Spatial Distributions of Thrips on Long Beans in UiTM Pahang

Mohd. Rasdi, Z.
Fairuz, K.
Fauziah, I.
Hazmi, A.D.
Hasni, H
Md. Jamaluddin, B

ABSTRACT

A study has been carried out to determine the population dynamics as well as the spatial distributions of thrips infesting long beans cultivation. This study was carried out at the student's share farm plot in UiTM Pahang. This study was aimed to obtain the primary data on the abundance of thrips population in of Universiti Teknologi MARA (UiTM) Pahang share farm plot and also to determine the spatial distributions of thrips on long bean. During the study, no insecticide has been applied in order to determine the abundance of thrips population naturally. Data collection started from the flowering stage till to the harvesting period. A total of 150 flowers were sampled every week for nine consecutive weeks. The population dynamics of thrips adults ($P<0.01$) and nymphs ($P<0.01$) presence in the plot were found significantly higher at the end of fruiting period. The increasing rates of adults thrips were found higher than the nymphs throughout the study. The spatial distributions of thrips in the plot were found aggregated where both variance-to-mean ratio and Morisita's index value for thrips adults and nymphs were greater than one (index>1) in every sampling dates. Although there were some natural enemies observed in this study, their population still did not sufficient in controlling thrips infestation. The development of natural enemies in the plot seems to be slower than the thrips population.

Keywords: *Long bean, Morisita's index, spatial distribution, thrips, variance-to-mean ratio*

Introduction

Legumes are one of the popular and highly demanded vegetables in Malaysia. Legumes are fruit vegetables such as long bean (*Vigna sinensis* L.), French bean (*Phaseolus vulgaris* L.), four-angled bean (*Psophocarpus tetragonolobus* L.), kidney bean (*Lablab purpureus* L.) and sweet bean (*Pisum sativum* var. *saccharatum*). Mostly, legumes are cultivated in Melaka, Negeri Sembilan, Johor and Selangor (Jabatan Pertanian Semenanjung Malaysia, 2000). Legumes are also cultivated in other states in Malaysia but not as many as in those four states. Recently, legumes are seriously attacked by thrips which is a small insect that can cause severe damages by attacking buds or blossoms, whitening or curling foliage and deforming and scarring fruits.

Many thrips species are destructive pests to a wide range of hosts, especially grain crops, fruits, vegetables and ornamentals. Feeding activities of thrips result in plant deformities, scarring, loss of yield, and in some cases, transmission of plant pathogens. Thrips mostly attack flowers, buds, shoots or young leaves of the plants. The attacks on the leaves cause discolouration and develop a distorted aspect between the lateral veins, whereas on flowers they become discoloured and dried. In addition to the feeding damage, both surfaces of the leaves are covered with small droplets of reddish fluid, voided by thrips that gradually changes to blackish in colour. Severely damaged leaves turn to yellow and drop to the ground. In legumes, thrips commonly attack flowers and cause the beans to be distorted, unmarketable and of no cosmetic value. Infestation of thrips has been observed on different legume cultivars particularly long bean (*Vigna sinensis*), French bean (*Phaseolus vulgaris*) and peas (*Pisum sativum*). The thrips damage has resulted in total crop failure (Talekar, 1991). Infestation usually depends on the quality of food, physiology of plants, protection afforded and the nature of environmental factors. Thrips concentrate their

feeding activities to restricted regions on the plants especially at the growing tissue, buds, leaves and flowers. The quality and cosmetic values of fruits will be reduced when the thrips attack or feed on the petals of blossoms or on developing fruits resulting in stripe that appears in tomato and brinjal or rust-like symptom on legumes. Leaves become dry, curling, turn brown and eventually drop or fall to the ground when the thrips infest heavily. Thrips also affect their host unfavourably by transmitting diseases, including toxemias caused by toxin in saliva. Bacterial and fungal diseases spread by mechanical contact and viruses transmitted during feeding (Sakimura, 1947).

