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THE VERTICAL DISTRIBUTION AND MONITORING POPULATION OF *THRIPS PALMI* KARNY (THYSANOPTERA: THRIPIDAE) ON *SOLANUM TUBEROSUM* (POTATO PLANT)

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Abstract: The study of vertical distribution and monitoring population of *Thrips palmi* Karny (Thysanoptera: Thripidae) on (potato plant) *Solanum tuberosum* was conducted at the field station of Lembang Vegetable Research Institute, West Java (alt. 1250 m) during dry season. The experiment was free from insecticide application. A total of 15 plant samples were taken diagonally from each plot and the number of nymphs and adults found on every leaf were recorded. Analysis of leaf nutrient contents was done at the Biotechnology Research Center, Bogor. Leaf factors observed were the protein content, total sugar, fat, mineral and thickness of leaves. Sample leaves were taken from three different positions: upper, middle and lower stratum, at four different ages of plant: 4, 6, 8 and 10 weeks after planting (WAP). The results showed that *T. palmi* invaded potato plants since the terminal shoots emergence stage. The adults were found on the upper leaves (first to fifth), while nymphs were mostly found on the middle leaves. Appropriate nutritional and physical factors of plant leaves caused the adults of *T. palmi* to choose the upper leaves as their food source and a place to lay eggs. Monitoring *T. palmi* populations are best done by observing middle leaves and the best time for monitoring is 0700–0800 or 1600–1700.

Keywords: Vertical Distribution, Monitoring, *Thrips palmi*, Potato Plant

INTRODUCTION

In the 1980s it was discovered that *Thrips palmi* had become one of the most important pests of *Solanum tuberosum* (potato plant) in the highlands of Sumatra and Java. The damage caused by this insect is very serious, especially in the dry season (Sastrosiswojo 1991). Both, nymphs and adults, feed primarily on the sap of living plant cells. If the cell content of a leaf surface has been sucked up extensively, silvery patches are formed by the presence of air (Childers 1997). These patches gradually become brown and the damage is usually followed by defoliation and a significant yield loss may occur (Cesar *et al*. 2002). Recently, it was reported that farmers failed to control *T. palmi* on potato plant in North Sumatra. This situation was probably due to improper use of insecticides on potato plants that caused problems of resistance combined with resurgence of the non-target species (Tobing *et al*. 2001).

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Up to now, observation done to estimate *T. palmi* population with the purpose of controlling the insect population is based on taking one leaf (the fourth or fifth from the top) as a sample (Udiarto & Sastrosiswojo 1998). The decision made to take this unit sample was not based on a research result but simply by experience in the field. Johnson (1995) stated that development of effective pest management strategies requires knowledge of the distribution of the pest within a crop. Therefore, in order to sample the correct leaf for monitoring *T. palmi*, this study was initiated to focus on the vertical distribution and to monitor *T. palmi* populations.

MATERIALS AND METHODS

The experiment was conducted in Lembang Vegetable Research Institute field station, West Java (alt. 1250 m) during dry season. The field was planted with HPS 7/67 variety. The plot size was 8 x 11 m, and planting distance was 30 x 80 cm, as such there were 360 plants/plot with an inter-plot spacing of 1 m. This experiment was free from insecticide application. Vertical distribution of *T. palmi* was observed directly in the field every week beginning from 4 until 11 WAP. A total of 15 plant samples were taken diagonally from each plot and the number of nymphs and adults on every leaf were recorded.

Leaf parameters measured were protein content, total sugar, fat, mineral, water and thickness of leaves. Three potato leaves were sampled from three different positions (upper, middle and lower leaves), taken from four different plant ages which were 4, 6, 8 and 10 WAP. The nutrient contents were analyzed using High Performance Liquid Chromatography (HPLC) Shimadzu 10AT VP at the Biotechnology Research Center, Bogor, West Java. A micrometer was used to measure the thickness of the potato leaves sampled from three positions (upper, middle and lower leaves), 10 pieces each from different plant ages which were 4, 6, 8 and 10 WAP.

