MANGOSTEEN THRIPS: COLLECTION, IDENTIFICATION AND CONTROL

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A B S T R A C T

The mangosteen international standard for export requires fruit free from scar. This was the most constraining issue for the Indonesian export of mangosteen. Thrips are pests which cause scars on mangosteen fruits. Hence, there is an inevitable need to control the thrips population. This research was aimed at identifying the thrips pest that causes scars on the mangosteen fruit. This project was also aimed at studying the effects of using yellow fluorescent sticky trap (YST), and the combination treatment: YST and intensive orchard care (YST+IOC) on the percentage and intensity of fruit scars caused by thrips. The research was conducted at a farm with a polycultured mangosteen orchard in Lima Puluh Kota, West Sumatra, Indonesia. It was conducted during the two fruit seasons from September 2006 to February 2007, and from October 2007 to February 2008. The results showed that there were two species of thrips pests that are associated with the mangosteen: *Scirtothrips dorsalis* (Hood) and *Selenothrips rubrocintus* Giard. All of the treatments gave significant differences in decreasing the percentage and intensity of scars. These differences were significantly different compared to the control group in the first year as well as in second year. The combined treatment of YST+IOC proved to have the best results in reducing the percentage (41.19% and 43.96%) and intensity of scars (32.14% and 15.81%) in the first year as well as in the second year, respectively.

Key words: mangosteen, thrips, identification, control

INTRODUCTION

Mangosteen in Indonesia has a very good possibility for being used for both domestic market and overseas export. The plants are widely grown throughout the country; hence, it is expected to become a major Indonesian fruit export. Indonesia is one of the main mangosteen producing countries in the world as well as Thailand and Malaysia (Poerwanto, 2000). Mangosteen juice is rich in the super antioxidants called xanthones. Xanthones have been known to kill or stop the spread of viruses, fungi, bacteria, and free radicals which are strongly associated with cancer. Medical science reveals that xanthones inhibit the oxidation of low density lipoprotein (LDL) one of the causes of arteriosclerosis (hardening of the arteries) and heart attacks (Dench, 2008). Furthermore, mangosteen juice has been proven to promote healing of such medical conditions as diabetes, premature aging and arthritis (Dench, 2008).

Indonesian mangosteen fruit export in 2000 reached 7 182 tons worth US $ 5 885 035 and contributed to 45% of the total fruit exports value (Winarno, 2002). After 2000, Indonesian mangosteen export value declined. One of the problems in exporting mangosteen fruit is the high percentage of visible fruit scar. From 2001 till 2006, only 4.9-13.1% of total Indonesian mangosteen production fulfiled international standard export quality (Indonesian Department of Agriculture, 2007). Preliminary studies show that it is the thrips (Thysanoptera : Thripidae) infestation that caused the scars on the mangosteen fruit. The pest is also known to cause scars on other fruit such as apples (Childs, 1927; Jacob, 1995), grapes (McNally et al., 1985), and avocados (Dennill and Erasmus, 1992b; Hoddle and Morse, 1997). Typical symptoms include: silvering of fruit skin, pale yellow/brown discoloration, elongated and patchy scars or hardened scars, and "alligator skin"-like scars that may cover the entire fruit surface. Heavily scarred skin can sometimes prevent normal fruit growth.

Methods of controlling thrips on mangosteen fruit are not yet available. However, several control methods of thrips on others fruit can be adopted such as applying botanical pesticides as "Sabadilla" derived from the seeds of *Schoenocaulon officinale,* as well as biopesticides such as abamectin and spinosad (Hoddle et al., 1998; Wee et al., 1999; Faber et al., 2000; Astridge and Fay, 2006). Other cultural control techniques which could be used to reduce thrips population are: composted organic yard waste, composted mulch applied under plant canopy, and augmentation of predatory thrips *Franklinothrips orizabensis*, *F. vespiformis* and *Leptothrips mc-cornnelli* (Hoddle et al., 1998; 2002; Wee et al., 1999). University of California Statewide Integrated Pest Management Program (2006) suggested integrated pest management (IPM) for controlling thrips. Such a plan would include: optimal use of natural enemies, removing all weeds under the canopy to eradicate its alternative hosts, regular pruning of infected trees, use of a fluorescent yellow sticky trap, and application of reflective mulch to disturb host plant orientation of the thrips. Chemical insecticide should be used only as a last alternative. Use of fluoresent yellow sticky traps is limited for monitoring the population of thrips due to the cost of adhesive glues such as the one called tanglefoot

(Chu et al., 2006). Therefore, it is necessary to modify the application of sticky traps not only for monitoring but also for controlling thrips population.

