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Population Dynamic of *Scirtothrips dorsalis* Hood (Thysanopetera: Thripidae) on Mango and Associated Weeds Under Low and Intensive Agricultural Practices

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ABSTRACT

Population dynamic information and its influence factors are basic need for the best insect strategic control. This research objective was to descript and compare thrips *S. dorsalis* population dynamic on mango and associated weeds under low and intensive cultural practices. Reseacrh was conducted in PT. Trigatra Rajasa mango plantation in Ketowan, Arjasa, Situbondo, East Java, Indonesia from February 2014 to January 2015. The investigation was done through observation of *S. dorsalis* number associate on each mango growth stages and weeds under the canopy of mango. Arithmetic and descriptive method were applied to ensure the population oscillations pattern among phenological stages of mango and weeds under mango tree canopy. Result showed that population fluctuation of *S. dorsalis* was determined by growth stages of mango trees and the availability of initial built up of population. Flush growth stage was the most preferred stage which had high input agricultural practices such as fertilizer and tree conditioning and was supported for more numbers of thrips. Weeds *Desmanthus leptophyllus*, *Achalypha indica*, *Azadirachta indica* and *Tephrosia vogelii* were functioning as breeding habitat for early built-up population on mango trees. Climate factors especially rainfall was also affected population fluctuation of *S. dorsalis* on mango trees and weeds.

INTRODUCTION

High market demand of mango enforces farmer to do unordinary agricultural practices to provide high production and quality. The most common agricultural practices that have been done by farmer to increase the production and quality of mango are by applying higher amount of fertilizer (Behera, Munsi, & Lenka, 2014; de Mello Prado, 2010; El-Shiekh, 2016; Peralta-Antonio, Rebolledo-Martínez, Becerril-Román, Jaén-Contreras, & del Angel-Pérez, 2014), increasing the number of weed to reduce competition toward prominent tree (Medina-Urrutia, Vázquez-García, & Virgen-Calleros, 2011; Syahri, Widaryanto, & Puji Wicaksono, 2017); application of flower induction to trigger concurrent fruit set (Kulkarni, 1988; Narvariya & Singh, 2018; Sarker & Rahim, 2018; Sarker, Rahim, & Archbold, 2016) and utilization of synthesis pesticide to reduce incidence of pests and diseases (Akotsen-Mensah et al., 2017; Md Wasim & Sarkar, 2018; Mukherjee et al., 2007).

Insect pests have given significant impact on economic decline of mango agribusiness (Akotsen-Mensah et al., 2017; Chaudhari, Sridharan, & Sundar Singh, 2017; Medina, Opina, de Jesus, &

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Calumpang, 2005). *Scirtothrips dorsalis* is one of the pest which was known to reduce the production and quality of mango (Affandi et al., 2017). The economic lost due to *S. dorsalis* attack on mango reached 1.040 – 1.300 USD/ha (Affandi et al., 2018). Application of pesticide is the most common way to control *S. dorsalis*. However, unwise utilization of pesticide will have an impact on pest resistance, resurgence and secondary pest outbreak as well as environmental negative impact (Azmi & Naqvi, 2011; de Bon et al., 2014; Hill, Macfadyen, & Nash, 2017).

The success of management strategies against *S. dorsalis* is determined by basic information about seasonal abundance and population fluctuation. Hence, all factors that will influence the abundance and population oscillation must be recorded. Weather especially rainfall is prominent factor that will determine mango growth stage including alternate host such weeds surrounding main host which *S. dorsalis* will survive, develop and reproduce. Pesticide application in term of mode of action, active ingredient, dosage and time of application including repeatability of spray will ascertain the affectivity and efficiency of chemical control. However, no single method could guarantee the fruitfulness of the result. Therefore, integrated pest management with proper agricultural practices plays an important role in managing population abundance under economic threshold. Hence, cultural practices in relation to population wavering of *S. dorsalis* associated with mango and weeds are inevitable need to be observed for best strategic population control.

The research objective was to descript and compare thrips *S. dorsalis* population dynamic on mango and associated weeds under low and intensive cultural practices.

