pests with piercing-sucking mouthparts, as they compare the densities of aphids and spider mites in the training systems named Solaxe and Centrifugal, that are considerably different from one another with respect to the crown porosity.

Although orchard farmers in Europe shape the crowns of their trees in tens of different manners, the system most widely adopted in Poland is the single-leader spindle, with the shape roughly resembling Christmas tree. An important limitation of the spindle crown is the poor exposure to sunlight of its lower scaffold branch. One breed of the spindle crown is the slender spindle crown, that is obtained by increasing the number of trees per unit area. This makes the basal tier of the scaffold branches slimmer and the newly growing shoots – more flexible. Superspindle is the tree with single leader and spurs of maximum 30 cm length [Pieniążek 2000].

In the recent years, the crowns stretched on trellis systems are often recommended, as they allow better light penetration to the inside of the crown and also impair cane formation. The most frequently trained system of the stretched, single-leader apple crown is V-Güttingen. Another novel concept has been the angled canopy in which two, three or four branches growing from the same trunk are stretched on the support wires. Such system is referred to as *multi-leader crowns*. The branches in such crowns are inclined in the direction of the alley and are trained at *ca*. 60–70º angle relative to the ground plain. The depth of the outer fruiting mantle maintained by the relevant summer and winter pruning does not exceed 0.5 m [Sosna 2004].

The aim of the study was to recognize the capacity for reducing spider mite development in apple trees, through modifications of crown architecture directly affecting the within-crown microhabitat factors.

MATERIAL AND METHODS

The study had been carried out in 2004–2006, at the Fruit Experimental Station in Samotwór near Wrocław (Poland). The experimental objects were the selected parts of the apple orchard, planted on Cutanic Luvsoil (Siltic) [FAO-WRB 2007], with the groundwater level at the depth of 2 m. The weather conduct data (tab. 1) come from the weather station located within the grounds of the experimental station in Samotwór.

Table 1. Meteorological characterization of the 2004–2006 growth seasons

	Month	Multian-nual mean 1961–1995	Mean monthly temperature			Temperature deviation from the multiannual mean of 1961–1995		
			2004	2005	2006	2004	2005	2006
Temperature (°C)	III	3.5	4.0	1.7	0.53	+0.5	-1.8	-2.97
	IV	8.2	9.8	9.8	9.7	+1.6	+1.6	+1.5
	V	13.3	12.8	14.3	14.1	-0.5	+1.0	+0.8
	VI	16.6	17.0	16.9	18.3	+0.4	+0.3	+1.7
	VII	18.2	18.6	19.7	23.1	+0.4	+1.5	+4.9
	VIII	17.6	19.6	17.7	17.1	+2.0	+0.1	-0.5
	IX	13.7	14.8	15.2	16.2	+1.1	+1.5	+2.5
	Mean	13.0	13.8	13.6	14.1	+0.8	+0.6	+1.1
	Month	Mean sum of rainfall 1961–1995	Monthly sum of rainfall			Percent of multiannual mean sum of rainfall		
			2004	2005	2006	2004	2005	2006
Rainfall (mm)	III	29.3	63.4	2.9	24.9	216.4	9.9	85
	IV	38.3	21.7	26.2	48.6	56.7	68.4	126.9
	V	60.7	33.1	122.8	16.2	54.5	202.3	26.7
	VI	73.2	38.7	28.8	69.1	52.9	39.3	94.4
	VII	75.1	60.0	100.8	10.8	79.9	134.2	14.4
	VIII	74.3	55.4	56.2	231.0	74.6	75.6	310.9
	IX	45.7	20.8	18.6	20.4	45.5	40.7	44.6
	Mean	396.6	293.1	356.3	421.0	82.9	81.5	100.4

Description of the tree training systems. The observations were conducted in two quarters of experimental apple orchard, in which, altogether, 10 training systems had been used (tab. 2).