Methods of controlling thrips on mangosteen need to be introduced to farmers because they do not realize how serious the problem of thrips infestation is on the quality of the mangosteen. Recently, the price of mangosteens at the farmers` level has been determined based on the quality of the fruit. Those fruit which were free of scars significantly determined the price.

This research was aimed at determining the species of thrips which cause scars on mangosteen fruit and at evaluating the effects of using Yellow Fluorescent Sticky Trap (YST) and combination treatment of YST and intensive orchard care (YST+IOC) on the percentage and intensity of fruit scars caused by thrips during two years of a three-year research project.

MATERIAL AND METHODS

The research was conducted at a mangosteen orchard in Lima Puluh Kota, West Sumatra, from September 2006 to February 2007, and from October 2007 to February 2008. The mangosteen trees were planted in a polyculture planting system along with cacao and coconut trees. The planting distance among mangosteen trees was 8-9 x 9 m. The cacao and coconut trees were planted sporadically in the orchard. The mangosteen trees were 10-15 years-old. They were approximately 4-7 meters high. Scar fruit intensity in the orchard was high (may even 100%) and endemic.

Collection and identification of mangosteen thrips

When the mangosteen trees entered the fruiting stage, four mangosteen fruits per tree were randomly cut off for thrips trap purposes. The samples were immediately put into zip-lock plastic bags, properly labelled and brought to the laboratory for the next stage. In the laboratory, samples were immediately put in the Berlese-Tullgren funnel, a device for extracting thrips. Extraction took place for at least 24 hours using a 40-watt bulb to create a step gradient of temperature and moisture. The extracted thrips were trapped into a small wide-mouthed jar with 70% ethyl alcohol. The trapped thrips were separated from accompanying bits of debris under a dissecting microscope. The thrips were then made ready for mounting on glass slides. The reason for mounting the specimen was to identify the thrips species associated with the mangosteen fruit.

To prepare the thrips specimen for sorting and identification, all thrips taken from all samples were mounted on glass slides using Hoyer's medium. However, before the mounting process, the specimen had to be macerated to remove the body for detail of the dorsal and ventral surface sculpture, and the presence of small setae for identification purposes. The method of Palmer et al. (1989) was used, including a combination of the

Krantz (1978) and Henderson (2001) methods for thrips slide mounting.

All of the mounted thrips in each sample were sorted and identified by species under a dissecting microscope, using the Thrips ID program produced by Lucid Australia (Moritz et al., 2001).

Intensive orchard care and sticky trap

Mangosteen trees were sampled and used for the experiment as a sampling unit. The experiment was done in a completely randomized design with three treatments, and six replications in the first year and four replications in the second year due to the limit of fruiting trees. Three treatments were used in this study. They were: 1) application of yellow fluorescent sticky trap (YST), 2) combination of IOC+YST and 3) the control.

The yellow fluorescent sticky trap tube (YST) was made of aluminium that formed a tube which was 10 cm in diameter. The tube was nailed on a 3-meter-long wooden stick. Transparent "Ultra Super" glue commonly used to trap rats/mice was smeared on one side of the surface of a transparent overhead projection (OHP) plastic "Yashica" (21 cm x 33 cm). The plastic, with the glue part facing outward, was then put on the YST tube (Fig. 1). Four wooden sticks with YST tubes were put at four opposite points about 30 cm from the outer side of the canopy. The trapped insects stuck onto the glued surface. The sticky trap plastic was removed and replaced with a new one every two weeks.

Intensive orchard care was applied by removing all weeds under the canopy of a mangosteen tree, followed with tilling the surface of the soil and fogging, which was done by burning coconut husks. Burning of coconut husks was done when there was no wind. These orchard practices were repeated monthly until harvest. The combination treatment of intensive orchard care and sticky trap (IOC+YST) was performed by combining both procedures as mentioned above.

Parameters observed

The following data were gathered:

a. Percentage and intensity of the fruit scars. Percentage of scars was defined as number of scarred fruits divided by total number of observed fruits and expressed in percents. Modification of the Mahfud et al. (1994) method was used to count the intensity of scarring that was defined as the value of scars (1-100) divided by the highest value of scars. The estimation of scar intensity value was made easier by dividing the mangosteen fruits into eight parts of the same proportion. This was done by standing the mangosteen fruit upright. The upper part is then divided into four parts and the lower part into four parts. This means that each part contained 12.5% mangosteen fruit. All of the treatments were

