PHENOLOGICAL STAGE AND COMPOSITION OF MITE FAUNA OF ‘SIEM’ (*Citrus reticulata* Blanco) CITRUS

Affandi

Indonesian Tropical Fruits Research Institute, PO Box 5 Solok 27301
West Sumatra, INDONESIA
e-mail: Affandi1970@yahoo.com

(Received May 15, 2007/Accepted August 10, 2007)

A B S T R A C T

A survey of mite fauna on ‘Siem’ (*Citrus reticulata* Blanco) citrus was carried out at the Indonesian Tropical Fruit Research Institute in order to know their diversity and composition as well as to determine their distribution and abundance at different growth stages of arboreal plant parts, weeds and in plant residues (litter) on the orchard floor. Ten plants were used as sampling units for each of the six growth stages namely; dormant, flush, flowering, at fruit development phases (Fdp) I, II and III. A total of 10,937 mites belonging to112 species were collected during the survey; the results of which showed a total of the phytophagous, predatory, and detritivorous mites, at 316, 3,861 and 6,760 respectively. The diversity of trophic groups of mite at Fdp II was the least at flush growth stage (H’=1.27), and the most at Fdp II growth stage (H’=1.93). Predatory mites were the most diverse of the three trophic groups whether on the arboreal parts of citrus trees, weeds and litter under the canopy of the citrus trees. The phytophagous mites were relatively abundant in the arboreal parts of the citrus trees, making up for 74.19% of all individual mites collected. Based on citrus phenological stages, the lowest numerical populations of phytophagous mites were on the leaves at flush growth stage, with an average of 1.4 mites per sample, and the highest at the Fdp II growth stage, with an average of 11 mites per sample. In these cases the population of the phytophagous mites was scarce and far from reaching economic threshold level. Weeds and litter contributed towards the population development of predatory and detritivorous mites which regulate phytophagous mites in the ‘Siem’ citrus orchard. The present study implies that knowledge of the phenological stage relating to the composition of mite fauna is important. Hence, our studies have shown that the most appropriate time to control phytophagous mite pest on ‘Siem’ citrus is at Fdp II.

Key words: mites, *Citrus reticulata*, phenological stage, composition

INTRODUCTION

Spider mites are considered to be important pests of citrus in many growing regions throughout the world (Jeppson et al., 1975). For instance, the citrus red mite, *Panonychus citri* (McGregor), is able to reduce production of 'Tahiti' lime by 29.25% (Childers and Abou-Setta, 1999). Many species of spider mites also cause direct injury to fruit resulting in scarring on the skin surface. Other effects of this mite may cause fruit to drop prematurely or mature with blemishes that reduce their quality and market value (Jeppson et al., 1975; Smith Mayer, 1981). This can have a serious impact on the profitability of citrus production.

The application of improper pesticides on citrus trees has resulted in an increase of spider mite population, due to their deleterious effects upon predators and the development of the spider mite's resistance to them (Jeppson, 1963; Helle, 1963; Bynum et al., 1997; Kim and Seo, 2001). Consumer health awareness has increased significantly, requiring agricultural products free from pesticide residues. To fulfil this requirement, knowledge of phenological stage and composition of mite fauna in relation to citrus phenological stage reflected by diversity of mite trophic groups, i.e. phytophagous, predatory and detritivorous, is important, so that proper kind and time of interventions can be applied. Hence, analysis of the diversity of all trophic group species, monitoring their relative abundance and their interrelationships in the ecosystem, are all essential factors in evaluating and predicting population outbreaks of pest. Mite fauna diversity is related to the number of predators in the system and their efficiency in preventing single species from monopolizing food resources. Therefore, predators play an important role in maintaining the community in diverse and stable conditions, and stabilizing factors involved in predator-prey population dynamics (Price, 1997).

Hence, this study was proposed in order to collect basic information on acarine species inhabiting citrus for future ecological work needed for the citrus Integrated Pest Management (IPM) program in Indonesia. The study specifically pursued the following objectives: (1) To compare the diversity of mite fauna of the citrus orchard at different stages of crop growth; (2) To determine the distribution and abundance of these mites at the different stages of development of arboreal plant parts, and on weeds and litter in the citrus orchard.