Table 2. The training systems of apple trees: single-leaders crowns and multi-leaders crowns

Training system			No. of trees × ha^{-1}	Spacing (m)
Single leaders crowns	spindle	1-row	3333	3 × 1
		2-row	5333	3 + 0.75 × 1
		3-row	6667	3 + 0.75 + 0.75 × 1
	slender spindle Güttingen V-system	1-row	5333	3.75 × 0.50
		2-row	5333	3.50 + 0.25 × 1
	superspindle	1-row	7407	2.25 × 0.60
		2-row	13223	2.25 + 0.50 × 0.55
Mikado system 4-leaders	tatura system 2-leaders		2381	3.5 × 1.2
	drilling system 3-leaders		1587	3.5 × 1.8
	mikado system 4-leaders		1190	3.5 × 2.4

In the first experiment, the single-leader crowns were trained into (1) spindle, (2) slender spindle and (3) superspindle form, with the concurrent use of one-, two-, and three-row planting. As the result, seven training systems had been obtained: spindle − 1-row spindle (1-r spl), 2-row spindle (2-r spl), 3-row spindle (3-r spl); slender spindle (V-Güttingen) − 1-row V-system (1-r V), 2-row V-system (2-r V); superspindle − 1-row superspindle (1-r S-spl) and 2-row superspindle (2-r S-spl).

In the second experiment, three types of the multi-leader crowns had been used (tab. 2). They were: two-leader – Tatura trellis type (2-lead.); three-leader – Drilling type (3-lead.); and four-leader – Mikado type (4-lead.).

The system-architectural aspect of the experiment was broadened by the fact that two apple cultivars 'Jonagold' and 'Elstar' had been used, characterized by apparently different density of canopy and different leaf morphology. 'Elstar', as compared to 'Jonagold', develops more flaccid and branched shoots, and the underside of the elongated leaves is heavily covered with trichomes. In contrast, the shoots of 'Jonagold' are thicker and show no tendency to branching, whereas their wider leaf blades are less mossy.

Estimation of the number of the overwintering eggs. During the dormant season the shoots had been sampled from trees of each experimental variant, in order to estimate the density of the hibernating eggs of the European Red Mite, *Panonychus ulmi* (Koch). The number of detected eggs of the pest had been standarized as the theoretical value per 1 m of the shoot length.

Growth season observations. The analyes of spider mite abundance on the apple tree leaves had been performed every year between May and September, in one-week intervals. The experiment was established in randomized blocks design in five replicates with one tree per plot. In total, the trial included 100 trees, 10 trees in each training system and in that number – 5 trees of each cultivar. From each tree 3 leaves were taken, one leaf from each of the three levels of crown: the lower, the middle, and the upper level. Therefore the weekly sample comprised 300 leaves: 30 leaves from each one of the training systems including 15 leaves from each cultivar within a system. The number of spider mite eggs and of their mobile stages were recorded under stereoscopic microscope type Precoptic Co.

Statistical analysis. The obtained data were analyzed using four-way Multi-Factor ANOVA for complete randomized block design. The four tested variables were: (1) training systems, (2) crown levels, (3) cultivars and (4) years of the experiment. In order to verify the null hypothesis the Fisher F-test was used. The mean squares of particular sources of variation were tested by the mean square of three-way interaction. In order to compare means and calculate the LSD value Duncan test was used at $\alpha = 0.05$. Only the significant interactions are included in figures.

RESULTS

Table 1 demonstrates comparative data on the intensity of spider mite infestation in single- and multi-leader crowns. In the single-leader crowns the mean abundance of overwintering eggs per training system was > 6 times lower than that observed in multi-leader crowns. Likewise, the summer egg density was lower in single-leader systems, although that difference was not that high. On the other hand, in the multi-leader crowns ca. 30% less of the mobile stages of all the identified spider mite species were observed.

Sigle-leader crowns. The density of hibernating eggs calculated per 1 m of the shoot length was significantly variable between training systems and crown levels (tab. 4). The highest density of overwintering eggs had been observed in one row super-spindle crowns (1-r S-spl), whereas the stretched V-Güttingen system (2-r V) hosted the least of them. Mites have laid the overwintering eggs mainly in the lower parts of crowns. There were almost no eggs laid on the top level of crowns.

