SUSCEPTIBILITY OF STRAWBERRY CULTIVARS TO INFESTATION BY THE STRAWBERRY MITE (*Phytonemus pallidus* ssp. *fragariae* Zimm.)

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A B S T R A C T

Twenty strawberry cultivars were evaluated in terms of their susceptibility to infestation by the strawberry mite (*Phytonemus pallidus* ssp. *fragariae* Zimm.). The trial was carried out from 2000 to 2002 at the Dąbrowice Experimental Orchard near Skierniewice in central Poland. Two to four times each season, both motile forms and eggs were counted on randomly sampled leaves of each cultivar. The highest numbers of mites were generally found in June and July. All of the strawberry cultivars evaluated were susceptible to infestation by the strawberry mite. The most susceptible cultivars were 'Marmolada', 'Kent', 'Honeoye', 'Evita', 'Elsanta', 'Selva', 'Polka', 'Kastor' and 'Elkat'. Moderately susceptible cultivars included 'Vega', 'Karel', 'Seal', 'Selection 1476', 'Temira', 'Tarda Vicoda', 'Malling Pandora', 'Selection 1248' and 'Senga Sengana'. The cultivars least susceptible to infestation by the strawberry mite were 'Selection 723' and 'Pegasus'.

Key words: strawberry, strawberry mite, *Phytonemus pallidus*, cultivars susceptibility

INTRODUCTION

The strawberry mite (*Phytonemus pallidus* ssp. *fragariae* Zimm.) was first detected in Poland over seventy years ago. It is a common strawberry pest in many countries all over the world (Alford, 1972; Łęska, 1964; Schaefers, 1963; Suski, 1958).

The strawberry mite damages plant foliage and greatly reduces fruit quality. Strawberries from infested plants are small, sour and difficult to sell on the fruit market. The strawberry mite also reduces yield, sometimes dramatically. The drop in yield is usually proportional to the level of infestation (Alford, 1976; Stenseth and Nordby, 1976).

Finding acaricides effective in controlling the strawberry mite is always a problem. Purchasing resistant

and tolerant strawberry cultivars is also extremely difficult. Some cultivars are partially resistant to the strawberry mite, but as of yet, no totally resistant cultivars have been found (Alford, 1972; Łabanowska, 2004; Berglund, 2005).

The aim of this study was to evaluate twenty strawberry cultivars in terms of their susceptibility to infestation by the strawberry mite. 'Senga Sengana', the cultivar most widely grown in Poland, served as the reference cultivar.

MATERIAL AND METHODS

The experiment was carried out from 2000 to 2002 at the Dąbrowice Experimental Orchard, which belongs to the Research Institute of Pomology and Floriculture in Skierniewice in central Poland.

In the spring of 1999, strawberry plants of twenty different cultivars were planted 0.5 x 1.0 meters apart in a field in which strawberries are grown every year. The cultivars evaluated are listed in Table 1. 'Senga Sengana' was included as the reference cultivar.

The experiment was carried out in a randomized block design with four replications of fifty plants per plot. Each plot consisted of two rows, each of which was twelve meters long.

No chemical pest and diseases control measures were carried out.

Two to four times during the course of the growing season, ten leaves were randomly sampled from each plot. Strawberry mite motile forms and eggs were counted with the help of a stereoscopic microscope.

Before statistical analysis, all data were transformed using the logarithmic function $y = \log (x+1)$, where x represents the number of mites found on the leaves sampled. All data were elaborated using analysis of variance, followed by means separation using Duncan's multiple range t-test at $P \leq 0.05$.

The cumulative index of infestation was then calculated for each cultivar (Wratten et al., 1979).

RESULTS AND DISCUSSION

The numbers of strawberry mites found on the leaves sampled are presented in Tables 1 and 2. The cumulative indices of infestation are presented in Table 3.

The first observations were carried out in May, 2000. Strawberry mites were found on all twenty cultivars. The level of infestation varied from cultivar to cultivar. The differences between cultivars were sometimes statistically significant (Tab. 1).