MATERIALS AND METHODS

Time of Study and Site Location

The research was conducted from January 2014 to January 2015. The research was done in PT. Trigatra Rajasa, a private mango plantation in Situbondo district, East Java Province, Indonesia. The site was located 30 m above sea level with an average rainfall of 780 mm per year. The orchard was only planted with a single mango variety i.e. Arumanis 143. The trees were planted in monoculture with a distance of 8 x 10 m. Due to regular pruning the mango trees were reaching only 4-5 m in height, with a parabolic-shaped canopy even though it has already 23 years old, The orchard was also treated with regular weeding, fertilization, irrigation and controlling pest and disease as well.

Data Gathering

The population of *S. dorsalis* was monitored biweekly for one year on thirteen mango trees. These trees were randomly picked along a diagonally laid transect line in 4 ha sampling areas measured 200 x 200 m which lies at the centre of the orchard. The population of *S. dorsalis* was also taken from weeds under the canopy of mango which used as samples. The samples were taken from two blocks: one representing the high input (HI) and other representing the low input (LI) production practices. The two blocks were 150 m apart. In the HI block, mango trees received 5 kg NPK (Mutiara ®) per tree, sprayed with pesticides 4 times and treated with paclobutrazol at 10 ml/l/tree. In contrast, mango trees in the LI block received 2.5 kg NPK (Mutiara ®) per tree, twice pesticide applications and no paclobutrazol treatment. Both production areas were pruned, weeded and watered in the same manner.

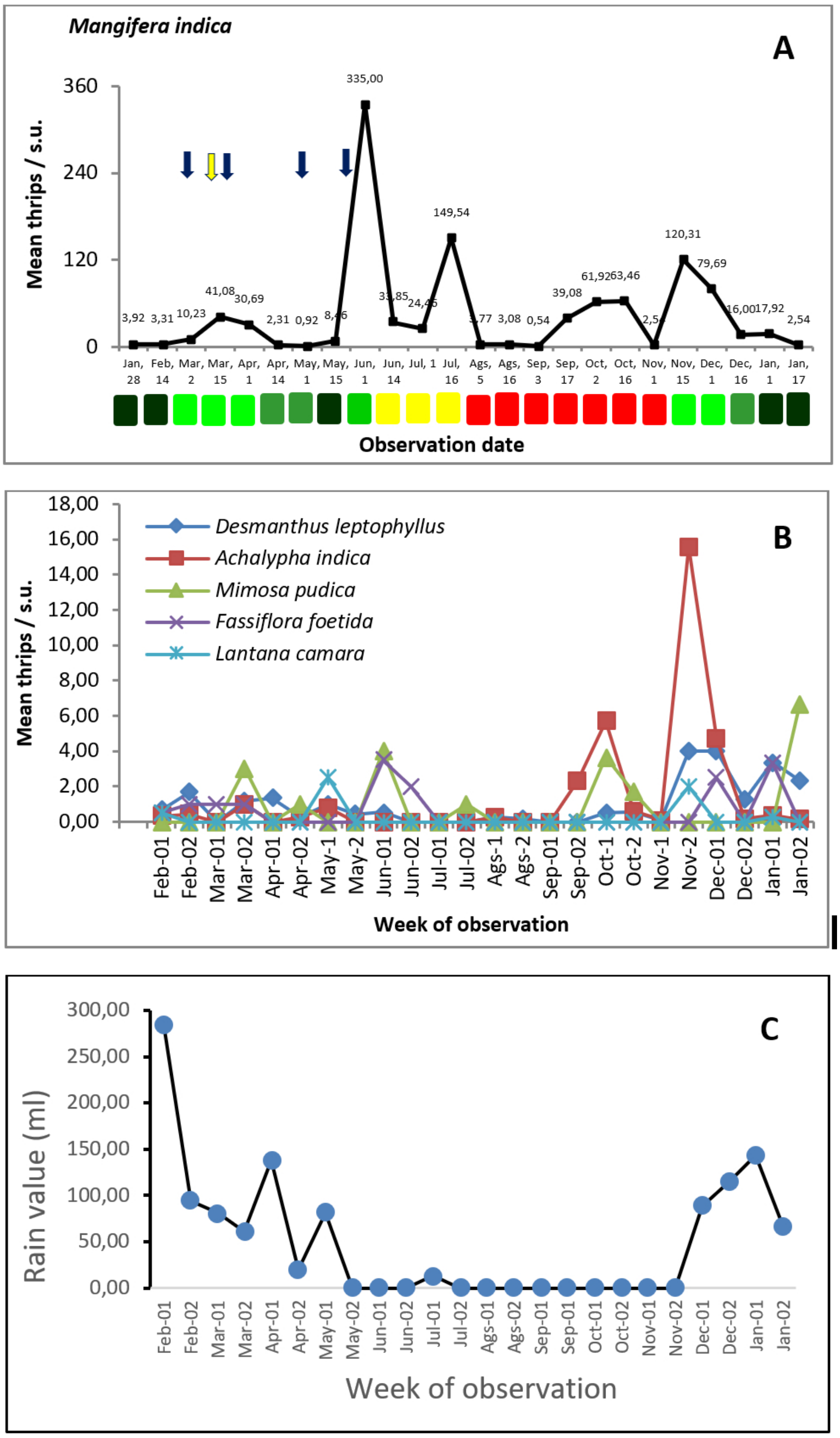
The leaves or flowers of mango were taken from where the weed samples were also picked up. Three shoots per plant were sampled for monocotyledonous type of weeds and three apical leaves per branch for dicotyledonous type of weeds. The book of Moody, Munroe, Lubigan, & Paller (1984) and Rukmana & Sugandi (1999) were utilized to identify weeds associate with mango agroecosystem.