MATERIAL AND METHODS

The research was conducted in the 'Siem' citrus orchard of the Indonesian Tropical Fruit Research Institute at Solok, West Sumatra, Indonesia, from December 2003 until October 2004. Ten plants were used as sampling units for each of the six growth stages, namely; dormant (Drmt), flush (Flsh) and flowering (Flwr), at fruit development phase I, which was sampled one month after flowering stage (Fdp I); fruit development phase II, which was sampled three months after flowering stage (Fdp II), and fruit development phase III, which was sampled five months after flowering stage (Fdp III). One sample from each growth stage was taken from those parts of citrus plants that could be reached easily. Five terminal twigs, of approximately 15 cm in length, were cut from each sample plant during the flush growth stage, immediately put in zip-lock plastic bags, properly labelled and brought to the laboratory for the next treatment stage. Here, five citrus leaves from each of the terminal twigs were randomly chosen and immediately placed into the Berlese-Tullgren funnel, which was used for the extraction of the mites. Extraction continued for at least 24 hours and a 40-watt bulb was used to create a step gradient of temperature and moisture in the mite's habitat. The extracted mites were collected into small wide-mouthed jars with the aid of 70% ethyl alcohol, which had been placed under each funnel. They were then separated from accompanying bits of debris under a dissecting microscope, before being mounted on glass slides. For the other plant growth stages, i.e. flowering, Fdp I, II and III, the stalks, containing the reproductive parts with leaves, were cut to a length of approximately 15 cm. Each five cluster sample was taken from tree branches which were easily accessible from each of the 10 trees. These samples were treated as for the terminal twigs, including the reproductive parts (flowers, Fdp I, II and III) and at given growth stages, and were placed in the Berlese-Tullgren funnel to trap the mite's fauna. All specimens of phytophagous, predatory, and detritivorous mites contained in the named plant parts were collected and mounted on glass slides for identification, sorting and counting.

To determine alternative hosts of phytophagous mites and the habitat range of predators and detritivores (Objective No. 2), weeds were collected from under the canopy of citrus plants and sampled for their mites' fauna. Ten twig samples from each weed species, along with five litter samples, each weighing approximately 0.5 kg, were taken from under the canopy of citrus plants during all growth stages, put in zip-lock plastic bags and properly labelled. Each sample was then treated as these of the terminal twigs.

To prepare the specimens of predatory, phytophagous and detritivorous mites for sorting, identification and counting, all mites taken from all samples were mounted on glass slides using Hoyer's medium. A combination of Krantz (1978) and Henderson (2001) methods were used for the mites' slide mounting. All of the mounted mites in each sample were sorted and identified to species level under a dissecting microscope using appropriate taxonomic references. They were then verified at the laboratory. All species of phytophagous, predatory, and detritivorous mites collected from the samples taken at all citrus growth stages, as well as those collected from weeds and litter, were counted.

Index of diversity (H') of phytophagous, predatory and detritivorous mites of each sample was analyzed (objective No. 1), using Shannon-Wiener function (Wallwork, 1976):

$$H = C/N \cdot \left(N \log N - \sum_{r=1}^{S} ni \log ni\right)$$

Where: C = 3.321928
N = total number of individual
ni = number of individual for each species

This index has the following elements: the number of species (S), and equitability (E) of the distribution of individuals from the various species. Temperature and relative humidity within the orchards was also recorded during the experiment.

RESULT AND DISCUSSION

A total of 10,937 mites belonging to 112 species were collected during the survey. These included mites inhabiting citrus trees, weeds, and litter in the citrus orchard. Based on the general knowledge of the primary feeding habits, mites were categorized into three trophic groups: saprophagous or detritivorous, phytophagous and predatory. The total number of the phytophagous, predatory, and detritivorous mites were 316, 3,861 and 6,760, respectively.

Diversity of mites

The average H' values of the three trophic guilds from arboreal parts taken together were 0.65, 0.92, and 0.00 for phytophages, predators and detritivores, respectively (Fig. 1).

Weeds in the citrus orchard probably served as alternative hosts, since the phytophagous mites were consistently present in weed samples. The average H' values of the three trophic guilds for all weeds taken together were 0.63 for phytophagous, 2.81 for predators and 2.41for detritivores (Fig. 2).

The diversity index analysis for the litter was shown at an average H' value for the three trophic groups as follows: 0.84, 3.35, and 2.84 for phytophages, predators and detritivores, respectively (Fig. 3).

Predatory mites were the most diverse in all habitats observed (arboreal parts, weeds and litter). The fluctuations of the H' values of the predatory mites, at the different growth stages, were due to the vertical movement between the citrus leaves, weeds, and/or litter underneath. Species such as *Asca butuanensis*, *A. longiseta*, *Amblyseius cinctus*, *Am. salebrosus*, *T. transvaalensis*, and *Lasioseius* sp, showed such fluctuations, since they were found not only in the citrus leaves but also on both weeds and litter. The genus *Asca* was the most dominant predator which existed in arboreal part, weeds, and litter. These mites appear to be generalist predators which move upward to the citrus