The most common species of thrips found on legumes is *Megalurothrips usitatus* Bagnall and mainly found on long bean (*Vigna sinensis*) and French bean (*Phaseolus vulgaris*). The soybean thrips feed primarily on soybean, bean and other legumes, but also infest cotton (*Gossypium* spp.), cucumber (*Cucumis sativus* L.), smartweed and a number of grasses famili Gramineae.

Although there have been studies on control measures of thrips especially on chemicals, however, in Malaysia there were still lack of detail study on the behaviour and spatial distributions of thrips. For that reason, this study was aimed to obtain the primary data on the abundance of thrips population in the share farm plot of Universiti Teknologi MARA (UiTM) Pahang. This study is also to determine the spatial distributions of thrips on long bean.

Materials and Methods

The study involved analyses of data and development of spatial distribution of thrips in the experimental plot. The data were generated through nine sampling weeks conducted at UiTM Pahang student's share farm.

Crop Management

Beds with the size of 5m long x 1m width were prepared manually. A total of 5 beds were prepared for this experiment. Each bed consisted of 10 long bean plants per row and a total of 20 plants per bed (Figure 1). Seedlings were transplanted to the field after two weeks in the nursery. The plants were watered manually twice every day for one month until the seedlings have established. Compound fertiliser NPK Blue Special® (12:12:17:2), was applied at the rate of 30 g per plant in four split applications every month. Watering was applied twice a day. No insecticide was applied to the seedlings. The long bean seedlings were kept in the nursery for two weeks before transplanted into the field. Throughout the experimental period, no insecticide was applied to the plant so that, the population of thrips can be determined naturally. However, the fungicide (cupric hydroxide at 10g per 4.5 litre of water) was applied to protect the plant from infection against fungal diseases. Weeding was done manually using a hoe to remove weeds.

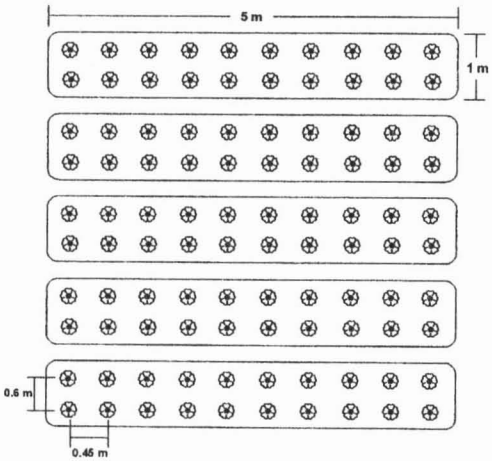

Figure 1: Plot Layout of Long Bean

Data Collection

Data collection commenced from 24th March 2006 to 19th May 2006 which was immediately after the plants started to produce flowers (Figure 2). A destructive sampling method was used in this experiment, where all the samples were destroyed after being collected. A total of 50 plants were systematically selected as samples in this study where 5 plants were selected from each row. Then, on each plant, 3 flowers were picked randomly to determine the population of thrips. The flowers were then immediately placed into sampling bottles containing half-full of 75% of alcohol for thrips preservation purpose.

The samples were shook carefully before flowers and buds were removed. The samples were then poured into petri dishes for isolation process. The number of thrips were counted and kept in bijou bottle before they were placed on slide for species identification.

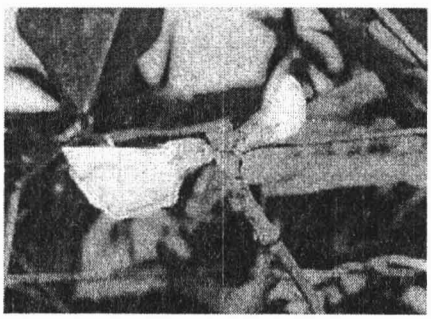

Figure 2: Flowers of Long Bean

Statistical Analysis

The data of thrips collected were transformed using square-root transformation [$\sqrt{(X + 0.5)}$] for normalization. Then, both adult and nymphs of thrips data were subjected to one way Analysis of Variance (ANOVA) to determine their significant differences between sampling dates. The significant means were then separated by using Tukey's *b* HSD (Gomez and Gomez, 1984). The data were performed using SPSS version 11.5.