Plant samples were placed in zip-lock plastic bag measuring 25 x 15 cm and brought in the laboratory for processing. The collection of thrips from the plant samples was following modified dipping method of Aliakbarpour & Md Rawi (2010). The zip-lock plastic was half filled with 70% ethanol, agitated gently for 10 seconds and the washings were poured into plastic jars for temporary storage until counted. Thrips collected from the samples were observed, identified and counted using a binocular microscope. Agrometeorological data were taken from the weather station of the plantation.

Nutrient were also analysed such as water contain, nitrogen, protein, cellulose and lignin on both block toward all mango growth stages including weeds under the canopy of mango.

Data Analysis

The collected data was analysed descriptively and was compared between high and low input including factors influencing the population dynamic.



Remarks: ■ Dormant leaves; ■ Mature leaves; ■ Flush leaves; ■ Flower stage; ■ Fruit stage; ⬇ Spray pesticide; ⬇ Tree conditioning

Fig. 1. *Scirtothrips dorsalis* population dynamics in mango (A) and selected weeds (B) including rain value oscilation (C) in high input plot

Table 1. Weeds under the canopy of mango arumanis 143 agro-ecosystem

No	Weeds	Family	High input		Low input	
			Rainy season	Dry season	Rainy season	Dry season
			N	N	N	N
1	*Desmanthus leptophyllus*	Fabaceae	11	13	11	13
2	*Passiflora foetida*	Passifloraceae	11	13	11	13
3	*Tridax procumbens*	Asteraceae	11	13	11	13
4	*Ipomoea triloba*	Convulvulaceae	11	13	11	13
5	*Achalypha indica*	Euphorbiaceae	11	13	10	13
6	*Momordica charantia*	Cucurbitaceae	11	13	8	9
7	Unidentified weed species 1	Fabaceae	11	10	9	9
8	*Cynodon dactylon*	Poaceae	11	13	10	13
9	*Kyllinga monocephala*	Cypereae	9	8	0	0
10	*Paspalum conjugatum*	Poaceae	8	5	8	6
11	*Lantana camara*	Verbenaceae	8	8	4	6
12	*Mimosa pudica*	Fabaceae	7	12	0	0
13	*Ischaemum rugosum*	Poaceae	3	12	3	12
14	*Tephrosia vogelii*	Fabaceae	3	1	7	6
15	Unidentified weed species 2	Fabaceae	1	1	1	0
16	*Ottochlona nodosa*	Poaceae	1	0	2	0
17	*Mimosa invisa*	Fabaceae	0	1	0	1
18	Unidentified weed species 3	Fabaceae	0	0	0	1
19	*Centrosema pubescents*	Fabaceae	0	0	3	3
20	*Azadirachta indica*	Meliaceae	0	0	4	1

RESULTS AND DISCUSSION

Population Dynamic in High Input Block

The population dynamics of *S. dorsalis* was found fluctuate in association with mango canopy and weeds under the canopy in high input orchards. The population was in accordance with phonological state of the mango trees and weeds as source of food for growth and development of the thrips. A complete oscillation of population is presented in Fig. 1.