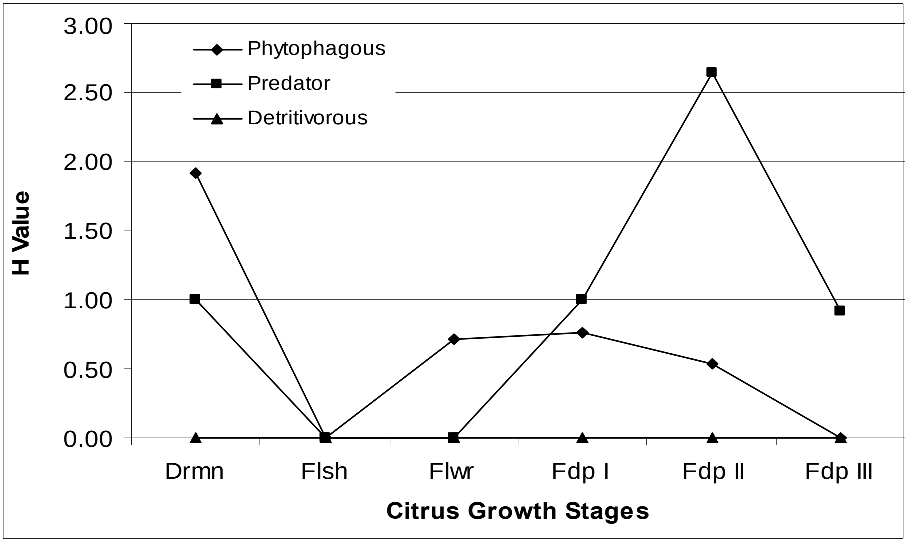

Figure 1. Fluctuation in diversity index (H') value of phytophagous, predatory, and detritivorous mites at various stages of the citrus trees on the arboreal part of the 'Siem' citrus orchard

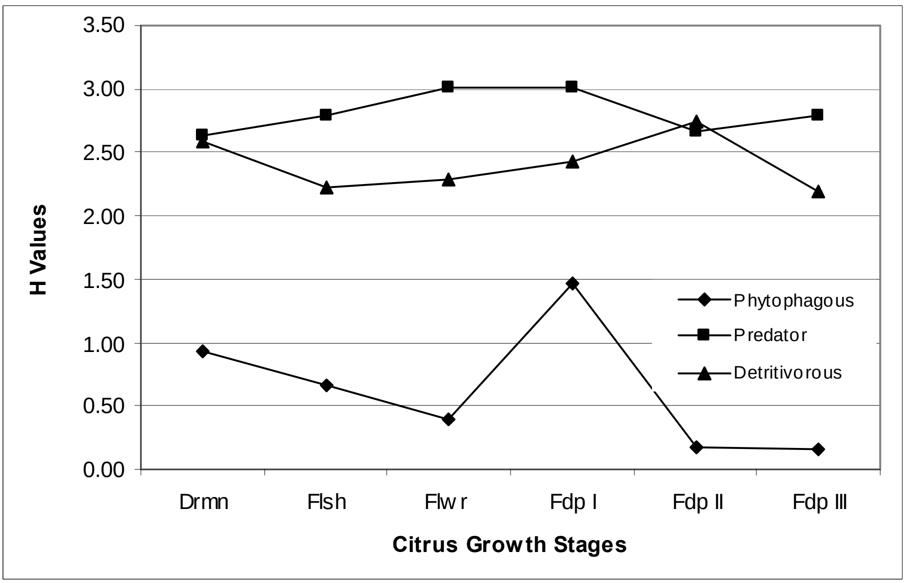

Figure 2. Fluctuation in diversity index (H') value of phytophagous, predatory, and detritivorous mites at various stages of the citrus trees on the weeds of the 'Siem' citrus orchard

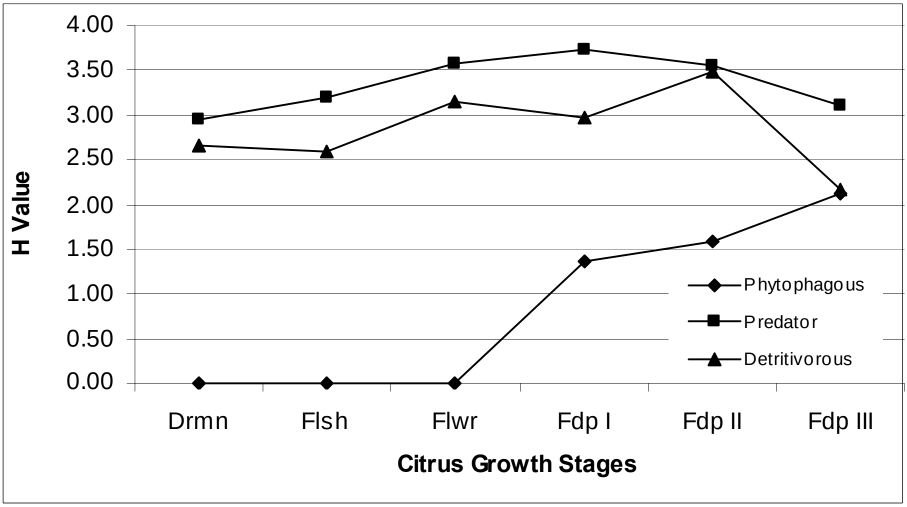

Figure 3. Fluctuation in diversity index (H') value of phytophagous, predatory, and detritivorous mites at various stages of the citrus trees on the litter in 'Siem' citrus orchard