The highest numbers of mites were found on 'Marmolada' and 'Honeoye', which had between 5.5 and 6.5 mites per leaf. The numbers of eggs found on these cultivars was relatively high compared to the numbers of motile forms, and ranged from 6.3 to 8.3 eggs per leaf.

The lowest numbers of mites were found on 'Pegasus', 'Karel', 'Seal' and 'Selection 723', which had fewer than one motile form and two eggs per leaf.

In the remaining cultivars, including 'Senga Sengana', the number of mites in May, 2000, ranged from 0.3 to 4.3 per leaf.

Table 1. Infestation of strawberry cultivars by motile forms of the strawberry mite (*Phytonemus pallidus* ssp. *fragariae* Zimm.); Dąbrowice Experimental Orchard, 2000

Cultivar	Mean number of motile forms per leaf			
	May 23	July 10	August 9	August 29
Elkat	0.3 b*	0.2 ab	1.9 b-d	5.3 c-f
Elsanta	2.0 fg	4.1 f-j	3.7 cd	3.4 cd
Evita	1.9 fg	1.0 c-e	1.7 b-d	8.3 e-g
Honeoye	6.5 h	10.4 j	0.7 b	4.8 c-f
Karel	0.1 a	1.6 d-f	4.1 cd	1.4 b
Kastor	3.3 gh	2.8 fg	6.6 d	7.9 e-g
Kent	4.3 gh	7.8 h-j	2.3 b-d	7.1 d-g
Malling Pandora	1.8 fg	2.4 ef	1.8 b-d	2.9 c
Marmolada	5.5 h	9.4 ij	6.1 d	3.9 c-e
Pegasus	0.02 a	0.4 a-c	0.7 b	0.6 a
Polka	3.2 gh	6.6 g-j	7.4 d	6.1 c-f
Seal	0.1 a	1.0 c-e	0.6 b	6.2 c-f
Selection 723	0.1 a	0.4 bc	0.7 b	0.8 ab
Selection 1248	0.9 c-f	0.7 b-d	4.8 d	9.7 fg
Selection 1476	0.5 b-e	0.5 bc	1.0 bc	4.9 c-f
Selva	1.1 d-f	3.1 f-h	6.7 d	13.8 g
Tarda Vicoda	0.4 bc	0.1 a	0.1 a	6.0 c-f
Temira	1.3 ef	3.9 f-i	5.1 d	3.4 cd
Vega	0.5 b-d	0.3 a-c	2.9 b-d	4.8 c-f
Senga Sengana **	**2.1 fg**	**1.9 d-f**	**1.1 bc**	**6.4 d-f**

*Means in the same column followed by the same letter are not significantly different according to Duncan's multiple range t-test at $P \leq 0.05$.
**Reference cultivar

Table 2. Infestation of strawberry cultivars by motile forms of the strawberry mite (*Phytonemus pallidus* ssp. *fragariae* Zimm.); Dąbrowice Experimental Orchard, 2001 and 2002