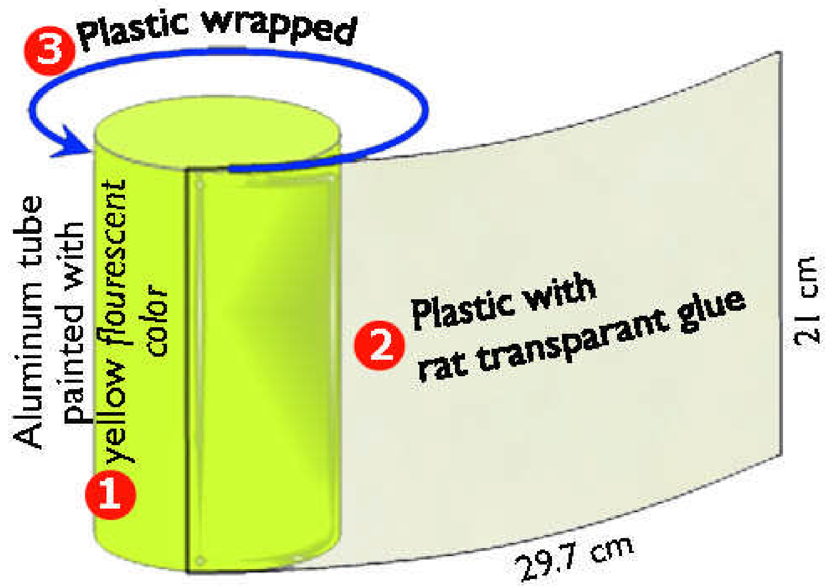

Figure 1. The yellow fluorescent sticky trap

observed six to nine times during the early fruit growth stage until harvest. The complete formula of percentage and intensity of scar is shown as follows,

$$P = \frac{n}{N} \times 100\%,$$

where:
P = percentage of scars
n = number of scarred fruits
N = total number of observed fruits

$$I = \frac{V}{Z} \times 100\%,$$

where:
I = intensity of scars
V = value of scarring
Z = highest value of scarring

b. The number of thrips caught by the sticky trap (21 cm x 30 cm) was also checked six to nine times during the fruit growth stage.
c. Average daily rainfall, rainy days, temperature and relative humidity.

Experimental data were analyzed by ANOVA and the Least Significant Difference (LSD) test was used for the estimation of significant differences between the treatments.

RESULT AND DISCUSSION

Identity of mangosteen thrips

The result showed that there were two species of phytophagous thrips associated with mangosteen fruits, namely the *Scirtothrips dorsalis* (Hood) and the *Selenothrips rubrocintus* Giard that are characterized as follows:

No.	Body part	Character of body part	
		S. dorsalis	***S. rubrocintus***
1.	Body colour	Body colour mainly yellow, antecostal ridges of tergites and sternites dark brown with a small associated brown area.	Dark blackish brown body.
2.	Antenna	Antennae 8-segmented, III and IV with constricted apical neck, sense cone forked and stout. Antennal segment I white, II and III grey, V – VIII brown.	Antennae 8-segmented, antennal segment II and III shape more or less symmetric, segments III and IV with constricted neck at base and apex, sense cone long and forked. Antennal segments III and V yellow in basal half, IV yellow at base and apex.
3.	Satae	Setae on abdominal tergite X slender, minute and scarcely visible. Major setae not dark.	Setae on abdominal tergite X slender, minute and scarcely visible.
4.	Forewing	Uniformly light brown, weakly shaded. Forewing first vein with 3 setae on distal half, second vein with 2 widely spaced setae; posterior fringe cilia straight; clavus with 4 veinal setae.	Uniformly dark brown with 2 rows of black setae. Forewing with costal cilia longer than costal setae; posteromarginal cilia wavy; both veins with a complete row of widely spaced setae.
5.	Head	Head shape not prolonged in front of compound eye. Head wider than long, postocular region and ocellar triangle with closely spaced transverse lines of sculpture; 3 pairs of ocellar setae present, pair III close together between median points of hind ocelli; 2 pairs of major postocular setae present.	Head shape not prolonged in front of compound eye. Head with cheeks constricted to basal neck, no transverse ridge dorsally; 1 pair of long ocellar setae.
6.	Pronotum	Pronotum with closely spaced transverse lines of sculpture; posterior margin with 4 pairs of setae, B2 about 30 microns long.	Pronotum short, surface with transverse lines of sculpture, 1 pair of long anteromarginal setae.
7.	Mesonotum	Mesonotum with pair of setae arising medially.	Mesonotum without median division.
8.	Metanotum	Metanotum with parallel longitudinal lines of sculpture on posterior half, campaniform sensilla absent, median setae arise behind anterior margin.	Metanotum with clearly defined triangle medially enclosing transverse reticulation, with 1 pair of setae medially and 1 pair of campaniform sensilla.
9.	Metathoracid endofurca	Metathoracid endofurca transverse, sometimes with simple median spinula.	Metathoracid endofurca elongate and Y-shaped