leaves from the weeds and litter. This abundance of alternative prey gives the predator population an advantage over the later-developing pest populations (Settle et al., 1996). This process strongly suppresses pest populations and generally lends stability by decoupling predator populations from a strict dependence on phytophagous populations.

The average H' values for phytophages were always low in all habitats observed, due to the dominance of *B. californicus.* The phytophagous mites, especially *Brevipalus* spp, were found to have high economic importance on citrus, which is their preferred host (Baker and Tuttle, 1987). Their occurrence on weeds indicates that these plants are within their natural host range. However, their low populations were apparent on the weeds, litter and the arboreal part of citrus trees.

Detritivores constituted the second most diverse group found on the arboreal parts, weeds, and litter of the citrus orchard. This lower diversity, in comparison to predatory mites, was due to the dominance of such detritivores as *Scheloribates praeincisus*, the undetermined *Nothroidea* sp. 1 and *Nothroidea* sp. 2. These mostly soil and litter inhabiting mites are apparently used as alternative prey by predators when phytophagous mite population is low.

Distribution and abundance of mites

The phytophagous mites were relatively abundant in the arboreal parts of the citrus trees, where they made up 74.19% of all individual mites collected. They were mainly false spider mites (family Tenuipalpidae), notably *Brevipalpus californicus*, *B. obovatus*, and *B. phoenicis*. Observation at different growth stages showed that the lowest populations of phytophages were on the leaves at flush growth stage and the highest at the Fdp II growth stage (Fig. 4).

All of the mentioned phytophagous species are known as pests of citrus throughout the world (De Leon, 1961; Manson, 1963; McMurtry et al., 1979; Barrion and Corpuz-Raros, 1975; Corpuz-Raros, 2001). Jeppson et al. (1975) stated that false spider mites attacked citrus, especially at fruit development growth phase. Furthermore, Childers (2003) added that the increases in temperature and relative humidity caused rapid development of population, as shown on the fruit development phase II (Fig. 4).

Four predatory families were collected in association with phytophages inhabiting the leaves of citrus, namely; Ascidae, Phytoseiidae, Cunaxidae, and Cheyletidae, with a total relative abundance of 17.20%. Predatory mites of the genera *Asca* (Ascidae) and *Amblyseius* (Phytoseiidae) were the most abundant among them. The most frequent and abundant of the predatory mites were species of the genus *Asca,* especially *A. longiseta* and *A. labrusca.*

Two species of detritivorous mites were also found on the leaves of citrus, with a total relative abundance of 8.61%. These included the acarids, *Caloglyphus* sp. and the oribatids, *Scheloribates praencisus praencisus.*

Mites belonging to all trophic groups inhabited weeds in the 'Siem' citrus orchard (Fig. 5). There were four species of weeds, namely: *Achyranthes aspera* L.**,** *Axonopus compressus* (Sw.) Beauv. and *Chromolaena odorata* (L.) R.M. King and H. Robinson, and *Borreria alata* (Aubl.) DC. Altogether, the number of mites totalled 9,428 individuals, distributed as follows: detritivores 5,597, predators 3,604 and phytophages 227.

Detritivorous mites were dominant on weeds in the 'Siem' citrus orchard. They belonged to the oribatid families Scheloribatidae and Trhypochthoniidae, and the superfamily Nothroidea. The fluctuation of their populations paralleled these of predatory mites, which were dominated by *Asca longiseta, A. labrusca, A. vulgaris* and of phytophagous mites, which were dominated by false spider mites *B. californicus, Tenuipalpus* sp. including *B. obovatus*. Hence, it is possible that the detritivorous mites also served as an alternative prey for the predatory mites.

