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AGE STRUCTURE AND SEX RATIO OF THRIP *Scirtothrips dorsalis* HOOD (Thysanoptera : Thripidae) ASSOCIATING WITH MANGO AGROECOSYSTEM IN EAST JAVA, INDONESIA

Affandi[1*)] and Celia dela Rosa Medina[2)]

[1)] Indonesian Tropical Fruits Research Institute
Jl. Raya Solok - Aripan KM. 8 Solok, West Sumatra, Indonesia, 27301
[2)] Department of Entomology, Crop Protection Cluster, College of Agriculture
University of the Philippines, Los Baños, College, Laguna, Philippines, 4031
[*)] Corresponding author Phone: +62-20137 E-mail: Affandi1970@yahoo.com

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ABSTRACT

The research conducted at PT. Trigatra Rajasa farm, Situbondo, East Java, Indonesia aimed to investigate the age structure and sex ratio of *S. dorsalis* Hood in mango agroecosystem. The research started from April to May 2013. A Completely Randomized Design, Analysis of Variance and Least Significant Difference were used to design, knew the variance and significantly different among the treatment, respectively. Thirteen mango trees set in cross section were sampled and observed for the presence of *S. dorsalis* including weeds under the mango canopy and four cardinal directions of border. The sample was taken every week for one month. The result showed that instar one and adult were preferred to associate with weeds under the mango canopy and borders compared to mango leaves, except second instar. Further, observation was presented that all the age structures were given equal male female sex ratio. Based on the total number of population, there was no significant difference in age structure and sex ratio of *S. dorsalis* associating with weeds inside the orchard including mango leaves and borders. Twenty-seven species of weeds were discovered to associate with mango agroecosystem and were comprehensively discussed based on what was the most dominant and preferred by *S. dorsalis*.

Keywords: *S. dorsalis*, age structure, sex ratio, mango, weeds.

INTRODUCTION

Mango is an exotic fruit originating from tropical Indo-Burma region. The demand of mango fruit has increased recently, not only for tropical country but also for European and United Stated (Mukhejee and Litz, 2009). However, for export reason, high quality of fruit is inevitable necessity. High demand on mango, then, also requires high productivity of the mango tree.

Insect infestation is the most constrain for high production and quality target. Thrips are the pest known to cause agent for undeveloping flush, damaging flower, young fruit drop and scarring of immature and mature fruit in major mango production country such as India, Indonesia, Malaysia, Thailand, Philippines, South Africa, Mexico and Australia (Ananthakrishnan 1984, Morton 1987; Grove *et al*., 2000; Pena *et al*., 2002; Suputa *et al*., 2010; Aliakbarpour and Rawi, 2011a; Chin *et al*., 2010 and Rocha *et al*., 2012). In Indonesia, Malaysia and Philippines, species of *Scirtothrips dorsalis* (Hood) are the most abundance thrips associated with all stages of mango tree including weeds under the canopy (Affandi, 2012; Aliakbarpour and Rawi, 2011b; Muniappan, 2012).

Scirtothrips dorsalis which is attributed to have minute size, high reproductive potential and keen ability to adapt to new areas remains undetectable until its huge population exists. Hence, *S. dorsalis* is being major concern in agricultural sector in many countries for the last decade (Kumar *et al.,* 2013). When its population is excessive, control action will not have any significant impact. Therefore, an initial early survey on the presence of *S. dorsalis* in mango and associate alternative hosts are obviously required. The age structure and sex ratio are essential components in assessing the population growth rate (Nunncy, 1983).

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A series of observation toward age structure and sex ratio could be used for population prediction. Moreover, it could be used as a prominent source of information whether controlling action needs to be done in relation to critical period of mango trees. The significance of sex ratio is associated with the mating habits of the species. Therefore, this research was to determine the age structure and sex ratio of *S. dorsalis* in different host plants in mango orchard and to list the weeds associating with mango orchard in the study area.