Distribution of Thrips

The degree of aggregation of thrips within the experimental plot was evaluated based on empirical relationships of Variance-to-Mean Ratio, (s^2/m) (Taylor, 1961) and Morisita's Index of aggregation, I_δ (Taylor, 1984). In each sampling dates, data were analyzed to obtain sample variance (s^2) and sample mean ($\bar{x}$). The mean and variance were obtained as equations 1 and 2 below (Gomez and Gomez, 1984):

$$\bar{x} = \frac{\Sigma(x)}{n} \quad \text{(equation 1)} \qquad s^2 = \frac{\Sigma\left[(x-x)^2\right]}{(n-1)} \quad \text{(equation 2)}$$

The value of variance-to-mean ratio was then compared to unity, whence larger than unity (>1), unity (=1) and less unity (<1) described aggregated, random and regular distribution respectively (Taylor, 1984). Morisita's Index is obtained as equation 3 (Southwood, 1978) where, **N**, is the total number of samples and $\sum\mathbf{x}$, is total numbers of individuals in all samples. An aggregation index, $\mathbf{I_b}$ is then calculated as equation 4 where, **G**, is the number of sampling occasions. Again, the index, $\mathbf{I_b}$, is then compared to unity, whence larger than unity (>1), unity (=1) and less unity (<1) described aggregated, random and regular distribution respectively.

$$I_\delta = N\frac{\Sigma x^2 - \Sigma x}{\Sigma(x)^2 - \Sigma x} \quad \text{(equation 3)} \qquad I_b = I_\delta \frac{G - 1/N}{G - 1} \quad \text{(equation 4)}$$

Results and Discussion

Population Dynamics of Thrips

The abundance of nymphs and adults thrips were illustrated in Figure 3. The results has shown that the number of adult thrips were significantly differed among sampling dates (df=8, F=14.23 & $P<0.01$). Significant higher number of adult thrips were found on the 12th (3 adult thrips/plant) and 19th (2.5 adult thrips/plant) May 2006 which were in the end of fruiting period of long bean. Meanwhile, significant lower population of thrips adults were found in the middle of fruiting period which were on the 20th , 28th April 2006 and 5th May 2006. The number of nymphs thrips were also found significantly diffred among all sampling dates (df=8, F=62.86 & $P<0.01$), where significant higher number of thrips nymphs were also found in the end of fruiting period which were on the 12th (5 nymphs/plant) and 19th (13 nymphs/plant) May 2006. On the other sampling dates, the number of nymphs thrips were found constantly lower. According to Bal (1991), eight and 22 thrips per 25 flower buds and 150 thrips per 25 flowers were determined as the action threshold where a minimum of two sprays needed. When only one spray is necessary during the flowering period, 90 thrips per 25 flowers is suggested action threshold to protect flower buds from thrips infestations.

The abundance of adults were found higher than the nymphs probably because of immigration of thrips adults from other plants and also from the alternate hosts nearby to the plot. Other posibilties is that, thrips apparently can rely almost entirely on parthenogenetic reproduction, in which the female produces young without mating. The optimum temperature and rate of development from egg to adult were between 15 to 30 °C (McDonald *et al.,* 1999). These factors are believed to be the most important factors which give high contribution to the high population of adult thrips.