All trophic groups of mites were found on litter below the canopy of the citrus trees. The most abundant were detritivores, totalling 1,115 individuals belonging to 26 species. Predators followed with 241 individuals of 42 species, with *Asca* spp being the most abundant among them. A few individuals belonging to 4 species of phytophagous mites, mostly false spider mites (*Brevipalpus* spp.), were also extracted from litter samples. Their presence could have been accidental and caused by leaves of citrus and weeds that fell to the ground as litter. The fluctuations in detritivore population were generally

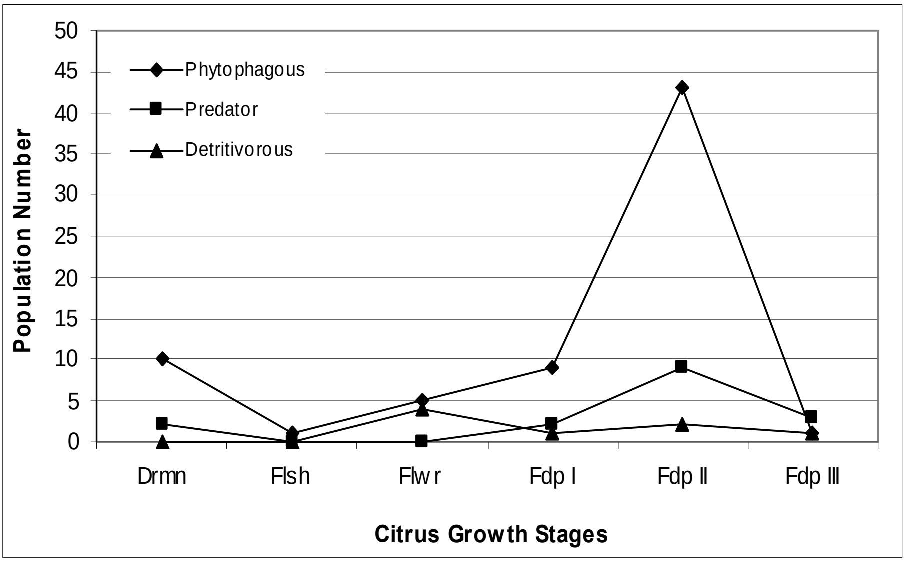

Figure 4. Total numbers of phytophagous, predatory and detritivorous mites on the arboreal part of the 'Siem' citrus orchard at various growth stages

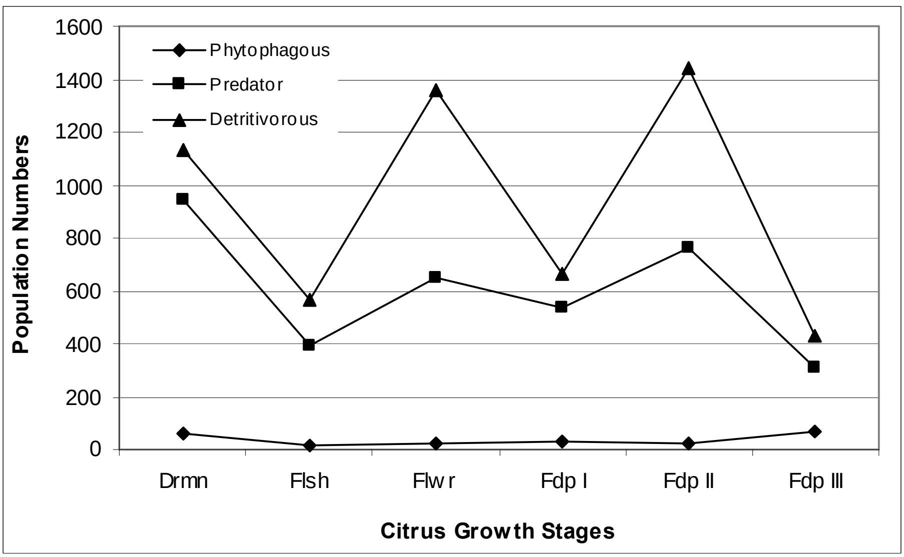

Figure 5. Total numbers of phytophagous, predatory, and detritivorous mites on the weeds of the 'Siem' citrus orchard at various stages of the citrus

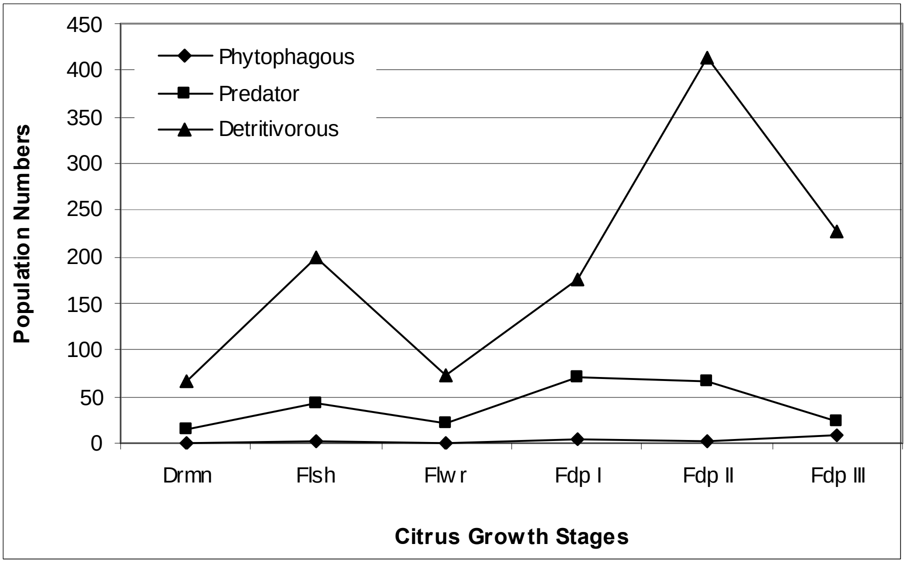

Figure 6. Total numbers of phytophagous, predatory, and detritivorous mites on the litter of 'Siem' citrus orchard at various stages of the citrus