Data Analysis

All experiments were arranged in a Randomized Complete Block Design with eight replications. Data was subjected to variance analysis and mean value were compared with multiple LSD at 5% level.

RESULT AND DISCUSSION

Vertical Distribution of *T. palmi*

The attack of *T. palmi* adults had taken place before 4 WAP. This was indicated by the fact that adults and nymphs were already present although the number was still low. The adults were found on the first to the fifth leaves, but they were mostly found (84.13%) on the upper leaves (first to third leaves); whereas nymphs were only found on the mid and lower leaves (fourth to the seventh leaves) (Table 1).

Observations showed that in a plant aged 5–11 WAP, adults spread beginning from the tip of the plant (the first leaf) all the way down to the lowest ones, but in a younger plant the number of the adults were higher (> 70%) in the upper part, which are the first until the fifth leaves, although it must be clarified that the number differed on each leaf at each observation. Kawai (1990) stated that the adults were generally found on the tissue whereas the nymphs were found on tissue of older or more mature leaves. On plants aged 5–6 WAP, the number of adults was similar on the first until the third leaves, but when the plants were aged 6–7 WAP, the number did not vary on the third to the fifth leaves. The adult population increased when the plant was 4–8 WAP, then the number decreased when the plant was 9–11 WAP. This was due to the fact that when the leaves began to mature, adults were no longer interested in them for food.

Table 1: Vertical distribution of *T. palmi* adults on *Solanum tuberosum* based on the position and age of leaf.

Plant age (WAP)	Adult population					
	Upper leaf		Middle leaf		Lower leaf	
	Population	(%)	Population	(%)	Population	(%)
4	7.52 ± 2.44a	84.13	1.35 ± 0.42b	15.08	0.07 ± 0.02b	0.79
5	24.01 ± 4.60a	71.65	9.03 ± 1.67b	26.93	0.47 ± 0.13c	1.41
6	30.85 ± 5.96a	72.45	11.23 ± 2.17b	26.37	0.50 ± 0.18c	1.18
7	30.12 ± 5.24a	74.91	9.91 ± 2.12b	24.64	0.18 ± 0.06c	0.45
8	34.16 ± 6.02a	73.40	12.01 ± 2.04b	25.80	0.37 ± 0.14c	0.80
9	24.54 ± 1.76a	85.74	4.02 ± 0.63b	14.05	0.06 ± 0.01c	0.21
10	14.53 ± 3.49a	74.09.	4.70 ± 0.38b	24.97	0.38 ± 0.12c	0.94
11	7.32 ± 1.99a	71.56	3.93 ± 0.31b	28.05	0.64 ± 0.21c	0.39

Means within rows followed by the same letters are not significantly different at 5% level, according to multiple LSD range tests.

Table 2: Vertical distribution of *T. palmi* nymphs on *Solanum tuberosum* based on the position and age of leaf.

Plant age (WAP)	Nymph population					
	Upper leaf		Middle leaf		Lower leaf	
	Population	(%)	Population	(%)	Population	(%)
4	0 ± 0a	0	0.36 ± 0.12a	46.75	0.41 ± 0.22a	53.25
5	15.45 ± 4.83c	9.54	88.43 ± 16.44a	54.62	58.03 ± 12.50b	35.84
6	15.85 ± 6.79c	9.90	99.41 ± 18.21a	62.09	44.85 ± 11.32b	28.01
7	33.90 ± 12.74c	12.93	165.51 ± 37.17a	63.15	62.69 ± 15.61b	23.92
8	20.51 ± 4.86c	7.33	167.28 ± 48.39a	59.80	91.93 ± 28.49b	32.87
9	110.29 ± 27.18b	29.24	200.07 ± 43.49a	53.04	66.82 ± 17.68c	17.72
10	224.39 ± 39.71b	40.28	266.12 ± 31.16a	47.77	66.53 ± 10.27c	11.95
11	113.60 ± 25.47b	32.68	173.69 ± 27.26a	49.77	60.28 ± 12.54c	17.35

Means within rows followed by the same letters are not significantly different at 5% level, according to multiple LSD tests.