10.	Tergites	Tergites III – VI with median setae small but close together; II – VIII with lateral thirds covered in closely spaced rows of fine microtrichia.	Abdominal tergites reticulate on lateral areas, these areas bearing long setae; III-VIII with 1 pair of long setae medially; VIII with complete comb of long microtrichia; X without longitudinal division.
11.	Sternites	Sternites without discal setae, covered with rows of microtrichia except anteromedially; posterior margins without comb of microtrichia; median setae on VII arising at margin.	Sternal marginal setae almost half as long as sternites.
12.	Microtrichia	The microtrichial fields had 3 discal setae and posterior margins with fine comb; VIII with comb complete across posterior margin, lateral discal microtrichia extending across middle of tergite; IX with several rows of discal microtrichia.	
13.	Figure	2 A	2 B
14.	Source	Moritz et al., 2001	Moritz et al., 2001

Figure 2. Thrips associate with mangosteen, *S. dorsalis* (Hood) (A) and *S. rubrocintus* Giard (B)

Species *S. dorsalis* is known as the pest that caused scar on mangosteen in Thailand (Pankeaw, 2006). Meanwhile, species *S. rubrocintus* is also known as a pest that caused scar on mangosteen in Australia (Astridge and Fay, 2006), and on avocados, cashews and cacao fruit worldwide (Dennill and Erasmus, 1992 a).

Effect of intensive orchard care and yellow fluorescent sticky trap

The result showed that all of the treatments gave significant differences in decreasing the percentage and intensity of scars compared to the control group, in the first year of research as well as in the second year. Application of YST reduced the percentage of scar as much as 21.65% and 35.44% compared to the control in the first and second year, respectively. Meanwhile, intensity of scar decreased by 26.28% and 10.82% compared to the control group in the first and second year, respectively. However, the combination treatment of IOC+YST showed the best results in reducing percentage (41.81% and 43.96%) and intensity of scar value (32.14% and 15.81%) in the first year as well as in the second year, respectively. A complete data of percentage and intensity of scarring at the end of the observation is presented in Table 1.

Surprisingly, the treatments which we used in the orchard had a positive side effect, i.e. decreasing the percentage and intensity of scar on the whole untreated mangosteen trees and expressed in control treatment. Intensive orchard care by removing weeds effectively reduced thrips infestation. Various weeds are used as alternative hosts for breeding habitat, food and as a place to seek refugee by the thrips (Rethwisch et al., 1998; Kuepper, 2004). Meanwhile, application of YST effectively reduced the remaining population of adult thrips. First the thrips were reduced using the intensive orchard care but then remaining thrips emerged as adults. The adults were then consequently trapped using YST. A similar result reported that use of the yellow sticky trap was effective in controlling thrips on avocado (Hoddle dan Morse, 2003) and citrus (Hasyim et al., 2003). The combination treatment of intensive orchard care and applying yellow fluorescent sticky trap (IOC+YST) showed an ability to reduce scarring intensity (32.14% and 15.81%) at the end of the observation in the first and second year, compared to the control group. However, the combination treatment of IOC+YST was not significantly different compared to only the YST treatment, in reducing intensity of scar in the first year as well as in the second year.

Fluctuation in the population of mangosteen thrips

A high number of thrips occurred in the first and second observation. Tsai et al. (1996) and Funderburk et al. (2002) stated that population fluctuation of flower thrips would be a function of flower density. Since then, the number of thrips was relatively low and far from being on the economic threshold (the third to the ninth observation). Hasyim et al. (2003) said that the economic injury level of thrips on citrus would

Table 1. Percentage and intensity of scars on mangosteen fruits from different treatments in the first and second year of the research (at the end of observation)

Treatment	First year		Second year	
	percentage of scarring [%]	intensity of scarring	percentage of scarring [%]	intensity of scarring
Control	100.00 a*	41.93 a	76.79 a	21.80 a
YST	78.37 b	15.65 b	41.35 b	10.98 ab
IOC + YST	58.19 c	9.79 b	32.83 c	5.99 b

*Mean values in each column with the same letter are not significantly different (p = 0.05) based on Least Significant Difference (LSD)

happen if there were 5 thrips per yellow fluorescent sticky trap. In fact, treatment of YST and the combination treatment of IOC+YST were effective at decreasing the number of thrips in the third to the fifth observation. Nevertheless, the varying number of thrips captured by yellow sticky trap was influenced by many factors such as trap attractiveness relative to the surrounding vegetation, host plant composition, thrips population size and proportion of the population that is dispersing, and thrips behaviour and agricultural practices. Long term weather variables such as temperature and precipitation are responsible for the majority of the variation in the thrips captured (Morsello et al., 2008). In addition, rainfall tends to negatively affect the population of thrips (Bailey, 1933; 1934) because heavy precipitation events can kill larvae (Kirk, 1997) and suppress dispersal (Lewis, 1963). The average number of thrips caught by YST and the combination treatment of IOC+YST are presented in Figure 3, and the average volume of rainfall including rainfall days based on biweekly observation are presented in Figure 4.