Higher number of thrips can help to produce other potential threat to the long bean. For instance, thrips is well known as a vector of Tomato Spotted Wilt tospoVirus (TSWV) on various types of vegetables (McPherson *et al.,* 1999; Boonham *et al.,* 2002; Mason *et al.,* 2003) which being considered as an economically important genus of plant virus (Goldbach and Peters, 1994; Mumford *et al.,* 1996). Similar to aphids, the viruses were transmitted by thrips through the salivery while sucking the plant sap. The major site of TSWV replication is in the salivary gland of the thrips mouth (Wijkamp *et al.,* 1993). TSWV can be infected to the plant within 12 and 24 hours for individuals feeding on virus-free plant (Mason *et al.,* 2003). Higher incidence of TSWV occurred when thrips vector species were more abundant (McPherson *et al.,* 1999).

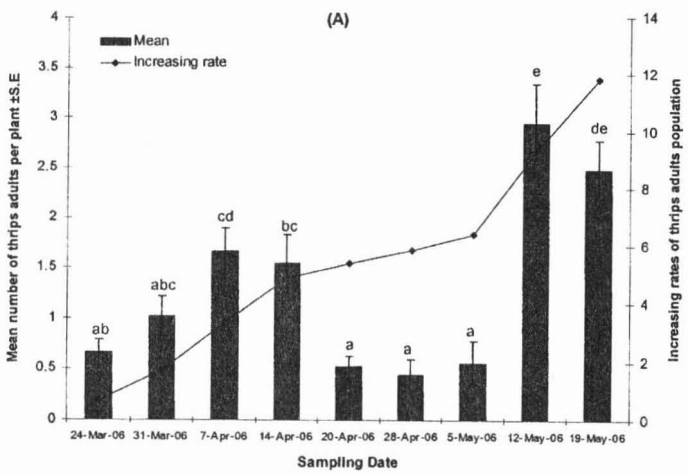

Figure 3(a): Mean Number (±S.E) and Increasing Rates of Thrips's Adults on Long Beans over Sampling Date

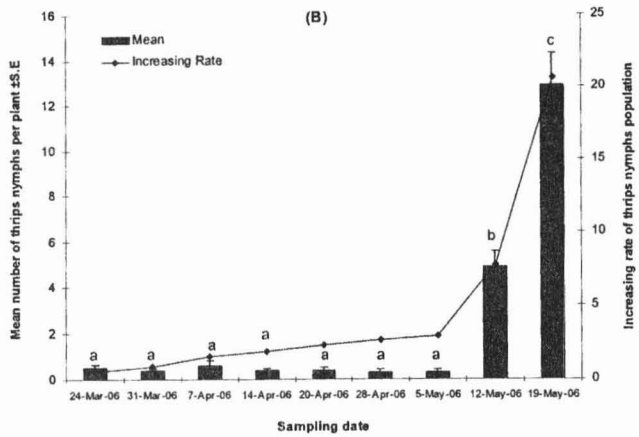

Figure 3(b): Mean Number (±S.E) and Increasing Rates of Thrips's Nymphs on Long Beans over Sampling Date

Spatial Distributions of Thrips

Variance-to-mean ratio and Morisita's Index have shown an aggregation type of thrips distribution in the plot (Table 1) for every sampling date. Further more, Variance-to-mean ratio has concluded that, the highest value of aggregation of adult thrips were found at 5th May 2006 (s^2/m=4.02) and nymph thrips were found at 19th May 2006 (s^2/m=7.66). However, Morisita's index has shown that, the highest value of aggregation of adult (I_b=7.28) and nymph (I_b=14.19) thrips was on the 5th May 2006. The aggregation distribution of thrips in the plot indicated that, there were more direct and indirect damage can be done to the long bean in a short period of time. Such direct damage is that thrips fed on flowers and causing them stunted and easily drops to the soil. Subsequently, it is obviously that when there were no flowers, fruits cannot be produced. For comparison, in Canada, the spatial distribution of adult and immature populations of *Frankliniella occidentalis* were found aggregated on the top stratum in both intra-plant and inter-plant of sweet pepper (Shipp and Zariffa, 1991). Similarly, Reitz (2002) also found more adults occurred in flowers in the upper part of the plant canopy than in flowers in the lower part of plant canopy of tomatoes in North Florida.