Cultivar	Mean number of motile forms per leaf				
	2001			2002	
	June 26	August 6	August 23	June 5	June 25
Elkat	3.0 e-g*	5.1 gh	0.5 b	7.7 hi	8.1 h
Elsanta	5.4 g-i	7.9 h-j	1.1 c	6.4 g-i	8.8 h
Evita	1.7 de	3.4 g	5.4 e	no plants	
Honeoye	8.7 i	4.9 gh	11.2 f	5.6 f-h	3.4 fg
Karel	2.0 d-f	0.7 b-d	3.2 d	1.7 cd	1.4 cd
Kastor	1.5 cd	6.8 h-j	3.5 d	10.7 i	3.8 fg
Kent	0.9 bc	5.1 gh	0.7 b	3.6 e-g	7.4 h
Malling Pandora	0.6 b	0.4 b	1.1 c	3.8 e-g	4.3 g
Marmolada	4.8 g-i	10.3 ij	0.7 b	10.7 i	7.6 h
Pegasus	3.4 f-h	0.9 c-e	0.7 b	1.6 cd	1.5 cd
Polka	5.4 g-i	1.3 d-f	1.6 c	2.3 de	1.0 bc
Seal	2.1 d-f	0.7 bc	0.2 a	3.5 e-g	3.0 e-g
Selection 723	0.6 b	0.5 b	4.0 de	0.1 a	0.6 b
Selection 1248	5.2 g-i	1.4 ef	0.7 b	0.4 b	3.3 fg
Selection 1476	0.8 b	1.8 f	1.4 c	3.2 ef	4.3 g
Selva	6.2 hi	11.7 j	3.1 d	4.4 f-h	1.8 c-e
Tarda Vicoda	5.4 g-i	6.1 g-i	0.2 a	0.2 ab	0.3 a
Temira	2.5 d-f	0.2 a	3.2 d	2.1 de	1.1 c
Vega	0.2 a	4.8 gh	0.5 b	1.0 c	0.3 a
Senga Sengana **	**0.8 bc**	**0.4 b**	**3.2 d**	**2.3 de**	**2.4 d-f**

*For explanations, see Table 1
**Reference cultivar

T a b l e 3. Infestation of strawberry cultivars by the strawberry mite (*Phytonemus pallidus* ssp. *fragariae* Zimm.) as expressed in terms of the cumulative index of infestation calculated on the basis of the numbers of strawberry mite motile forms and eggs; Dąbrowice Experimental Orchard, 2000 to 2002

Cultivar	2000		2001		2002	
	motile forms	eggs	motile forms	eggs	motile forms	eggs
Elkat	117.4 ab*	118.2 ab	223.4 ef	355.4 f-h	158.8 i	267.5 i
Elsanta	312.0 c-f	579.3 e-g	351.2 hi	402.3 gh	152.8 i	208.8 h
Evita	219.1 b-d	352.4 b-e	184.5 e	281.7 d-f	no plants	
Honeoye	584.9 hi	733.0 g	425.0 j	629.6 i	94.0 gh	120.5 e-g
Karel	176.7 a-d	207.7 a-c	95.5 a-c	133.8 a-c	32.0 a-d	64.3 b-d
Kastor	396.6 e-g	475.2 d-f	269.1 fg	324.5 e-g	148.8 i	157.3 g
Kent	507.8 gh	788.0 g	173.8 de	251.2 de	115.3 h	156.8 g
Malling Pandora	224.4 b-d	351.4 b-e	34.9 a	48.1 a	83.3 fg	103.0 de
Marmolada	670.2 i	809.7 g	412.8 ij	441.4 h	185.8 j	236.3 hi
Pegasus	49.3 a	36.6 a	112.0 b-d	126.3 a-c	32.8 b-d	47.3 ab
Polka	534.0 g-i	749.8 g	172.1 de	186.4 b-d	33.5 b-d	32.5 ab
Seal	123.8 ab	106.9 ab	66.8 ab	113.7 a-c	66.0 ef	94.3 c-e
Selection 723	50.9 a	45.3 a	65.8 ab	94.1 ab	8.3 ab	9.3 a
Selection 1248	250.0 b-e	263.9 a-d	158.9 c-e	209.7 cd	38.0 cd	56.3 bc
Selection 1476	124.3 ab	112.4 ab	84.1 ab	190.3 b-d	80.5 fg	108.8 ef
Selva	422.7 fg	680.9 fg	501.1 k	592.7 i	64.8 ef	146.5 fg
Tarda Vicoda	94.7 ab	112.7 ab	293.0 gh	379.2 gh	6.5 a	12.5 a
Temira	319.7 d-f	445.6 c-f	86.3 ab	105.0 ab	35.5 cd	33.5 ab
Vega	147.8 a-c	146.6 ab	157.6 c-e	214.4 cd	13.5 a-c	9.8 a
Senga Sengana**	**217.6 b-d**	**401.7 c-e**	**57.7 ab**	**70.0 a**	**49.8 de**	**48.8 ab**

*For explanations, see Table 1
**Reference cultivar

The number of mites increased during July and August. At the end of August, the highest number of mites was found on 'Selva', which had 13.8 mites per leaf. High numbers of mites were also found on 'Kent', 'Marmolada', 'Kastor', 'Evita' and 'Selection 1248', which had between 6.6 and 9.7 mites per leaf. The differences between these cultivars and 'Selva' were not statistically significant.