In the first and second year, population fluctuation of mangosteen thrips captured by yellow fluorescent sticky trap (Fig. 5) was mostly influenced by climatic factors, especially days with rainfall (Fig. 6). The correlation analysis of climatic factors showed that volume of rainfall, rainfall days, temperatures and relative humidity negatively correlated with the average number of thrips trapped in yellow fluorescent sticky traps. However, rainfall days and relative humidity were the most significantly correlated factors counting towards population fluctuation of thrips caught by yellow florescent sticky traps, as expressed by regression equation: $y = 394.17 - 1.06\ x_1^* + 0.012\ x_2 - 1.38\ x_3^* - 10.32\ x_4$ and $R^2 = 0.9979$ (x_1 = rainfall days, x_2 = average volume of rainfall (mm), x_3 = relative humidity and x_4 = temperature).

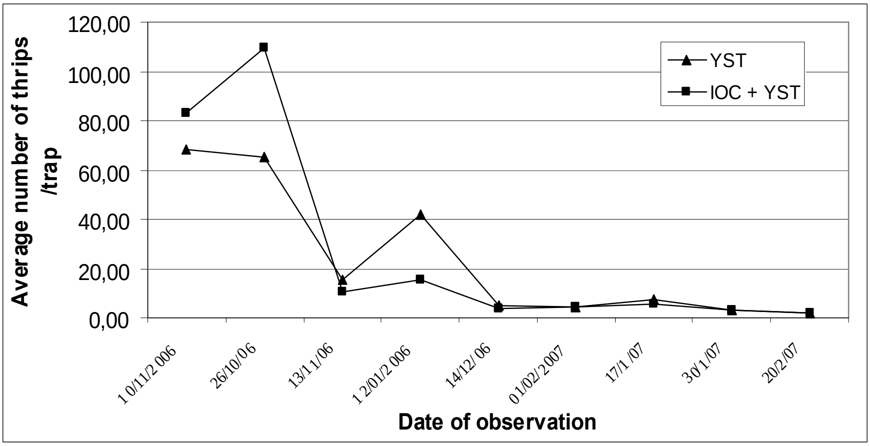

Figure 3. Average number of thrips caught on yellow fluorescent sticky traps in combination where only traps ere employed (YST) and in combined treatment of intensive orchard care and yellow fluorescent sticky traps (IOC+YST) during the years 2006-2007

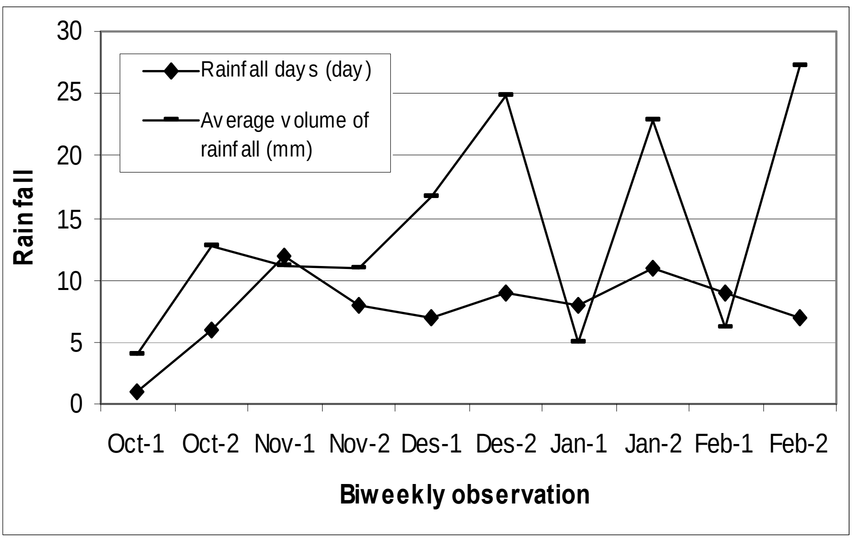

Figure 4. Average volume of rainfall and number of rainfall days during the years 2006-2007