MATERIALS AND METHODS

The research was conducted from May to June 2013, during the last growth stage before the emergence of flower, in PT Trigatra Rajasa, Ketowan village, Arjasa subdistrict, Situbondo district, East Java Province, Indonesia.

Situbondo lies at a position between 7° 35' - 7° 44' SL and 113° 30' - 114° 42' EL. The site was located 30 m above sea level with average rainfall of 780 mm per year. The planting area normally had 3 wet months and 9 dry months yearly. These longer dry months with plenty of sunlight and short wet months made this area suitable for Arumanis 143 plantation.

Arumanis 143 was the only variety planted. The trees were planted monoculturally with distance of 8 X 10 m. The mango trees are 22 years old, yet they were 3-5 m high with parabolic canopy shape due to regular prunning. Application of good cultural practices such as regular prunning, weed control including pre and post harvest handling was given in order to produce high quality fruit.

The entire weed species associating with mango orchard and those at the border outside the mango orchard were sampled for the presence of *S. dorsalis*. Weed sample was taken under the canopy of mango trees (inside the orchard), in line cross transect, and so were the weeds outside the orchard (borders). The sample was segregated between the leaf and the flower. Three shoots per plant were sampled for monocotyledonous type of weeds and three apical leaves per branch for dicotyledonous type of weeds. Three flowers were also sampled in each weed. The sample was placed in the zip-lock plastic bag sized 25 x 15 cm. Hereafter, the plastic was brought to the laboratory for further treatment. Then, modification of Aliakbarpour and Rawi (2010) dipping method was used to direct collection of the thrips associated with leaf and flower of weeds. The zip-lock plastic with each weed part, i.e. flower and leaf was half filled with ethanol 70% and agitated gently for 10 s. For better restore. The ethanol 70% with the thrips contain was transferred to the plastic jar. Furthermore, the ethanol was poured to the Petri disk and was directly observed using compound microscope for the presence of thrips. Sample of each weed was replicated 13 times. A series of weed sampling was done weekly for a month. The weeds associated with mango orchard were identified based on the book of Moody *et al*., (1984) and Rukmana and Sugandi (1999). Collection of thrips was done also on the leaves and flowers of mango where the weed samples were taken.

The nuisance factors or variance among the treatments were eliminated by applying Completely Randomized Design. The variance among the data was analyzed by Analysis of Variance (Anova), and the significant difference among the treatment analyzed by Least Significant Different (LSD) test ($p = 0.05$). The data was also compared among the age structure and sex ratio inside and outside the orchard by using t-test analysis.

A number of the first and second larval instar including adult were observed to know the age structure and sex ratio of *S. dorsalis* in each segregated weed sample (leaf and flower). In each stage was also observed the sexual type (female and male). Additional data such as daily temperature, relative humidity, number of day, and volume of rainfall were also gathered from the orchard climatic station.

RESULTS AND DISCUSSION

Age Structure and Sex Ratio of *S. dorsalis* on Different Host Plant

Age structure observation of *S. dorsalis* on weeds associating with mango trees showed that there was no significantly difference in average population. However, there was a significant difference of each age structure in different host plant among the first instar and adult except second instar (Table 1).

S. dorsalis feeds on the meristems, terminals and other tender plant parts of the host plant above the soil surface resulting in undesirable feeding scars, distortion of leaves, and discoloration of buds, flowers and young fruits

(Seal *et al*., 2010). The pest prefers young plant tissue and it is not reported to feed on mature host tissues (Kumar *et al*., 2013), and most of the weeds associating with mango orchard are soft especially meristem tissue. Meanwhile, the mango

Adult stage of *S. dorsalis* associates with weeds instead of mango leaf. The presence of weeds with soft tissue and flower in all seasons will provide the pest with more nutrients. Pollen is a prominent source of protein for phytophagous thrips to produce eggs (Tsai *et al*., 1996). Adult females require source of protein to mature their ovaries and eggs. In part, protein deprivation may manifest itself in the failure to secrete juvenile hormone which is needed for ovary and egg development. Nation (2001) added that protein was a very important dietary for insects. Restriction of protein dietary less than 20 % resulted in low growth and high mortality of nymph. Thrips can consume pollen with a wide range of host plants, including the pollen of grass species that grow adjacent to mango trees (Chellemi et al. 1994). Adult thrips consume cell dilution of shoot leaf if the availability of pollen was limited (Teulon *et al*., 1993; Toapanta *et al*., 1996).

trees during observation were on the last dormant stage, hence, it was not associate with young plant tissue and tender plant part which were not preferred by *S. dorsalis*.