The growth season densities of the mobile stages and eggs, calculated as the number of individuals per 1 leaf, were significantly variable between training systems, crown levels and cultivars, as well as between the experimental years. The mobile stages and summer-laid eggs were most abundant in 1-row superspindles and spindles (1-r S-spl and 1-r spl). The other systems did not show significant differences in this respect.

On the other hand, significant differences in spider mite distribution between particular levels of crowns had been observed. The distribution of the summer-laid as well as hibernating eggs was similar on the lower and on the middle levels of the crowns, whereas their density observed on the top level was significantly lower. The majority of the mobile stages occurred in the crowns` lower parts (the average density of 29.1 indiv. per 1 leaf) and, with the observations gradually moving up the tree, the spider mite density decreased systematically and significantly, to reach the average value of 11.4 at the top-most portion of the tree's crown.

Table 3. The mean number of spider mites depending on the type of apple tree crown

Training system	Spider mites total no. × system^{-1}				
	eggs		mobile stages		
	winter	summer	*P. ulmi*	*T. urticae*	*T. viennensis*
Single-leader crowns (7 systems)	71	3184	57	1739	28
Multi-leader crowns (3 systems)	451	6816	27	1225	26

Furthermore, the mean spider mite density on the leaves of 'Elstar' or 'Jonagold' cvs. amounted to 22.0 or 18.2 indiv. per 1 leaf, respectively, and the difference had been shown significant. Likewise, the summer egg densities observed on the two cultivars were statistically different.

The abundance of the spider mite mobile stages also varied significantly across the growth seasons of the study. They were most numerous in 2004, particularly in the second half of the summer, when the temperatures higher that multiannual fostered their development (tab. 1). In 2005, the breakdown of spider mite populations occurred, resulting from the intense reduction of the pest density by the excessive rainfall in May and July. Although the weather course during the next growth season, 2006, had fa-