followed by those of predatory mites that possibly took them as an alternative prey. A fluctuation in the population of mites' fauna in the litter is presented in Figure 6.

Predatory mites belonging to *Asca* spp. have not been as extensively studied as phytoseiids and has been confined to general observations of their predation on other mites, small insects like thrips, insect eggs, and collembolans (Hurlbutt, 1963), as well as nematodes (Epsky et al., 1988). Predatory mites *Asca* spp are classified as generalist predators and their habitats are moss, sod, litter, the nests of spiders, birds, mammals, citrus bark and the leaves of several types of plant, especially these of warm climates (Hurlbutt, 1963). In Australia, for example, *Asca* species are considered as a factor in the natural control of the phytophagous mite family Tenuipalpidae, especially *Brevipalpus* spp. (Walter et al., 1993).

Furthermore, generalist predators like *Asca* spp and phytoseiids can continue to exist on the arboreal part of citrus trees, even with the absence of their principal prey phytophages, due to there occasional move down to the ground and the underlying litter (Chuleui and Croft, 2000; Gerson, 2003), where detritivorous alternative prey is abundant. This food searching behaviour (high searching capacity), is exhibited among the more advanced generalist predators, which come, settle and survive in every habitat where their prey exist.

Therefore, the presence of these alternative food sources is an important factor in the management of pest. The contribution of weeds and litter are numerous. They serve as alternative host environments for detritivorous mites and provide alternative prey and breeding ground for the predators. Consequently, when prominent prey populations develop and achieve pest proportions, the predatory mites already have a foothold, in terms of population densities, and are more readily able to control and diminish the pest population. Hence, there would be no need for the regular inundate release of predators, as usually done for predators that are unable to settle and survive under low populations of prominent prey.

Generally, a high species diversity and relative abundance of mites occurred on the citrus trees in the orchard. Even though the citrus growth stage Fdp II had high population of phytophagous mites, with an average of 11 mites per sample, these were far from reaching economic threshold level. The predators, as regulators of phytophage population, exhibited a high richness in species diversity and evenness of number distribution to those of the other various species. This non-pest condition, in the citrus germplasm orchard of the Indonesian Tropical Fruit Research Institute (ITFRI), very likely resulted from their cultural practices, given that pesticides are not applied and cover crops of weeds are maintained as standard practice. Monneti and Fernandez (1995) and Nohara et al. (2000) stated that abundant application of pesticides often results in outbreaks of phytophagous mites and a decrease in the population of predatory mites. On the other hand, Muma (1961), Huang (1978), Govena et al. (1993) and Papaioannou-souliotis et al. (2000) explained that weeds may serve as natural ecological refuges and potential sources of phytoseiid species populations.

CONCLUSIONS

A total of 10,937 mites belonging to 112 species were collected during the survey. The total numbers of the phytophagous, predatory, and detritivorous mites were 316, 3,861 and 6,760 respectively. They belonged to 6, 62 and 43 species respectively.

Predators were the most diverse of the three trophic groups, whether on arboreal parts of the citrus trees, or weeds and litter under the canopy.

The diversity of trophic groups of mites at the Fdp II growth stage was the least at flush growth stage (H'=1.27), and the most (H'=1.93) at Fdp II growth stage. Among the weeds, *Axonopus compressus* had the most diverse mite fauna, with an average H'=2.70. Among the citrus growth stages, the Fdp II stage showed the most abundant populations of phytophagous mites. These included *Brevipalpus califor-nicus, B. obovatus, B. phoenicis, Tenuipalpus* sp., *Panonychus citri*, *Eotetranychus* sp., and *Oligonychus* sp. However, they were relatively not numerous and far from reaching economic threshold level. Four predatory families, Ascidae, Phyto-seiidae, Cunaxidae, and Cheyletidae, were present with citrus phyto-phagous mites and acted as regulators for phytophagous mite control. Mites of the genera *Asca* (Ascidae) and *Amblyseius* (Phytoseiidae) were the most abundant predators. The *Asca* species, especially *A. longiseta*, *A. labrusca*, and *A. vulgaris,* were the most frequent and abundant among them.