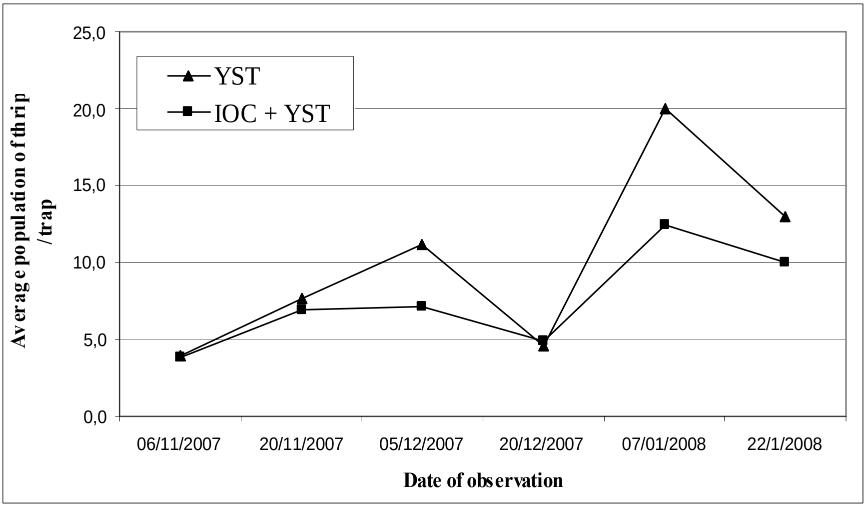

Figure 5. Average number of thrips caught on yellow fluorescent sticky traps in combination where only traps ere employed (YST) and in combined treatment of intensive orchard care and yellow fluorescent sticky traps (IOC+YST) during the years 2007-2008

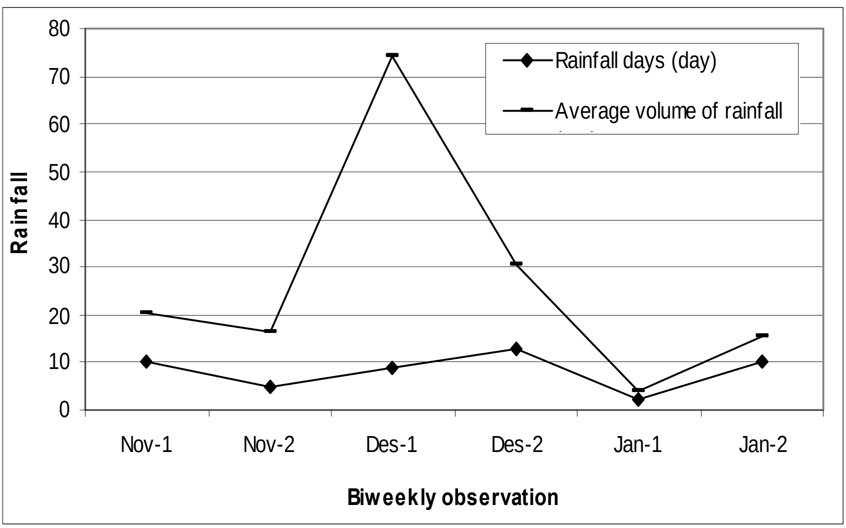

Figure 6. Average volume number of rainfall and rainfall days during the observation years 2007-2008

It suggests that during low rainfall days and low relative humidity periods, farmers should pay extra attention to intensive orchard care. A similar result was reported for dry weather favouring thrips population growth (Bailey, 1933; 1934; 1944; Fennah, 1965). Franssen and Huisman (1958), and Kirk (1997) added that infestation of *Thrips angusticeps* Uzel during the rainy and cool season was significantly lower than infestations during the dry and hot season. This is presumably because of high larval mortality and slower population growth rate. Hence, even though population size and proportion of the population that is dispersing thrips is relatively high, due to effective catches by the YST, it still resulted in a low percentage and intensity of scar in the second year of the research.

CONCLUSION

There were two species of phytophagous thrips associated with mangosteen fruit, namely *Scirtothrips dorsalis* (Hood) and *Selenothrips rubrocintus* Giard.

The combination treatment of IOC+YST showed the best result in reducing percentage (41.81% and 43.96%) and intensity of scars (32.14% and 15.81%) in the first year as well as in the second year, respectively.

Application of intensive orchard care and yellow fluorescent sticky trap also drastically decreased the population of thrips in the orchard; hence, the population of thrips was now lowered to the point that they no longer posed a threat to the mangosteen fruit quality.

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REFERENCES

Astridge D., Fay H 2006. Red-banded thrips in rare fruit. http://www2.dpi.qld.gov.au/horticulture/5064.html. 3 p. Accessed on: January 6th, 2006.

Bailey S.F. 1933. The biology of bean thrips. HILGARDIA 7: 467-522.