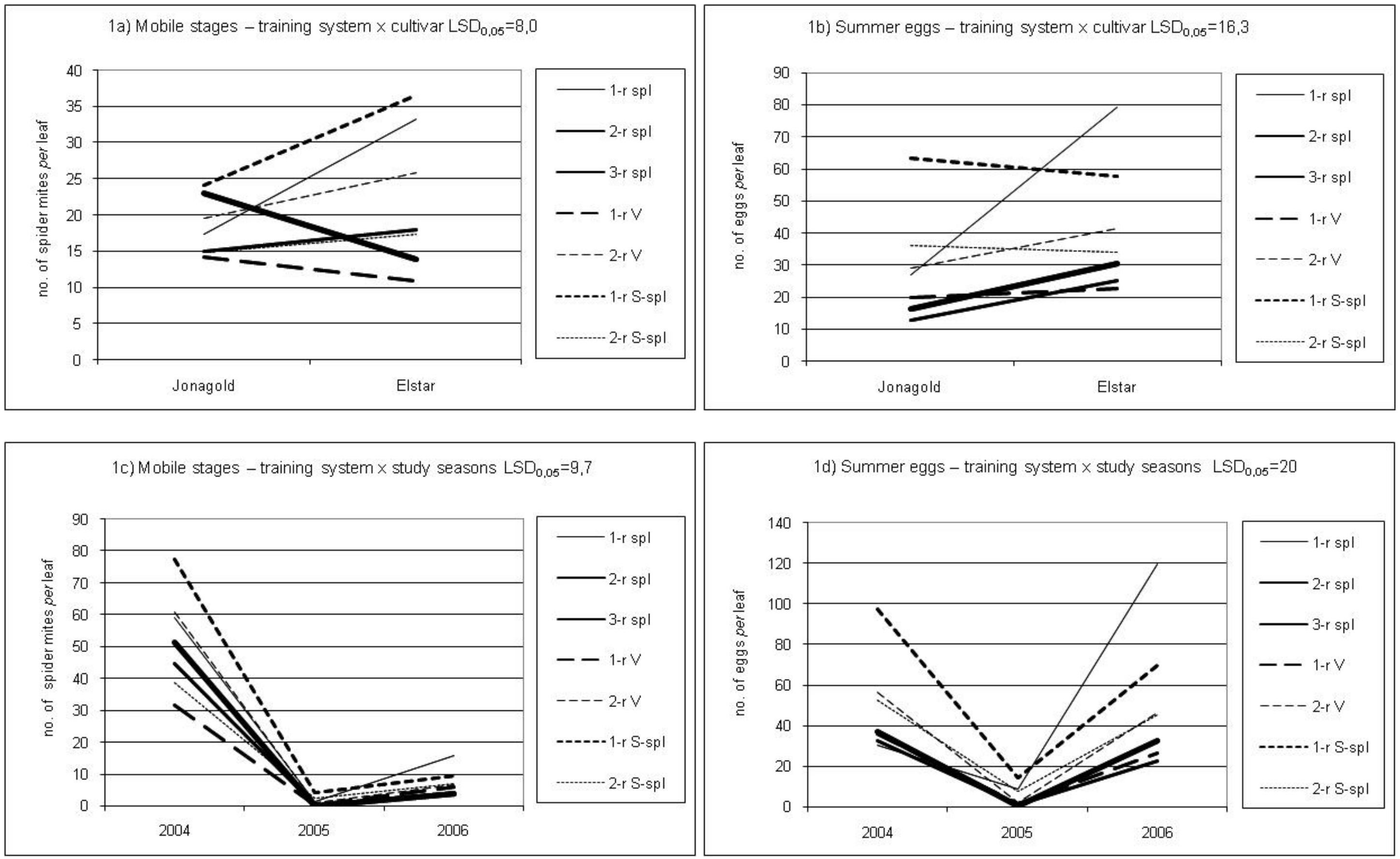

Fig. 1. Multiple interactions of number of mites and training systems, cultivars and study seasons in sigle-leader crowns