The population of *S. dorsalis* in February to middle of May showed relatively low. The peak population of *S. dorsalis* associated with mango occurred in early June, and again in the middle of July and November with average total numbers of 335, 150 and 120 thrips, respectively (Fig. 1A). Meanwhile, the highest number of *S. dorsalis* associated with weed *Ach. indica, M. pudica, D. leptophyllus, P. foetida* and *L. camara* the average of total number are 15, 10, 4, 2,5 and 2 thrips per sampling unit, respectively (Fig. 1B) and it is relatively low compared to the thrips monitored in mango.

The availability of flush growth stages during mid-November was also rendered high population of thrips. Agricultural practices in high input block such as cutting of the base point of stalk after fruits were harvested which triggered the emerging of new flush. Consequently, the availability of the most preferred stage sparked *S. dorsalis* to develop faster, especially in the absence of rainfall (Fig. 1C).

The appearance of flush before flower emergence in high input mango orchard was the perfect condition to support high population of thrips. Urías-López, Salazar-García, & Johansen-Naime (2007) stated that the population of the thrips was determined by phenological stages of the host plant and young buds and flowers were the most preferred stages. This observations indicated that flush stages combined with dry conditions (middle of May until June) gave the peak population numbers of the thrips associating with mango.

Twenty species of weeds belonging to 10 families were recognized associating with mango arumanis 143 agro-ecosystem (Table 1). Nevertheless, the weeds species *D. leptophyllus*, *P. foetida, L. camara*, *Ac. indica* and *M. pudica* shared collectively 78.95% of the population of thrips in the high input. The weed *D. leptophyllus, Ac. indica* and *M. pudica* were displayed distinguishable seasonal pattern but not in *P. foetida,* and *L. camara*. The population of thrips was low in the dry season and high in the rainy season, which is the opposite of what was observed in mango. Wheather was an exchange of thrips population between mango and weed *D. leptophyllus, Ach. indica* and *M. pudica* and could not be proven by this study. Nevertheless, weeds surrounding main host could serve as alternate host and serve as a potential reservoir and pathway for thrips moving to preferred hosts (Mannion, Derksen, Seal, Osborne, & Martin, 2014; Song, Kim, Yang, Hong, & Lee, 2013). Aliakbarpour & Md Rawi (2011) indicated that weeds surrounding the canopy of mango were utilized by thrips *S. dorsalis* as alternate host in pesticide high input and low input orchard. The availability of *D. leptophyllus* which bud leaves in all year around must also be considered as an alternative and source of initial built up population in mango. Affandi, dela Rosa Medina, Velasco, Javier, & Depositario (2018) informed that *D. leptophyllus* was bear more nitrogen content than mango flushes, however, mongo flush furnished more balance proportion between nitrogen and water. Derksen, Mannion, Seal, Osborne, & Martin (2016) revealed that *S. dorsalis* transfered from main host to the surrounding weed when the population was over. Affandi, dela Rosa Medina, Velasco, Javier, & Depositario (2018) observed that flush growth stage of mango and *D. leptophyllus* including *Ach. indica* were given the same range *S. dorsalis* life cycle from egg to adult i.e. 12.55, 12.50 and 12.82 days, respectively.