In 'Pegasus' and 'Selection 723', however, the number of mites remained low until the end of August, and never exceeded 0.8 mites per leaf.

The overall level of infestation for the 2000 growing season was highest in 'Marmolada', 'Selva', 'Polka', 'Honeoye', 'Kent', 'Kastor', 'Evita" and 'Selection 1248', on which at the date, when the highest number of mites was noted between 7.4 and 13.8 mites per leaf. In these cultivars, mites were found on 65% to 95% of the leaves sampled.

'Elsanta', 'Temira' 'Vega', 'Malling Pandora', 'Tarda Vicoda', 'Karel', 'Elkat', 'Seal' and 'Selection 1476' were moderately infested, as was 'Senga Sengana'. At the end of the growing season, the number of mites on 'Senga Sengana' was 6.4 per leaf, and mites were found on 35% of the leaves sampled.

The overall level of infestation for the 2000 growing season was lowest in 'Pegasus' and 'Selection 723', which had fewer than one mite per leaf. In these cultivars, mites were found on only a few percents of the leaves sampled.

The number of eggs was generally correlated with the number of motile forms found.

In all of the highly and moderately infested cultivars, the number of mites found per leaf was higher than four, which is the economic threshold level. Infestation below this level has no significant effect on yield the next year (Alford, 1972;1976). Infestation above the threshold level, however, does reduce yield the next year (Berglund, 2005).

Predatory mites of the family Phytoseiidae were also counted. However, because they were present only in low numbers, it was difficult to draw any conclusions on the relationship between the strawberry mite and phytoseiid mites for the cultivars evaluated.

At the end of June, 2001, the strawberry mite was found on all twenty cultivars. The differences in infestation level between cultivars was statistically significant (Tab. 2).

The highest numbers of mites were found on 'Marmolada', 'Polka', 'Tarda Vicoda', 'Elsanta', 'Selva', 'Honeoye' and 'Selection 1248', which had between 4.8 and 8.7 motile forms per leaf, and between 5.0 and 12.6 eggs per leaf.

The lowest numbers of mites were found on 'Vega', 'Malling Pandora', 'Senga Sengana', 'Kent', 'Selection 723' and 'Selection 1476', which had fewer than one motile form per leaf, and fewer than 1.2 eggs per leaf.

The remaining cultivars had between 1.0 and 3.4 motile forms per leaf.

In most cultivars, the number of mites was high at the beginning of August, but by the end of the month had dropped significantly to 0.2 to 11.2 mites per leaf.

The overall level of infestation for the 2001 growing season was highest in 'Honeoye', 'Selva' and 'Marmolada', which had between 8.7 and 11.2; 6.2 and 11.7 or 4.8 and 10. 3 mites per leaf, respectively. In these cultivars, the cumulative index of infestation was seven to eight times higher than in 'Senga Sengana'.

'Vega', 'Kent', 'Polka', 'Elkat', 'Evita', 'Kastor', 'Tarda Vicoda', 'Elsanta' and 'Selection 1248' were moderately infested, and had between 4.8 and 8.0 mites per leaf.

In all of the highly and moderately infested cultivars, the number of mites was higher than the economic threshold level.

The overall level of infestation for the 2001 growing season was lowest in 'Malling Pandora', 'Seal', 'Pegasus', 'Temira', 'Karel', 'Selection 1476' 'Selection 723' and 'Senga Sengana', which all had fewer than four mites per leaf.

The number of eggs was again correlated with the number of motile forms found.