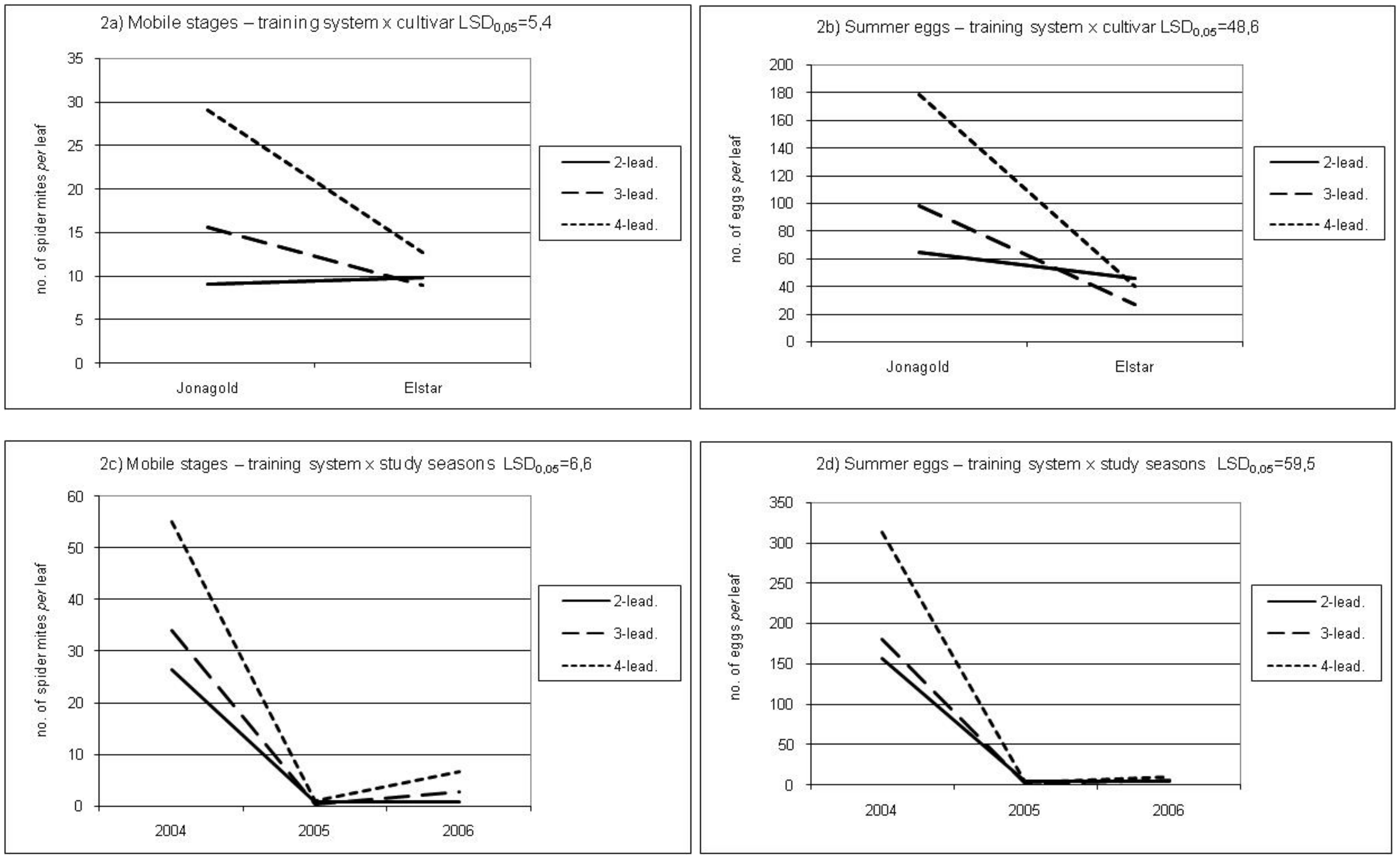

Fig. 2. Multiple interactions of number of mites and training systems, cultivars and study seasons in multi-leader crowns

Table 4. Single-leader crowns – four-way ANOVA for the number of spider mites on apple trees in particular training systems, crown levels, cultivars and years

Source of variation		Hibernating eggs	Mobile stages	Summer eggs	No. eggs × mobile stages^{-1}
Training system	1-r spl	19.6 bc*	25.33 ab	53.07 a	2.09
	2-r spl	6.2 bc	16.45 c	18.98 c	1.15
	3-r spl	9.5 bc	18.41 c	23.36 bc	1.26
	1-r V	7.1 bc	12.53 c	21.28 c	1.69
	2-r V	2.8 c	22.70 bc	35.30 b	1.55
	1-r S-spl	62.0 a	30.28 a	60.54 a	1.99
	2-r S-spl	41.2 ab	16.10 c	35.12 b	2.18
Crown level	upper	1.0 b	11.4 c	25.7 b	2.25
	middle	23.1 a	20.1 b	36.6 a	1.82
	lower	39.5 a	29.1 a	43.7 a	1.50
Cultivar	Jonagold	22.6	18.2 b	29.2 b	1.60
	Elstar	19.8	22 a	41.5 a	1.88
Study seasons	2004	13.7	51.9 a	48.9 a	0.94
	2005	28.7	1.3 c	5.3 b	4.07
	2006	–	7.4 b	51.9 a	7.01
LSD 0.05	System	33.4	5.7	11.6	
	Crown level	21.9	3.7	7.6	
	Cultivar	17.9	3.0	6.2	
	Year	17.9	3.7	7.6	

* Means in columns followed by the same letter are not significantly different at α = 0.05

voured the spider mites initially, the drought and heat spell in July had strongly reduced their populations nevertheless. Later that season the pest densities had only returned to the level below the 20% of that recorded in 2004. Unlike that of the mobile stages, the abundance of the summer-laid eggs did not significantly differ between the study years, with only one exception for 2005, when their density was considerably lower than in the two other seasons.