Scirtothrips dorsalis instar two prefers all available host plants such as weeds and mango leaves. It seems that this stage has no special nutrients requirement, for its development and adaptation capability are relatively high. Stadium of larvae prefers cell dilution of new growth and young plants**,** a very abundance source feed, and it is almost available all the times (Funderburk *et al*., 2002; Seal *et al*., 2006).

Based on t-test analysis, sex ratio observation on each age structure of *S. dorsalis* on weeds associating with mango orchard including mango leaves exhibited that all of the stages did not show significant difference on male female sex ratio. Similarly, sex ratio on each age structure on different host plant did not bear significant difference on weekly observation either (Table 2). Overall, there was also no preference among all age structures and sex differentiations towards host plant parts (flowers and leaves) (Table 3).

Table 1. Age structure of *S. dorsalis* in different host plant based on total population

Age structure / Host plant	**1st Week**	**2nd Week**	**3rd Week**	**4rd Week**	**Average**
Instar 1					
Weeds under canopy	29	75	98	34	**59.00 a**
Mango leaf	12	12	0	3	**6.75 b**
Weeds at border	64	69	52	23	**52.25 ab**
Total	105	156	150	60	117.75
Instar 2					
Weeds under canopy	31	72	40	29	**43.00 a**
Mango leaf	47	41	11	5	**26.00 a**
Weeds at border	52	74	48	13	**46.75 a**
Total	130	187	99	47	115.75
Adult					
Weeds under canopy	21	65	53	13	**38.00 a**
Mango leaf	3	1	1	2	**1.75 b**
Weeds at border	25	36	50	20	**32.75 ab**
Total	49	102	104	35	72.5

Remarks - Means value in each column with the same letter is not significantly different (p = 0.05) based on Least Significantly Different (LSD) test

Table 2. Sex ratio in each age structure, different host plant and observation time based on t-test analysis

Age structure / Host plant	1st Week		2nd Week		3rd Week		4rd Week	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Instar 1								
Weeds under canopy	3.00	26.00	7.00	68.00	15.00	83.00	6.00	28.00
Mango leaf	4.00	8.00	1.00	11.00	0.00	0.00	1.00	2.00
Weeds at border	3.00	61.00	3.00	66.00	14.00	38.00	8.00	15.00
t-stat		**0.108**		**0.062**		**0.132**		**0.108**
t-table (0,05)		2.132		2.132		2.132		2.132
Instar 2								
Weeds under canopy	11.00	20.00	4.00	68.00	0.00	40.00	2.00	27.00
Mango leaf	13.00	34.00	2.00	39.00	0.00	11.00	0.00	5.00
Weeds at border	0.00	52.00	0.00	74.00	5.00	43.00	0.00	13.00
t-stat		**0.083**		**0.017**		**0.043**		**0.108**
t-table (0.05)		2.132		2.132		2.132		2.132
Adult								
Weeds under canopy	5.00	16.00	16.00	49.00	7.00	46.00	1.00	12.00
Mango leaf	1.00	2.00	0.00	1.00	0.00	1.00	0.00	2.00
Weeds at border	7.00	18.00	8.00	28.00	7.00	43.00	0.00	20.00
t-stat		**0.074**		**0.096**		**0.087**		**0.051**
t-table (0.05)		2.132		2.132		2.132		2.132

Sex ratio observation based on age structure, host plant and observation time revealed that there was no significant difference in population between male and female. In other words the sex ration could be simplified with 1:1 in number of population. Lewis (1973) stated that in equal number of sex ratio the females apparently predominate because they often live longer than the males. Sex ratio has important implication for population growth since the number of females at a given time has a significant effect on the composition of the next generation (Brown and Keller, 2000).