Generally, weeds and litter contributed towards the regulation of predatory and detritivorous mite's population development in the 'Siem' citrus orchard. Hence, weeds and litter management in 'Siem' citrus orchard should focus on cultural practices that support establishment and reproduction of natural predators of phytophagous mites.

Acknowledgements: My deepest thanks go to the following researchers for their help during this study: Dr. I. Djatnika, Director of the Indonesian Tropical Fruit Research Institute, for generously permitting me to use all of their facilities; Dr. L.A. Corpuz-Raros, Laboratory of Acarology (Department of Entomology), at the University of the Philippines in Los Banos, for the verification of mite identification.

REFERENCES

Baker E.W., Tuttle D.M., 1987. The false spider mites of Mexico (Tenuipalpidae: Acari). U.S. DEPT. OF AGRICULTURE, TECH. BULL. 1706: 237.

Barrion A.T., Corpuz-Raros L.A. 1975. Studies on citrus mites (Acarina): biology of *Eotetranychus cendanai* Rimando (Tetranychidae) and population trends in *Brevipalpus obovatus* Donnadieu (Tenuipalpidae). PHILIPP. ENT. 3(1): 30-45.

Bynum E.D. Jr., Archer T.L., Plapp F.W.Jr. 1997. Comparison of banks grass mites and two-spotted spider mite (Acari:Tetranychidae): Response to Acaricide alone and in synergistic Combination. ENTOM. SOC. AMER. 90(5): 1125-1130.

Childers C.C., Abou-Setta M.M. 1999. Yield reduction in 'Tahiti' lime from *Panonychus citri* feeding injury following different pesticide treatment regimes and impact on the associated predacious mites. EXP. APPL. ACAROL. 23 (10): 771-783.

Childers C.C. 2003. False spider mite damage on citrus orchard in Florida: subscription renewal, final notice water situation and firing citrus utilization to date current situation. FLORIDA COOPERATIVE EXTENSION SERVICE, INSTITUTE OF FOOD AND AGRICULTURE SCIENCE, UNIV. OF FLORIDA, USA. 4 p.

Chuleui J., Croft B.A. 2000. Survival and plant-prey finding by *Neoseiulus fallacis* (Acari:Phytoseiidae) on soil substrates after aerial dispersal. EXP. AND APPL. ACAROL. 24 (8): 579-596.

Corpuz-Raros L.A. 2001. New mite pests and new host records of phytophagous mite (Acari) from the Philippines. PHILIPP. AGRIC. SCI. 84(4): 341-351.

De Leon D. 1961. The genus *Brevipalpus* in Mexico, Part II (Acarina: Tunuipalpidae). FLA. ENT. 44(1): 21-52.

Epsky N.D., Walter D.E., Capinera J.L. 1988. Potential role of nematophagous microarthropods as biotic mortality factors of entomophagous nematodes (Rhabditida: Steinernematidae: Heterorhabditidae). J. ECON. ENTOMOL. 81: 821-825.

Gerson U. 2003. Acarine pests of citrus: overview and non-chemical control. SYS. APP. ACAROL. 8: 3-12.

Govena S., Colleti A., Yamamoto P.T. 1993. Influence of green cover with *Ageratum conyzoides* and *Eupatorium pauciflorum* on predatory and phytophagous mites in citrus. BULL. OILB. SROP. 16(7): 104-114.

Henderson R.C. 2001. Technique for positional slide-mounting of Acari. SYS. AND APPL. ACAROL. (Spec. pub.) 7: 1-4.

Helle H. 1963. Resistance in the Acarine:Mites. In**:** Naegele J.A. (ed.). 1963. Advance in Acarology. Vol. II. Cornell Univ. Press. New York. pp. 71-93.

Huang M. 1978. Studies on integrated control of the citrus red mites with the predaceous mite as a principal controlling agent. ACTA. ENTOMOL. SIN. 21: 260-270.

Hurlbutt H.W. 1963. The genus *Asca* Von Heyden (Acarina: Mesostigmata) in North America, Hawaii and Europe. ACAROLOGIA 5: 480-518.

Jeppson L.R. 1963. Principles of chemical control of phytophagous mites. In: Naegele J.A. (ed.). 1963. Advance in Acarology. Vol. II. Cornell Univ. Press. New York. pp. 31-51.

Jeppson L.R., Keifer H.H., Baker E.W. 1975. Mites injurious to economics plants. Univ. of California Press, Berkeley, California, 615 p.

Kim S.S., Seo S.G. 2001. Relative toxicity of some acaricides to the predatory mites, *Amblyseius womersleyi* and the two-spotted spider mite, *Tetranychus urticae* (Acari; Phytoseiidae, Teranychidae). APPL. ENTOMOL. 36(4): 509-514.