For either the mobile stages of spider mites and the summer-laid egg density, the significant interactions have been demonstrated between the orchard training systems and cultivars (figs 1a, b), or between the training systems and the study seasons (figs 1c, d).

Of all the systems using 'Elstar' and 'Jonagold' the most infested by spider mite mobile stages was 1-row superspindle (1-r S-spl) and the least infested system was 1-row V-system (1-r V). The greatest differences between the cultivars were observed within the 1-row spindle system (1-r spl), in which Elstar cv. was nearly twice as high infested as Jonagold (fig. 1a). This effect is also apparently expressed in the significant differences in the load of the spider mite eggs on the leaves in 1-row spindle (1-r spl), where the mean egg density per leaf was 79.2 on 'Elstar' and 26.9 on 'Jonagold' (fig. 1b). In any other of the tested systems of single leader crowns and with both apple tree cultivars, no differences were found with respect to the spider mite density.

The interaction between the training systems and the study seasons (figs 1c, d) had shown that in 2004, at temperatures conducive for spider mite development, at moderate rainfall levels and with the resultant rapid multiplication of the pest, the observed differences in mobile stages density between the systems were significant (fig. 1c). The most intensively infested system was 1-row superspindle (1-r Ssp), whereas the least infested was 1-row V-system (1-r V). In contrast, at the observed decline of spider mite populations in 2005 caused by the excessive raifall in May and July no differences were demonstrated at all, whereas in 2006 with its moderate course of the weather (exluded the stormy August), the only training system with spider mite counts significantly higher than in all the other systems was 1-row spindle (1-r spl).

The interaction between the training systems and the study seasons for egg density (fig. 1d) had shown that in 2004 and 2006, with the sufficiently abundant egg load on the leaves, only two systems differed significantly from the remaining ones. These were the 1-row superspindle (1-r S-spl) in 2004 and 1-row spindle (1-r spl) in 2006, which had shown the highest mean densities of the summer eggs (tab. 4). In 2005 the egg density was apparently low in general, and no significant differences had been found between the studied training systems.

Multi-leader crowns. Significant variation in mite eggs and mobile stages density had been also found among all the multi-leader crown training systems. The differences were observed between the systems, crown levels, cultivars and years (tab. 5).

Table 5. Multi-leader crowns – our-way ANOVA for the number of spider mites on apple trees in particular training systems, crown levels, cultivars and years

Source of variation		Hibernating eggs	Mobile stages	Summer eggs	No. eggs × mobile stages^{-1}
Training system	Tatura trellis – 2-lead	535.0 a	9.4 b	55.3 b	5.88
	Drilling – 3-lead	251.8 b	12.2 b	62.8 b	5.14
	Mikado – 4-lead	569.5 a	20.9 a	109.0 a	5.21
Crown level	upper	99.9 b	11.2 b	55.0 a	4.91
	middle	594.7 a	12.8 b	83.0 a	6.48
	lower	661.7 a	18.5 a	89.2 a	4.82
Cultivar	Jonagold	619.1 a	17.9 a	113.9 a	6.36
	Elstar	285.1 b	10.4 b	37.5 b	3.60
Study seasons	2004	898.6 a	38.4 a	216.6 a	5.64
	2005	5.7 b	0.7 b	3.1 b	4.42
	2006	–	3.4 b	7.4 b	2.17
LSD 0,05	System	238.2	3.8	34.6	
	Crown level	238.2	3.8	34.6	
	Cultivar	194.5	3.1	28.2	
	Year	193.5	3.8	34.6	

* Means in columns followed by the same letter are not significantly different at α = 0.05

The hibernating eggs were twice as sparser in the Drilling (3-lead.) crowns than in the two other systems, whereas the leaves were the least loaded with eggs and the least infested by the mobile stages in the trees trained into Tatura trellis (2-lead.) system. Conversely, the variation observed between the (2-lead.) and (3-lead.) crowns was, in principle, insignificant, The exception was Mikado (4-lead.) system, which had been infested at significantly higher a level.