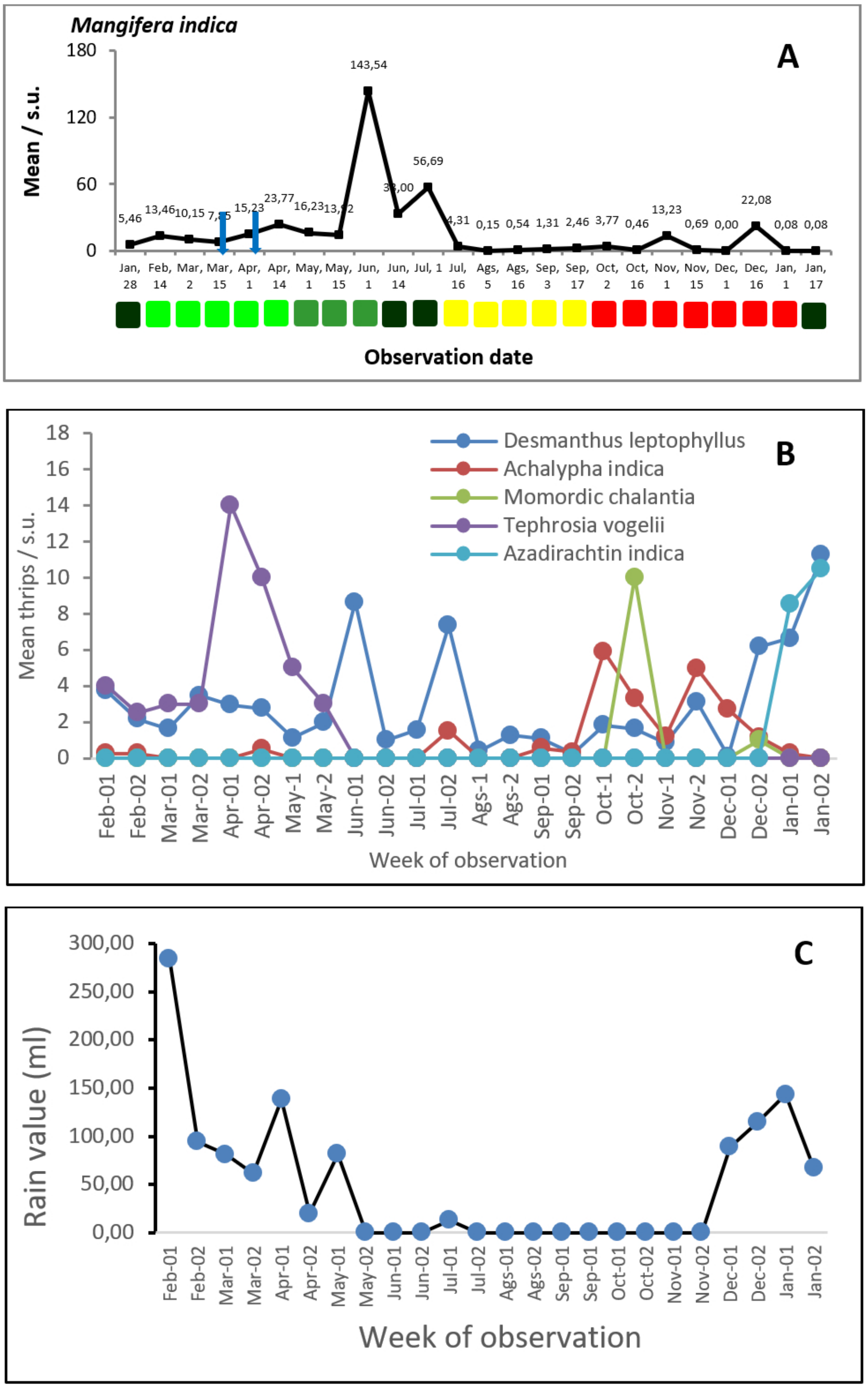
Population Dynamic in Low Input Block

Scirtothrips dorsalis population dynamics in low input block in February to middle of May was also displayed relatively low numbers same as in high input block. The peak population of *S. dorsalis* associated with mango occurred in early June, and again in the middle of July and December with the average total numbers of 144.57 and 22 thrips per sampling unit, respectively (Fig. 2A). Meanwhile, weeds *D. leptophyllus, Az. indica, T. vogeli, M. charantia* and *Ach. Indica,* were given the highest thrips density with the average total number of 11, 11, 10, 10 and 6 thrips per sampling unit, respectively (Fig. 2B) which contributed *S. dorsalis* population 81.94%. These weeds thrips density association was relatively low compared to mango.