Phytoseiid mites were found only in low numbers on the leaves sampled.

In 2002, mites were found on all of the cultivars except 'Evita', which had dried out (Tab 2).

The overall level of infestation for the 2002 growing season was highest in 'Elkat', 'Elsanta', 'Honeoye', 'Kastor', 'Kent' and 'Marmolada', which had between 3.4 and 10.7 mites per leaf. 'Selva', 'Seal', 'Selection 1476', 'Malling Pandora' and 'Senga Sengana' were moderately infested, and had between 2.3 and 4.4 mites per leaf. The overall level of infestation for the 2002 growing season was lowest in 'Tarda Vicoda', 'Selection 723', 'Vega', 'Pegasus', 'Karel', 'Polka', 'Temira' and 'Selection 1248'.

Throughout the three year observation period, the strawberry mite was found on all of the cultivars evaluated. The strawberry mite had been previously found on various strawberry cultivars (Łabanowska, 2004; Berglund, 2005).

The numbers of mites found varied from year to year, and from month to month in a particular year.

The cultivars with the highest three-year overall level of infestation were 'Marmolada', 'Kent', 'Honeoye', 'Evita', 'Kastor', 'Selva', 'Polka', 'Elsanta' and 'Elkat'. Cultivars which were moderately infested included 'Vega', 'Karel', 'Seal', 'Selection 1248', 'Selection 1476', 'Temira', 'Tarda Vicoda', 'Malling Pandora' and 'Senga Sengana'. The cultivars with the lowest three-year overall level of infestation were 'Selection 723' and 'Pegasus'.

In an earlier experiment in which 'Senga Sengana' also served as the reference cultivar, it was less infested by the strawberry mite than all of the other cultivars evaluated (Łabanowska, 2004). Also, in previous experiments, 'Kent', 'Elsanta' and 'Honeoye' were only moderately infested (Łabanowska, 2004).

CONCLUSIONS

1. All of the strawberry cultivars evaluated were susceptible to infestation by the strawberry mite (*Phytonemus pallidus* ssp. *fragariae* Zimm.).
2. Of the cultivars evaluated, those most susceptible to infestation by the strawberry mite were 'Marmolada', 'Kent', 'Honeoye', 'Evita',

'Elsanta', 'Selva', 'Polka', 'Kastor' and 'Elkat'.

3. 'Vega', 'Karel', 'Seal', 'Selection 1476', 'Temira', 'Tarda Vicoda', 'Malling Pandora', 'Selection 1248' and 'Senga Sengana' were moderately susceptible.
4. The cultivars which were least susceptible to infestation by the strawberry mite were 'Selection 723' and 'Pegasus'.

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ZASIEDLENIE DWUDZIESTU ODMIAN TRUSKAWKI PRZEZ ROZTOCZA TRUSKAWKOWCA – *Phytonemus pallidus* ssp.*fragariae* Zimm.

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S T R E S Z C Z E N I E

Doświadczenia nad występowaniem roztocza truskawkowca na 20 odmianach truskawek prowadzono w latach 2000-2002 w Sadzie Doświadczalnym Instytutu Sadownictwa i Kwiaciarstwa w Dąbrowicach k. Skierniewic. Liczebność stadiów ruchomych i jaj roztocza określano 2-4 razy w sezonie wegetacji. W grupie obserwowanych odmian żadna nie okazała się całkowicie odporna na roztocza.

Najsłabiej zasiedlane przez roztocza były odmiany – 'Klon 723' i 'Pegasus', średnio – 'Vega', 'Karel', 'Senga Sengana', 'Seal', 'Klon 1248', 'Klon 1476', 'Temira', 'Tarda Vicoda' i 'Malling Pandora', a najsilniej – 'Marmolada', 'Kent', 'Honeoye', 'Evita', 'Kastor', 'Selva', 'Polka', 'Elsanta' i 'Elkat'.

Słowa kluczowe: truskawka, roztocz truskawkowiec *Phytonomus pallidus* ssp. *fragariae*, podatność odmian