The mobile stages only occurred at significantly higher densities on the leaves of the lower levels of crown, but the differences in egg density between the crown levels within a system were not significant.

On the leaves of 'Jonagold' the spider mites occurred with the mean density of 17.9 individuals per 1 leaf but on 'Elstar' that value was only 10.4. The egg density varied significantly too, as they were three times as much abundant on 'Jonagold' compared to 'Elstar'.

The spider mite density in 2004 was significantly higher compared to the two other seasons, 2005 and 2006, which were otherwise similar to one another with this respect.

Furthermore, for mites density significant interactions were shown between the systems and cultivars (figs 2a, b) and between the systems and seasons of the experiment (figs 2c, d). In the severely infested 'Jonagold' all differences in the mobile stages and egg density were significant between all of the training systems, whereas in case of the less infested 'Elstar', the systems did not differ significantly as to the egg and mobile stages abundance (fig. 2a). The interactions demonstrated between the systems and study seasons (figs 2c, d) indicate that the densities of spider mites and their eggs in different training systems were significantly different only in the 2004, when these pests occurred in greatest numbers. In 2005 and 2006, during the two seasons with low level of spider mite infestation, all investigated orchard training systems were affected in like manner.

DISCUSSION

The accomplished research has shown a significant variation of the spider mite abundance within the studied apple orchard training systems: the single-leader and multi-leader ones. According to Pieniążek [2000], the single-leader crowns are more heterogenous with respect to their microhabitat conditions because their lower part is considerably shaded. In the angled canopies light penetrates the whole interior of the multi-leader crown in a more uniform manner. The statistically important variability of the spider mite infestation between the particular levels of crowns in single-leader training systems testifies of the presence of different microhabitats within such crowns. On the contrary, the infestation by the spider mite mobile stages observed in the multi-leader crowns, undifferentiated between their upper and the middle levels, and the absence of variation with respect to the egg abundance, confirm the greater uniformity of microhabitat conditions in the multi-leader type of canopy.

Among the one-leader crowns, the most often infested system was 1-row superspindle (1-r S spl). It has been concluded from the analysis of the apple tree growth pattern by Licznar-Małańczuk [2004], that there is more effective nutrient supply to the leaves of trees that are planted in one-row systems. This in turn may prove advantageous to the spider mite fertility. Additionally, the minimum sum of the shoot length in superspindle crowns testifies for these shoots being mainly the spurs on which, according to Bielak [1986], the spider mites reach their maximum fecundity.

Among the spindle-shaped crowns, more spider mites were observed on 'Elstar', which develops more compact crown and has leaves covered with trichomes. These cultivar-specific traits of 'Elstar' might have offered some kind of advantage to the spider mites under unfavourable weather conditions – during the hot weather or the more abundant rainfall. Conversely – on 'Jonagold' trees it could have been more difficult for the pest to find shelter, and as the result the spider mite populations had been subject to some reduction. Sauge and Fauvel [1996] hold it that in the natural circumstances the air humidity affects the spider mite abundance stronger than does the air temperature. Abundant rainfall may wash spider mites down from the leaves, causing considerable reduction of their numbers. Boczek [1999] had already mentioned that an intensive plant irrigation may contribute to the pest decline. Sangita and Thakur [2004] had shown the direct correlation between the temperature and RH on the one hand and the spider mite abundance – on the other, and had also demonstrated that the pest density is negatively correlated with rainfall intensity. In the laboratory experiment, Kasap [2003] found out the highest rate of spider mite reproduction at the temperatures ranging from 25–30°C. Bylemans [1998] notified that high temperatures in July and August had triggered outbreak of the mites abundance in the orchards. Park et al. [1994] reported on a 100 mm rainfall causing important density reduction of spider mites. The latter seems to confirm the presumption that in the current experiment the spider mites could be prevented from the wash down by the rainfall from the trichome-covered leaves of 'Elstar', particularly in the lower portions of spindle crowns, but at the same time their numbers were reduced on 'Jonagold', bearing less trichomes on the leaf underside.