Krantz G.W. 1978. A manual of acarology. 2nd edition. Oregon University Book Store, Inc., Corvallis, Oregon, USA, 509 p.

Manson D.C.M. 1963. Mites of the families Tetranychidae and Tenuipalpidae associated with citrus in South East Asia. ACAROLOGIA 5(3): 351-364.

McMurtry J.A., Shaw J.G., Johnson H.G. 1979. Citrus red mites population in relation to virus disease and predaceous mites in Southern California. ENVIRON. ENTOMOL. 8: 160-164.

Monetti L.N., Fernandez N.A. 1995. Seasonal population dynamic of the European red mites (*Panonychus ulmi*) and its predator *Neoseiulus californicus* in a sprayed apple orchard in Argentina (Acari: Tetranychidae, Phytoseiidae). ACAROLOGIA 36(4): 325-331.

Muma M.H. 1961. The influence of cover crop cultivation on population of injurious insect and mites in Florida Citrus Groves. FLA. ENTOMOL. 44: 61-68.

Nohara K., Nakao S., Nagatomi A. 2000. A study of relationship between pesticide treatment and the fauna in citrus groves on Nagashima Island, Kagoshima Perfecture. J. APPL. ENT. ZOOL. 35(2): 271-281.

Papaioannou-Souliotis P., Markoyiannaki-Printziou D., Zeginis G. 2000. Observation on acarofauna in four apple orchards of Central Grcee. II. Green cover and hedges as potential sources of phytoseiid mites (Acari: Phytoseiidae). ACAROLOGIA 41(4): 411-427.

Price P.W. 1997. Insect Ecology. John Wiley & Sons, Inc., New York, 874 p.

Settle W.H., Ariawan H., Astuti E.T., Cahyana W., Hakim A.L., Hindayana D., Lestari A.S., Pajarningsih S. 1996. Managing tropical rice pests through conservation of generalist natural enemies and alternative prey. J. ECOLOGY 77(7): 1975-1988.

Smith Mayer M.K.P. 1981. Mites pests of crops in Southern Africa. REP.

SOUTH. AFRICA DEPT. AGRIC. TECH. SERV. SCI. BULL. 397: 1-91.
Walter D.E., Halliday R.B., Lindquist E.E. 1993. A review of the genus *Asca* in Australia, with description of three new leaf-inhabiting species. INVERTEB. TAX. 7: 1327-347.
Wallwork J.A. 1976. The distribution and diversity of soil fauna. Academic Press Inc., London, 355 p.

STADIA FENOLOGICZNE MANDARYNKI ‘SIEM’(*Citrus reticulata* Blanko) A SKŁAD GATUNKOWY FAUNY ROZTOCZY

Affandi

STRESZCZENIE

Badania fauny roztoczy mandarynki ‘Siem’ przeprowadzano w Indonezyjskim Instytucie Owoców Tropikalnych. Celem badań była ocena różnorodności i składu gatunkowego oraz rozmieszczenia i liczebności różnych stadiów roztoczy na nadziemnych częściach drzew, chwastów i innych roślin zielnych rosnących w podłożu (ściółce) sadu. Próby pobierano z dziesięciu rośliny (powtórzeń) w kolejnych 6 fazach fenologicznych. Zebrano łącznie 10.937 roztoczy należących do 112 gatunków. Wśród zebranych roztoczy wyróżniono 3 grupy troficzne – roztocze roślinożerne, drapieżne i detrytofagiczne z następującą liczebnością: 316; 3,861 i 6,760 osobników, odpowiednio. Wśród tych trzech grup najbardziej różnorodne były roztocza drapieżne. Roślinożerne roztocza były relatywnie liczne w nadziemnych partiach drzew cytrusowych, stanowiąc do 74,19% wszystkich pozyskanych osobników roztoczy. Bazując na stadiach fenologicznych stwierdzono, że najmniejsza liczebnie populacja roślinożernych roztoczy występowała na liściach w początkowym stadium ich rozwoju, a największa w stadium wzrostu owoców Fdp II (średnio 11 roztoczy/próbę). Była to populacja roślinożernych roztoczy bardzo niewielka i daleka od osiągnięcia ekonomicznych progów szkodliwości.

Chwasty i ściółka przyczyniały się do rozwoju populacji roztoczy drapieżnych i detrytofagicznych, które z kolei regulowały liczebność roztoczy roślinożernych. Wykonane badania wykazały, że znajomość relacji pomiędzy stadiami fenologicznymi a składem i rozmieszczeniem roztoczy jest ważna. Stwierdzono także, że właściwszy okres zwalczania roślinożernych roztoczy na drzewach cytrusów odmiany ‘Siem’ przypada na fazę rozwojową FdpII.

Słowa kluczowe: roztocza, *Citrus reticulate,* stadia fenologiczne, skład gatunkowy