Host plant part preference (flower and leaves) of each age structure and kind of sex *S. dorsalis* indicated that both flowers and leaves were preferred by all age structures and sexes. It implies that *S. dorsalis* is capable of adapting to all growth stages and utilizing the available resources such as food, refuge and breeding habitat to prolong life sustainability. Kumar *et al*. (2013) reported that *S. dorsalis* is an opportunistic generalist species that is able to feed on a variety of host plants, depending upon present availability in the region. Its great reproductive potential and keen ability in invasion combined with easy adaptation to newly invaded areas are a few of the qualities which make *S. dorsalis* a major concern for agriculture in many countries (Seal *et al*., 2010)

Age Structure and Sex Ratio of *S. Dorsalis* in Mango Orchard and Non Mango Agroecosystem

T-test analysis based on total population indicated that age structure and sex ratio of *S. dorsalis* associating with weeds inside the orchard and borders did not give significant difference (Table 4).

Population dynamic, age structure and sex ratio of insect mostly depend on the availability of food, refuge and breeding habitat including suitable abiotic factor such as temperature, relative humidity and precipitation. The equality of age structure and sex ratio inside and borders of mango orchard was apparently due to all of the affected factors were unlimited or equal in both site. Besides, it revealed that continuing sea wind during day and land wind during night will also lead the spread out of thrips population evenly. Pickett *et al*. (1988) revealed that migration plays an important role in the population dynamic and changing age structure of thrips. Pearsall and Myers (2000) informed that exposure of orchards to a wind flow which carries dispersing thrips may play a role in thrip movement.

Table 3. Preference of each age structures and sex of *S. dorsalis* towards host plant parts (flowers and leaves)

Age structure / Host plant	**1st Week**				**2nd Week**				**3rd Week**				**4rd Week**
	Male		**Female**		**Male**		**Female**		**Male**		**Female**		**Male**
	Flw	**Lvs**	**Flw**	**Lvs**	**Flw**	**Lvs**	**Flw**	**Lvs**	**Flw**	**Lvs**	**Flw**	**Lvs**	**Flw**
Instar 1													
Weeds under canopy	2.00	1.00	8.00	18.00	4.00	3.00	34.00	34.00	5.00	10.00	25.00	58.00	3.00
Mango leaf	0.00	3.00	13.00	48.00	0.00	3.00	20.00	46.00	3.00	11.00	17.00	21.00	5.00
Weeds at border	0.00	4.00	0.00	8.00	0.00	1.00	0.00	11.00	0.00	0.00	0.00	2.00	0.00
t-stat		**0.145**		**0.233**		**0.539**		**0.435**		**0.318**		**0.511**	
t-table (0,05)		**2.132**		**2.132**		**2.132**		**2.132**		**2.132**		**2.132**	
Instar 2													
Weeds under canopy	0.00	0.00	10.00	42.00	0.00	0.00	19.00	55.00	3.00	2.00	28.00	15.00	1.00
Mango leaf	0.00	13.00	1.00	33.00	0.00	2.00	0.00	39.00	0.00	0.00	0.00	9.00	0.00
Weeds at border	6.00	5.00	5.00	15.00	3.00	1.00	18.00	50.00	0.00	0.00	10.00	30.00	0.00
t-stat		**0.403**		**0.042**		**1.00**		**0.010**		**0.795**		**0.632**	
t-table (0.05)		2.132		2.132		2.132		2.132		2.132		2.132	
Adult													
Weeds under canopy	2.00	5.00	6.00	12.00	4.00	4.00	14.00	14.00	4.00	3.00	17.00	26.00	0.00
Mango leaf	0.00	1.00	0.00	2.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00
Weeds at border	2.00	4.00	6.00	9.00	10.00	6.00	22.00	27.00	5.00	2.00	19.00	27.00	1.00
t-stat		**0.219**		**0.363**		**0.715**		**0.849**		**0.492**		**0.596**	
t-table (0.05)		**2.132**		**2.132**		**2.132**		**2.132**		**2132**		**2.132**	

Remark: Flw = Flower, Lvs = Leaves

Sex ratio observation also indicated an equality between male and female toward all age structures i.e. instar 1 and 2, including adult stage. Apparently, comprehensive and simultaneous biotic and abiotic factors such as the availability of food, breeding habitat and refuge including climate bolster for producing more offspring in balance sex ratio.