Table 2 shows the increase of nymph populations on every leaf although on a plant of 4 WAP was still very low and the highest population was 0.24 on the sixth leaf. But on older plants with more leaves, these had the highest number of nymphs and they were found on all leaves.

Observations on the vertical distribution of *T. palmi* nymphs showed that there were a tendency for the nymphs to be found in higher number on the middle to the lower leaves (leaves 6–16). Most of the nymphs (> 50%) were found on the middle leaves (leaves 6–10), although the number varied on every leaf at every observation point. The distribution of the nymphs on the middle leaves took place mostly on three leaves which were close to each other. On plants at 9–11 WAP, nymphs were mostly found on the upper and middle leaves (first to ninth leaves). This was due to the fact that the lower leaves had been attacked by nymphs and moreover their number was so great that the leaves had no capacity for more nymphs. In addition, many leaves became senescent and then withered.

Therefore, it is advisable to take the middle leaves as sample from all stages of plant growth to give a more accurate estimation of *T. palmi* populations. It was observed that after 8 weeks after planting, insect number started to vary, which means taking one leaf as a sample, normally done by potato growers, is inadequate. Taking 4–6 leaves from as many as 50% of the middle leaves is recommended. To find threshold level for control purposes, it is suggested to take samples that grow alternately in the plant.

The correct time for observation must also be associated with the insect live; *T. palmi* adults are active in the morning (0700–0900) and in the afternoon (1600–1800). However, on cucumber plant, *T. palmi* adults occur in the afternoon (1700–1800) (Chang 1991). In the morning, the nymphs are found along the midrib. As temperature rises, the nymphs even start to move to other leaves. Therefore, it is suggested that the nymphs' activity should be observed in the morning (0700–0800) or in the afternoon (1600–1700).

Relationship Between Vertical Distribution of *T. palmi* and Potato Plant Nutrition

Results from plants aged 4 WAP show that most of the adults (84.13%) are found on the upper leaves (leaf 1–3). Though the plant become older and has more leaves the spread of adults were always mostly found (72.45%–74.09%) on the upper leaves (leaf 1–5) when the plant reaches the age of 6, 8 and 10 WAP (Table 1).

It is assumed that most *T. palmi* adults dwell on the upper leaves of a plant due to physical factor – light. Pupae living in the ground would emerge into imagoes and move to the upper part of the plant due to light stimulation (Tobing 2000). They will remain there probably because of the advantageous nutritional status. Furthermore, the nutritional status in the upper leaves is appropriate as the source of imago weaving material. The analysis of nutritional content of potato leaves presented in Table 3 shows that the protein content, total sugar,

fat, mineral and water varies depending on the position of the leaf (upper, middle and lower leaves) and age of the plant (4, 6, 8, and 10 WAP).

Table 3 shows that protein and nitrogen levels are always higher in the upper leaves compared to the middle and lower leaves. The upper leaves are chosen as a dwelling place by the adult *T. palmi* because the level of protein and nitrogen is higher compared to the middle and lower part of the plant. Southwood (1973) states that in comparison to other groups of phytophagous insect, most insects that belong to the thrips class feed on rich proteins and sterols found in parts of a young plant. Furthermore, Anantakrishnan (1993) states that it is assumed that there is a significant correlation between nitrogen amino content and trips attack. Blum (1985) and Chapman (1998) proposed that food plays a big role in the proliferation of insects most particularly with the fertility of female insects.

When a plant reaches the age of 10 WAP (Table 3), the results show that the population of adults and nymphs begin to decrease. It is assumed that the reason for this is because the upper leaves of the potato plant become drier, so the adults are not interested in obtaining food from those leaves and to lay eggs on them. Van Emden and Way (1971) stated that the decrease of nutritional status of a plant as the result of the increase of its age is related to certain changes of amino acids content in the plant. As seen in Table 3 the plant maturation is followed with the decrease of protein content all over the leaves.