Bailey S.F. 1934. A winter study of onion thrips in California. CADA BULL. 23: 149-152.

Bailey S.F. 1944. The pear thrips in California. University Of California, College Of Agriculture, Agricultural. Exp. Station. Bull. 687 p.

Chu C.C., Ciompelik M., Chang M.A., Richards N., Henneberry M. 2006. Developing and evaluating traps for monitoring *Scirtothrips dorsalis* (Thysanoptera : Thripidae). FLA. ENT. 89(1): 47-55.

Childs L. 1927. Two species of thrips injurious to apples in the pacific

North-West. J. ECON. ENT. 20: 805-808.
Dench B. 2008. The Secrets of Mangosteen. (http://www.medical-point.com.au/the-secrets-of-mango-steen.-asp. Accessed on: July 27th, 2006, 3 p.
Dennill G.B., Erasmus M.J. 1992a. The insect pests of avocado fruits – increasing pest complex and changing pest status. J. ENTOMOL. SOC. SOUTHERN AFRICA 55(1): 51-57.
Dennill G.B., Erasmus M.J. 1992b. Basis for a practical technique for monitoring thrips in avocado orchards. CROP PROTEC. 11(2): 89-91.
Faber B.A., Wee L.Y., Phillips P.A. 2000. Effect of Abactin treatment for avocado thrips on population of Persea and avocado bud mite and their associated damage to leaves and fruit. CALIF. AVO. SOC. YEARBOOK. 84: 95-109.
Fennah R.G. 1965. The influence of environmental stress on the cacao tree in predetermining the feeding sites of cacao thrips, *Selenothrips rubrocinctus* (Giard), on leaves and pods. BULL. ENTOMOL. RES. 56: 333-349.
Franssen C.J.H., Huisman P. A. 1958. The biology and control of *Thrips angusticeps* Uzel. VERSLAGEN LANDBOUWKUNDIGE ONDERZOEKINGEN. 64: 1-104.
Funderburk J.E., Stavisky J., Tipping C., Gorbet D., Momol T., Berger R. 2002. Infection of *Frankliniella fusca* (Thysanoptera : Thripidae) in peanut by the parasitic nematode *Thripinema fuscum* (Thylenchidae : Allantonematidae). ENVIRON. ENTOMOL. 31: 342-346.
Hasyim A., Syamsuwirman, Mu'minin K. 2003. Periode kritis dan ambang kendali hama thrips (*Scirtothrips* sp.) pada tanaman jeruk. J. FARMING 3: 33-38.
Henderson R.C. 2001. Technique for positional slide mounting of Acari. SYS. AND APPL. ACAROL. (SPEC. PUB.) 7: 1-4.
Hoddle M.S., Morse J.G. 1997. Avocado thrips: A serious new pest of avocados in California. CALIF. AVO. SOC. YEARBOOK. 81: 81-90.
Hoddle M.S., Morse J.G., Philliph P.A., Faber B. 1998. Progress on the management of avocado thrips. CALIF. AVO. SOC. YEARBOOK. 82: 87-100.
Hoddle M.S., Morse J.G., Philliph P.A., Faber B., Jetter K.M. 2002. Avocado thrips: New challenge for growers. CALIF. AGRIC. 56(3): 103-105.
Hoddle M.S., Morse J.G. 2003. Avocado thrips, biology and control. AVORESEARCH. SPEC. ED. 8.
Indonesian Department of Agriculture. 2007. Agricultural Statistic. Center For Statistical Data, Department Of Agriculture. 302 p.
Jacob S. 1995. Thrips damage and control in apple orchards. DECIDUOUS FRUIT GROWER 45(8): 323-330.
Kuepper G. 2004. Thrips management alternative in the field. www.attra.ncat.org. Accessed on: January 21st, 2006, 6 p.
Kirk W.D.J. 1997. Distribution, abundance and population dynamics. In: Lewis T. (ed.), Thrips as crop pets. CAB, OXON, UNITED KINGDOM, pp. 217-257.
Krantz G.W. 1978. A manual of acarology. 2nd edition. Oregon University Book Store, Inc., Corvallis, Oregon, USA, 509 p.
Lewis T. 1963. The effect of weather on emergence and take-off of overwin-

tering *Limothrips cerealium* Haliday (Thysanoptera). ANN. APPL. BIOL. 51: 489-502.

Mahfud M.C., Rosmahani L., Sidik N.I. 1994. Bionomi hama silphidae dan penyakit bercak daun (*Pestaliopsis palmarum*) pada salak. PENEL. HORT. 6(2): 29-39.