Population density observation during flush stage (middle of February to end of April) was very low. Hereafter, mango growth stage was entering mature or dormant at May to half month of July which was high in population density in early two months, then low until the end of observation. Low *S. dorsalis* density during flush stage was most probably due to sweep out by high rainfall value and intensity (Fig. 2C). Furthermore, mature and dormant stages were seemingly considered as less suitable source of food and shelter. Lewis (1997) revealed that hard rain could wash adult and larvae off the plant and rainfall with value more than 20 mm/200 ml was the main suppressive of population densities of thrips in pepper crop. Thrips prefer meristematic regions and outer extremities of plant where nitrogen is mostly deposited in the host plant (Hansen et al., 2009; Lewis, 1997; Reitz, 2002). Kumar, Kakkar, McKenzie, Seal, & Osborne (2013) indicated that thrips *S. dorsalis* do not fed on mature host tissue.

The peak population density of *S. dorsalis* occurred in early June and July (the same time as in high input block). Nevertheless, the highest population number was relatively low compared to high input orchard (335 thrips per sampling unit). Low population density in low input block was seem likely caused by low nutrients such as nitrogen, an important element for fast development of *S. dorsalis*. The low nitrogen contain was evidenced by prolong maturing time of mango leaves and nutrient contain analysis (Table 2). Then, mango trees entered flower stage that emergence from mature/dormant leaves stage. Further, during small, initiation and maturing fruits stages there were almost no thrips found.

Population of thrips seems to increase with the availability of food which flush growth stage was the most preferred by *S. dorsalis*. Nevertheless, growth stages were influenced by cultural practices such as fertilizer dosage, watering, time of pruning and tree conditioning application.



Remarks: ■ Dormant leaves; ■ Mature leaves; ■ Flush leaves; ■ Flower stage; ■ Fruit stage; ↓ Spray pesticide

Fig. 2. *Scirtothrips dorsalis* population dynamics in mango (A) and selected weeds (B) including rain value oscilation (C) in low input plot

Table 2. Nutrients content (%) of some mango phenological stages and selected weed under the canopy of mango

Nutrients content	High Input					Low Input				
	Water	Nitrogen	Protein	Celullosa	Lignin	Water	Nitrogen	Protein	Celullosa	Lignin
Mango Dormant	60.68	0.54	3.35	21.91	23.44	60.11	0.48	3.03	4.56	5.43
Mango Flush	79.91	0.97	6.09	19.46	16.46	79.37	0.57	3.55	18.27	21.49
Mango Flower	80.25	0.67	4.17	15.55	17.36	79.46	0.75	4.68	13.82	20.32
Ach. Indica	83.60	0.71	4.42	16.56	22.73	80.40	0.43	2.68	14.56	18.72
D. leptophyllus	73.64	1.06	6.63	19.64	19.87	73.00	1.12	7.00	21.55	18.23
P. foetida	81.28	0.86	5.37	19.79	18.75	83.98	0.93	5.82	21.71	17.39
Az. indica	76.89	0.90	5.61	8.75	34.63	77.78	0.92	5.74	12.54	33.56
M. charantia	82.74	0.84	5.27	20.70	22.61	80.23	0.58	3.64	24.04	18.34

In low input block the orchard was pruned in early January, half dosage of fertilizer (2.5 kg per tree) was applied without tree conditioning application. Application of high nitrogen fertilizer over the standard was needed by plant and with sufficient irrigation water affects vegetative growth and susceptibility of thrips (Buckland, Reeve, Alston, Nischwitz, & Drost, 2013; Lu, Yu, Heong, & Hu, 2007; Patel, Koshiya, Korat, & Vaishnav, 2010; Schuch, Redak, & Bethke, 1998; Veromann et al., 2013). High protein content in leaves of host plant is increase oviposition and damage level quantity of the host plant associate with thrips *Frankliniella occidentalis* and *Heliothrips haemorrhoidalis* (Brown, Simmonds, & Blaney, 2002). Chau, Heinz, & Davies Jr (2005) added that the development and fluctuation population of Western Flower thrips *F. occidentalis* was determined by phenological stages of the plants and lack of nitrogen content prolong each growth stages as well as production time in chrysanthemum. Similar conditions were apparently affected in decreasing the population development of *S. dorsalis* in low input orchard.