The observation on the distribution of nymphs of *T. palmi* on potato plants shows that most nymphs (> 70%) are found on the middle and lower leaves, beginning from the sixth leaf down to all leaves in the lower part of the plant when the plant is still 5 to 9 WAP. The nymphs discovered that the upper leaves are suitable places to obtain food. Eggs which were laid on the tissues of the upper leaves hatch into nymphs in the following days on the leaves which are now in the middle position. The addition of the age of the potato plant up to the age of 8 WAP followed by the increase in the number of leaves will result in the increase in the number of adults and nymphs on the plant and this is due to the presence of more hollows on the leaves for the insects to dwell. This shows that both the quality and the quantity available can meet the optimal need for the life cycle of nutrients *T. palmi.* Table 3 shows that when the plant reaches to the age of 10 and 11 WAP, the highest number of nymphs are found on the middle and upper leaves and the reason is because the plant is now aging and as a result the number of leaves does not increase at this time.

Besides nutritional factors, physical factors of a plant also have some effects on the life cycle of the insect (Huffaker *et al*. 1984). Physical factors of potato plant such as the thickness of the leaves are most likely correlated with the selection of the leaves as the place for egg-laying. As presented in Table 4, middle and lower leaves are thicker compared to upper leaves, and therefore the cuticle layer on the leaves is thinner.

Table 3: Content of mineral, fat, protein, and total sugar based on the leaf position and age of *Solanum tuberosum* plant.

No.	Chemical parameters (%)	Plant age (WAP)											
		4			6			8			10		
		U	M	L	U	M	L	U	M	L	U	M	L
1.	Nitrogen	3.42	2.91	2.10	4.40	3.20	3.17	2.94	2.49	2.32	2.35	2.03	1.98
2.	Phosphor	0.53	0.36	0.31	0.55	0.27	0.26	0.38	0.26	0.24	0.26	0.20	0.19
3.	Potassium	6.29	7.95	7.88	5.07	6.57	8.03	5.41	5.98	6.15	4.93	5.22	6.86
4.	Calcium	1.68	2.65	2.49	1.25	2.40	1.77	2.31	2.98	2.70	2.10	2.37	2.12
5.	Magnesium	0.51	0.63	0.58	0.45	0.38	0.44	0.36	0.39	0.33	0.31	0.29	0.28
6.	Fat	4.11	5.07	4.39	4.85	5.44	5.41	4.34	5.62	5.90	4.64	5.43	5.61
7.	Protein	21.38	18.19	13.13	27.50	20.00	19.81	18.37	15.56	14.50	15.11	12.74	10.35
8.	Total sugar	4.30	5.52	10.72	7.42	10.80	16.66	8.56	11.44	19.14	10.42	15.04	25.38
9.	Sucrose	1.04	2.06	2.62	1.16	2.24	3.35	1.58	2.69	2.85	2.02	3.09	3.42
10.	Glucose	1.15	1.83	2.07	2.68	2.68	2.86	2.75	2.95	4.14	3.60	3.89	5.35
11.	Fructose	1.72	2.02	2.47	2.39	2.71	3.33	1.38	3.39	6.19	1.62	5.17	8.43

WAP = weeks after planting; U = upper leaf, M = middle leaf and L = lower leaf

Table 4: The average of leaf thickness (µm) based on leaf position and age of potato plant.

	Plant age (WAP)			
Leaf position	4	6	8	10
Upper leaf	210.55	219.35	223.44	225.12
Middle leaf	285.62	312.72	320.65	318.21
Lower leaf	304.87	313.15	319.45	262.46

WAP = weeks after planting

CONCLUSION

Results of the present study showed that *T. palmi* adults are found on the upper leaves (first to fifth) while nymphs are mostly found on the middle leaves (beginning from the sixth leaves). Appropriate population of *T. palmi* adults are found on the upper leaves, therefore adults of *T. palmi* choose the upper leaves as their food source and a place to lay eggs. Monitoring *T. palmi* populations are best done by observing middle leaves, for example 2–3 leaves taken alternately, and the best time for monitoring is at 0700–0800 or 1600–1700.

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