In the multi-leader systems spider mites probably encountered better trophic conditions, which had been also clearly expressed as the higher and better yield obtained from those trees [Licznar-Małańczuk 2004, 2006, Sosna 2004]. Consequently, the pest attained there a higher level of fecundity. Additionally, at the end of summer, when the overwintering eggs are laid, or in early spring, when first generation of spider mites lay their eggs, the temperature in the interior of the stretched crowns must be higher than in more shaped single-leader crowns and this may also foster mite fecundity. This refers in particular to the 4-leader crowns, where the well sun-lit interior of the crown is tightly surrounded by the leaders with their leaves already developed. It therefore explains why the intensity of spider mite infestation is higher where there is a higher number of leaders in a crown.

However, during the summer time, a strong reduction of the spider mite youngest stages had been observed in this system, caused probably by the better light penetration through the canopy [Mika 2001, Buler and Mika 2009], which in turn resulted in lower air RH. This notion also refers to the least infested single-leader system: the 1-row V-system with slender spindle crown (V-Güttingen). Balevski [1984] accounts for the high egg mortality of spider mites in temperatures > 35°C. In the stretched crowns with their interior parts more exposed to direct sunlight radiation, the spider mite density might have been strongly reduced during the summer heat time as the result of the high mortality of their youngest instars brought about by the low air RH. It seems to be confirmed by the notion, that the twice as higher egg numbers in multi-leader-, compared to single-leader crowns did not translate consequently into any greater abundance of the mobile stages. Conversely, these were even less abundant in the stretched crown systems, which may speak for the high egg mortality.

CONCLUSIONS

1. The modelling of crown architecture may be an important factor limiting the incidence of the phytophagous spider mites in apple orchards. The level of infestation by the pest is also determined by the morphological traits of the trees such as crown compactness or the density of trichomes on the leaves.

2. In the single-leader crowns better conditions are created for the development of spider mites population. Although the eggs are laid there less abundantly, the crowns of single-leader systems are better shaded and characterized by higher air humidity, which increases pest survival rate in summer.

3. In the multi-leader stretched crowns with higher light interception, the egg density, particularly those laid in autumn and in spring, was considerably higher. But during the summer months, in the interior parts of these crowns, more open and more exposed to direct sunlight radiation, the spider mite density might have been strongly reduced during the heat or rainy time.

4. The single-leader V-Güttingen system and the stretched 2-leader Tatura trellis crowns in which the spider mite density was the lowest, should be recommended for integrated and organic apple fruit production.

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ROZRODCZOŚĆ POPULACJI PRZĘDZIORKÓW (*Acari: tetranychidae*) W JEDNO- I WIELOPRZEWODNIKOWYCH KORONACH JABŁONI ‘ELSTAR’ I ‘JONAGOLD’

Streszczenie. Integrowana produkcja owoców wskazuje na potrzebę ograniczeń stosowania pestycydów. Celem badań było poszukiwanie alternatywnych technik redukujących liczebność szkodliwych roztoczy w 7 systemach jabłoni o koronach jednoprzewodnikowych i 3 wieloprzewodnikowych. Porównywano także liczebność przędziorków na odmianach Elstar i Jonagold, różniących się zwartością koron i omszeniem liści. W rozpinanych koronach wieloprzewodnikowym przędziorki składały więcej jaj, jednakże stadia ruchome przędziorków były liczniejsze w koronach jednoprzewodnikowych. Przypuszczalnie w koronach rozpinanych, dzięki lepszemu naświetleniu i obniżeniu wilgotności, liczebność przędziorków była silnie redukowana. W koronach jednoprzewodnikowych najmniejszą ilość przędziorków stwierdzono w typie V-Güttingen, a wieloprzewodnikowych w koronie Tatura trellis (2 przewodniki), wobec czego te formy koron powinny być szczególnie polecane do integrowanej i ekologicznej produkcji owoców.

Słowa kluczowe: *Malus domestica*, architektura drzew, przędziorek owocowiec, przędziorek chmielowiec

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