Table1: Conformity of Thrips to the Indices of Aggregation (s^2/m and I_b)

Sampling Date	N	Adults of Thrips			Nymphs of Thrips		
		Mean	s^2/m [1]	I_b [2]	Mean	s^2/m	I_b
24-Mar-06	50	0.66	1.15 a	1.38 a	0.52	1.98 a	3.28 a
31-Mar-06	50	1.02	1.94 a	2.16 a	0.38	1.17 a	1.64 a
7-Apr-06	50	1.66	1.66 a	1.57 a	0.62	2.76 a	4.35 a
14-Apr-06	50	1.54	2.66 a	2.32 a	0.38	1.06 a	1.31 a
20-Apr-06	50	0.52	1.27 a	1.73 a	0.40	2.14 a	4.43 a
28-Apr-06	50	0.44	2.98 a	6.32 a	0.30	3.16 a	9.62 a
5-May-06	50	0.56	4.02 a	7.28 a	0.28	4.09 a	14.19 a
12-May-06	50	2.94	2.77 a	1.79 a	4.88	4.77 a	1.98 a
19-May-06	50	2.48	1.75 a	1.46 a	12.88	7.66 a	1.69 a

[1] Variance-to-mean ratio
[2] Moristita's Index
[a] Aggregated distributions

Indirect damages such as transmitting several types of virus will worsen the situation effect on the rapid virus spread. The flowering and fruiting periods are the most crucial periods where these periods will determine whether the farmers are going to make profit or loss. The freshness of the flowers must be taken into account especially in the early of flowering period. Since thrips abundance are always inside the flowers, the freshness of the flowers only can be determine when the flowers have shown a physiological disorders symptoms and changes in colours. The air circulation in the plot also must be maintained by pruning some of the crowded leaves which provide shelter to the thrips and other pest from heavy wind, rainfall as well as their natural enemies. Throughout this study, there were also other arthropods observed such as coccinellids, spiders, ants, aphids, whiteflies and plant hoppers. Some of them were considered as potential pests and some were natural enemies and predators. However, their presence in the field were after the population of thrips have been established and the abundance is way too low than the abundance of thrips. This has made the function of natural enemies is no longer effective in the field.

Conclusion

Thrips abundance in UiTM Pahang's share farm were increasing towards to the end of cropping period. The increment of thrips has lead to the reduction of yield on long beans. Control measures such as crop rotation, field sanitary, removal of alternate hosts, and drainage improvement are highly recommended to be practiced in the UiTM Pahang student's share farm in order to reduce the infestation of thrips as well as other potential pests of long bean and other vegetables. The abundance of other arthropods, especially natural enemies, parasitoids and predators have to be measured since the biological control has become the backbone of the integrated pest management (IPM). A mass rearing of natural enemies such as coccinellids seems to be needed for field release.

Further study is needed to look into the biological aspect of thrips because of the insects' importance in viral diseases spread on vegetables. There may be a possibility to develop an economic threshold level based on the number of thrips per plant for different vegetables and cultivars. Detail samplings of thrips need to be considered by looking at which plant stratum (upper, middle and lower strata) is more preferred.

Acknowledgements

We gratefully acknowledged the assistance of Ms. Marlia and Ms. Wahida in data collection. We thank the Plantation Unit of UiTM Pahang for providing field facilities.

References

Bal, A.B. (1991). Action threshold for flower thrips on cowpea (Vigna unguiculata (L.) Walp.) in Senegal. *Journal of Tropical Pest Management, 37,* (4), 363-367.