Similar research on *Frankliniella occidentalis* showed that winged species with a haplodiploid sex determination are assumed to disperse after emergence. Therefore, sex ratio is close to 1 : 1. Further, *S. dorsalis* displays this type of behaviour dispersing immediately after hatching and adults move around frequently (Kumm, 2002).

Sex ratio of thrips is typical for local species and depends on internal and environmental conditions such as temperature (Tsai *et al*., 1996; Murai, 2000). Vasiliu-Oromulu (2002) informed that more droughty weather affected the sex ratio index of thrip population in mountainous meadows to be more males.

Table 4. Comparison of age structure and sex ratio of *S. dorsalis* between inside and borders of mango orchard

Time of observation inside the orchard	Instar 1			Instar 2			Adult			Total numbers
	Male	Female	Total instar 1	Male	Female	Total instar 2	Male	Female	Total adult	
1st week	3.00	26.00	29.00	11.00	20.00	31.00	5.00	16.00	21.00	81.00
2nd week	7.00	68.00	75.00	4.00	68.00	72.00	16.00	49.00	65.00	212.00
3rt week	15.00	83.00	98.00	0.00	40.00	40.00	7.00	46.00	53.00	191.00
4rd week	6.00	28.00	34.00	2.00	27.00	29.00	1.00	12.00	13.00	76.00
Average	7.75	51.25	**59.00**	4.25	38.75	**43.00**	7.25	30.75	**38.00**	
Time of observation outside the orchard (borders)	**Instar 1**			**Instar 2**			**Adult**			**Total numbers**
	Male	**Female**	**Total instar 1**	**Male**	**Female**	**Total instar 2**	**Male**	**Female**	**Total adult**	
1st week	3.00	61.00	64.00	0.00	52,00	52.00	7.00	18.00	25.00	141.00
2nd week	3.00	66.00	69.00	0.00	74,00	74.00	8.00	28.00	36.00	179.00
3rt week	14.00	38.00	52.00	5.00	43,00	48.00	7.00	43.00	50.00	150.00
4rd week	8.00	15.00	23.00	0.00	13,00	13.00	0.00	20.00	20.00	56.00
Average	7.00	45.0	**52.00**	1.25	45,50	**46.75**	5.50	27.25	**32.75**	
t-stat	**0.295**	**0.345**	**0.330**	**0.215**	**0.264**	**0,330**	**0,240**	**0,307**	**0,284**	**0,354**
t-table			**1.943**			**1.943**			**1.943**	**1.943**

List of The Weeds Associating with Mango Orchard in The Study Area

Twenty seven weeds were found to associate with mango trees and border of site research site (Appendix 1). However, species of weeds such as *Ischaemum rugosum* Salisb, *Desmanthus leptophyllus* Kunth., *Paspalum conjugatum* P.J.Bergius, *Tridax procumbens* L., *Passiflora foetida* L., *Ipomoea triloba* L. and *Acalypha indica* L. dominantly associated with mango trees and border. The consecutive sequent of association was 17, 13, 10, 10, 9, 9 and 9, respectively. Meanwhile, other weeds were associate with mango trees and border in five or less.

The presence of *S. dorsalis* thrips associating with weeds must also be considered in term of population management, since some weeds shared little association but their weekly average total population was very high (Table 5).