The population of *S. dorsalis* associated with weeds in low input block was relatively low. However, the line graph velocity trend of thrips population completed each other between fluctuation of *S. dorsalis* associated with arboreal part of mango and weeds under mango canopy. Low population of *S. dorsalis* associated with mango during February to May and middle of July to January was supported by relatively high population of *S. dorsalis* associated with weeds *T. vogelli*, *Ach. indica* and *D. leptophyllus* during month of April, October to November and January, respectively (Fig. 2A and Fig. 2B). Most probably, there was movement of adult *S. dorsalis* from arboreal part of mango to weeds and from weed to weed as alternate host when phenological stage of mango did not support developmental growth of *S. dorsalis*. *D. leptophylus* Kunth, *T. vogelli* (Hook.f.) Kuntze and *Az. indica* A. Juss contributed to high numbers of *S. dorsalis* in low input block since it presented awhole year around and always provided meristematic and tender apical plant part.

The line graph indicated that population fluctuation was affected by growth stages of mango and rainfall (Fig. 2A and Fig. 2C). It seems that flush and flowering growth stages had significant impact for high population numbers. Seal, Klassen, & Kumar (2010) stated that *S. dorsalis* feeds on the meristem, terminal and other tender plant parts of the host above the soil surface such as buds, flowers and young fruits. Kirk (1995) added that flush contain higher nitrogen and water, hence leaf thrips breed rather than on mature leaves. Flush are softer for feeding and egg lying, additionally it also provides a more humid microclimate. Similar research revealed that young plant tissues such as buds and terminal leaves were the most preferred part by *S. dorsalis* and it has never been reported to feed on mature host tissue (Kumar, Kakkar, McKenzie, Seal, & Osborne, 2013; Mannion, Derksen, Seal, Osborne, & Martin, 2013; 2014).

Pollen is a prominent source of protein for phytophagous thrips to produce eggs and is required by female adult thrips for maturation of ovaries and eggs (Tsai, Yue, Funderburk, & Webb, 1996). Dietary protein of less than 20% resulted in low growth and high mortality of nymph (Nation, 2001). Complete diet such as juice nutrients from flush and additional source of protein from pollen was obtained by thrips to bolster high population numbers. High nitrogen in flush and flower at high input block seemingly was due to the high application of fertilizer (NPK Mutiara : 16-16-16) as much as 5 kg per tree in the high input block (Table 2). Furthermore, the application of flower inducer “Paclobutrazol” containing nitrogen as part of its element would also increase the availability of nitrogen in arboreal part of mango.

High and Low Input Comparation

The data proved that thrips *S. dorsalis* preferred the arboreal part of mango trees compared to weeds under the canopy. Hence, it could be declared that mango Arumanis 143 was one of the main hosts for *S. dorsalis* in Indonesia. Some researchers also reported that *S. dorsalis* was also an important pest in mango (Aliakbarpour & Md Rawi, 2011; Chen et al., 2010; Kumar, Kakkar, McKenzie, Seal, & Osborne, 2013).

Apparently, several factors worked together simultaneously to affect *S. dorsalis* numbers in a time series of observation. Those factors involved the availability of preferred growth stages of host in relation with food, shelter/refuge and breeding habitat. Cultural practices such as pruning, weeding, pesticide application, and especially fertilization including tree conditioning had given a significant impact on population volatility. Population development was also allegedly affected by climate conditions such as rainfall, temperature and relative humidity according to the population data gathered.

CONCLUSION

Agricultural practices and climate affect phenological stage of the mango and weeds under the canopy of mango which contributed to the population fluctuation of *S. dorsalis*. High fertilizer input and application of tree conditioning increased nutrient availability and population fluctuation of *S. dorsalis* in mango and several weeds associated with mango. Early built-up *S. dorsalis* population on mango trees was provided by weeds *D. leptophyllus*, *Ach. indica*, *Az. indica* and *T. vogelii* which were employed as alternate breeding habitat.

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