Boonham, N., Smith, P., Walsh, K., Tame, J., Morris, J., Spence, N., Bennison, J. and Barker, I. (2002) The detection of *Tomato spotted wilt virus* (TSWV) in individual thrips using real time fluorescent RT-PCR (TaqMan). *Journal of Virological Methods, 101,* 37–48.

Goldbach, R. and Peters, D. (1994). Possible cause of the emergence of tospovirus diseases. *Seminar in VIROLOGY, 5,* 113-120.

Gomez, K.A. and Gomez, A.A. (1984). *Statistical procedures for all agricultural research,* 2nd Edition. John Wiley & Sons, Singapore. 680 pp.

Jabatan Pertanian Semenajung Malaysia. (2000). Perangkaan Keluasan Tanaman. 236 pp.

Mason, G., Roggero, P. and Tavella, L. (2003). Detection of Tomato spotted wilt virus in its vector *Frankliniella occidentalis* by reverse transcription-polymerase chain reaction. *Journal of Virological Methods*, *109*, 69-73.

McDonald, J.R., Bale, J.S. and Walters, K.F.A. (1999). Temperature, development and establishment potential of *Thrips palmi* (Thysanoptera: Thripidae) in the United Kingdom. *European Journal of Entomology*, 96(2), 169-173.

McPherson, R.M., Pappu, H.R. and Jones, D.C. (1999).Occurrence of five thrips species on flue-cured tobacco and impact on spotted wilt disease incidence in Georgia. *Journal of Plant Disease*, 83(8), 765-767.

Mumford, R.A., Barker, I. and Wood, K.R. (1996). The biology of the tospoviruses. *Journal of Annals of Applied Biology*, *128*(1), 159-183.

Reitz, S.R. (2002). Seasonal and within plant distribution of Frankliniella thrips (Thysanoptera: Thripidae) in North Florida tomatoes. *Journal of Florida Entomologist*, *85*(3), 431-439.

Sakimura, K. (1947). Thrips in Relation to Gall-forming and Plant Disease Transmission: A Review. *Proc. Hawaii. Ent. Soc.* (13), 59-96.

Sandra, D.S., and Ramon, C.L. (1987). *SAS System for Elementary Statistical Analysis*. SAS Institute Inc. 418 pp.

Shipp, J.L. and Zariffa, N. (1991). Spatial patterns of and sampling methods for western flower thrips (Thysanoptera: Thripidae) on greenhouse sweet pepper. *Journal of Canadian Entomologist*, *123*(5), 989-1000.

Southwood, T.R.E. (1978). *Ecological Methods: with particular reference to the study of insect populations*. Chapman and Hall, London. 524 pp.

Talekar, N.S. 1991. Thrips in Southeast Asia in Proceedings of a Regional Consultation Workshop. 13 March 1991. Asian Vegetable Research and Development Center. AVRDC. Publication. Taipei. 74 pp.

Taylor, L. R. (1961). Aggregation, Variance, and the Mean. *Journal of Nature, 189*, 732-5.

Taylor, L. R. (1984). Assessing and Interpreting the Spatial Distributions of Insects Population. *Annu. Rev. Entomol*, *29*,57-321.

Wijkamp, I., Van Lent, J., Kormelink, R., Goldbach, R. and Peters, D. (1993). Multiplication of tomato spotted wilt virus in its insect vector, *Frankliniella occidentalis*. *Journal of General Virology*, *74*(3), 341-349.

MOHD. RASDI, Z., FAIRUZ, K. & MD. JAMALUDDIN, B. Faculty of Applied Science, Universiti Teknologi MARA Pahang, Lintasan Semarak, 26400 Bandar Jengka, Pahang, Malaysia

FAUZIAH, I. & HAZMI, A.D., Faculty of Applied Science, Universiti Teknologi MARA Malaysia, 40450 Shah Alam, Selangor, Malaysia.

HASNI, H. Plantation Unit, Universiti Teknologi MARA Pahang, Lintasan Semarak, 26400 Bandar Jengka, Pahang, Malaysia.