McNally P.S., Fogg C., Flynn J., Horenstein J. 1985. Effect of thrips (Thysanoptera : Thripidae) on shoot growth and berry maturity of Chenin Blanc grapes. J. ECON. ENT. 78: 69-72.

Moritz D., Morris D., Mound L. 2001. Thrips ID. Pest Thrips of the world. An interactive identification and information system. Csiro Publ., Canberra, Act.

Morsello S.C., Groves R.L., Nault A.B.A., Kennedy G.G. 2008. Temperature and precipitation affect seasonal patterns of dispersing tobacco thrips, *Frankliniella fusca*, and onion thrips *Thrips tabaci* (Thysanoptera : Thripidae) caught on sticky trap. ENVIRON. ENTOMOL. 37(1): 79-86.

Palmer J.M., Mound L.A., du Heaume G.J. 1989. Thysanoptera. CABI Institute of Entomology. British Mus. Nat. Hist. 73 p.

Pankeaw K. 2006. Thrips outbreaks and damage on mangosteen in Southern Thailand and control measures. Master Thesis., Department of Pest Management, Faculty of Natural Resources, Prince Songkla University, 62 p.

Poerwanto R. 2000. Teknologi budidaya manggis. Diskusi Nasional Bisnis dan Teknologi Manggis. Kerjasama Pusat Kajian Buah-Buahan Tropika dengan Direktorat Jendral Hortikultura dan Aneka Tanaman, Departemen Pertanian. Bogor. November 2000, p. 15-16.

Rethwisch M.D., McDaniel C., Peralta M. 1998. Seasonal abundance and field testing of a citrus thrips temperature development model in Arizona citrus. College of Agriculture, Univ. of Arizona, Tucson, Arizona, 13 p.

Tsai J.H., Yue B.S., Funderburk J.E., Webb S.E. 1996. Effect of plant pollen on growth and reproduction of *Frankliniella bispinosa*. ACTA HORT. 431: 535-541.

University of California Statewide Integrated Pest Management Program. 2006. Thrips: identification, life cycle, damage and management. http://www.ipm.ucdavis.edu/PGM/ PESTNOTES/ pn7429.html. 8 pp. Accessed on : July 27th , 2006

Wee L.Y., Philliph P.A., Hoddle M.S., Morse J.G. 1999. Further progress on avocado thrips biology and management. CALIF. AVO. SOC. YEARBOOK. 83: 105-125.

Winarno M. 2002. Pengembangan usaha agribisnis manggis di Indonesia. Disampaikan pada seminar Agribisnis manggis. Bogor, 24 Juni 2002. Direktorat Jenderal Bina Produksi Hortikultura. Departemen Pertanian, 12 hal.

WCIORNASTKI ŻERUJĄCE NA OWOCACH MANGOSTANU: ZBIÓR, IDENTYFIKACJA I OCHRONA

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

Międzynarodowe standardy w eksporcie mangostanu dopuszczają jedynie owoce bez uszkodzonej powierzchni. Owoce mangostanu w Indonezji uszkadzane są przez wciornastki, co przyczynia się do ograniczeń w handlu. Konieczna jest zatem kontrola populacji tych szkodników. Celem przeprowadzonych badań była identyfikacja gatunków wciornastków żerujących na owocach mangostanu, jak również poznanie wpływu stosowania fluoryzujących żółtych pułapek lepowych oraz kombinacji żółtych pułapek lepowych i intensywnych zabiegów agrotechnicznych na procent i intensywność uszkodzeń owoców powodowanych przez te szkodniki. Badanie przeprowadzono w sadzie zawierającym wiele odmian mangostanu, znajdującym się w Lima Puluh Kota na Sumatrze Zachodniej, która jest jedną z prowincji Indonezji, podczas dwóch sezonów owocowania – od września 2006 do lutego 2007 oraz od października 2007 do lutego 2008 roku. Podczas badań wykazano, że dwa gatunki wciornastków uszkadzają owoce mangostanu, a mianowicie: *Scirthothrips dorsalis* (Hood) and *Selenothrips rubrocintus* Giard. Wszystkie przeprowadzone zabiegi spowodowały znaczne zmniejszenie uszkodzeń owoców w porównaniu z owocami w kontroli zarówno w pierwszym, jak i w drugim roku badań. Najlepsze wyniki uzyskano w kombinacji z zastosowaniem żółtych pułapek lepowych połączonych z racjonalną agrotechniką stosowaną w sadzie, gdzie uzyskano zmniejszenie liczby uszkodzonych owoców 41,19% i 43,96% oraz intensywności uszkodzeń o 32,14% i 15,81%, odpowiednio w pierwszym i drugim roku badań.

Słowa kluczowe: mangostan, wciornastki, identyfikacja, ochrona