Table 5 shows that weeds such as *A. hypogaea*, *Momordica* sp., *T. terrestris* and *M. invisa* were associate equal to or less than four but the population number of *S. dorsalis* associating with those weeds were relatively high. Hence, weed management is needed to avoid population explotion. Apparently, yellow color of flower such as in *A. hypogaea* and *T. terrestris* including pink to red in *Ipomoea* sp. and *M. invisa* attracted *S. dorsalis* to come, occupy, and possibly breed on the weed. Color attraction research on *S. dorsalis* revealed that yellowish-green and yellow were the most preferred color compared to blue and white (Tsuchiya et al. 1995; Cho et al. 1995; Chu *et al*. 2006). Suitable nutrient in term of availability and composition was also another consideration causing *S. dorsalis* to prefer certain weed species. Brodbeck et al (2001) and Mound (2005) stated that the duration of the larval and pupal stadia of members of the Suborder

Table 5. *S. dorsalis* the most prefered weeds that associate with mango orchard based on total population numbers

No.	Weed	1st week	2nd week	3rd week	4rd week	average
1	*Ipomoea triloba* L.	12	54	37	22	31.25 a
2	*Desmanthus leptophyllus* Kunth	17	45	41	16	29.75 ab
3	*Tridax procumbens* L.	7	41	37	5	22.50 ab
4	*Arachis hypogaea* L.	10	43	24	5	20.50 ab
5	*Momordica* sp.	6	10	41	21	19.50 ab
6	*Digitaria ciliaris* (Retz.) Koel.	18	19	26	10	18.25 ab
7	*Tribulus terrestris* (Caltrop.)	23	33	9	4	17.25 ab
8	*Ischaemum rugosum* Salisb.	12	24	16	11	15.75 ab
9	*Mimosa invisa* Mart.	3	15	22	9	12.25 ab
10	*Passiflora foetida* L.	14	21	9	2	11.50 b

Remarks: Means value in each column with the same letter is not significantly different (p = 0.05) based on Least Significantly Different (LSD) test

Terebrantia was influenced by the access of the larvae to nutrients. However, additional research was needed to determine suitability and preference of *S. dorsalis* toward certain weeds host associating with mango orchard.

CONCLUSION

Population number of each age structure was equal. Instar one and adult stage of *S. dorsalis* preferred associating with weeds in both under the mango canopy and at border, except for the second instar that spread prevalently on several plant leaves including mango leaves. Male and female sex ratio in all age structure and hosts associating with mango agroecosystem were equal. Twenty seven weeds were identified to associate with mango trees and borders. Species of weeds of *Ischaemum rugosum* Salisb was the most associated weed, while *A. hypogaea* L. was the most preferred weed by *S. dorsalis*.

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Appendix 1. Weeds found associate with mango trees and border of site location of the research and it dominance among others

No.	Weeds	Number of association with mango trees and borders
1	*Ischaemum rugosum* Salisb.	17
2	*Desmanthus leptophyllus* Kunth	13
3	*Paspalum conjugatum* P.J.Bergius	10
4	*Tridax procumbens* L.	10
5	*Passiflora foetida* L.	9
6	*Ipomoea triloba* L.	9
7	*Acalypha indica* L.	9
8	*Pennisetum* sp.	5
9	Unidentified 1.	4
10	*Mimosa invisa* Mart.	4
11	*Barleria prionitis* L.	4

Appendix 1 *(Continued)*

No.	Weeds	Number of association with mango trees and borders
12	*Momordica* sp.	4
13	*Lantana camara* L.	3
14	*Crotalaria retusa* L.	3
15	*Tribulus terrestris* (Caltrop.)	3
16	*Mimosa pudica* L.	2
17	*Arachis hypogaea* L.	2
18	*Achyranthes aspera* L.	1
19	*Crotalaria mucronata* Desv.	1
20	*Amaranthus spinosus* L.	1
21	*Cleome rutidosperma* DC.	1
22	*Capsicum annuum* L.	1
23	*Sida acuta* Burm F.	1
24	*Ipomoea carnea* L.	1
25	*Chromolaena odorata* (L.) King & Robinson	1
26	*Centrosema pubescens* Benth.	1
27	*Stachytarpheta jamaicensis* (L.) Vahl.	1