PREFERENCE OF SCIRTOTHRIPS DORSALIS (THYSANOPTERA : THRIPIDAE) HOOD ON SEVERAL PHENOLOGICAL STAGES OF MANGO 'ARUMANIS 143': IMPLICATION FOR CONTROL

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ABSTRACT

The production and quality of Indonesia's 'Arumanis 143' mango have been on the decline due to the serious infestation of *Scirtothrips dorsalis* Hood. Laboratory studies were done to determine the preference of *S. dorsalis* on several phenological stages of mango. Collection of mango samples was conducted in a mango plantation in Situbondo, East Java, Indonesia, between June to August 2015. Subjecting *S. dorsalis* to different food sources, a series of choice tests (based on choice and no-choice tests) on growth stages of mango were undertaken to determine the host preference on growth stage. T-test analysis was performed to determine the significant difference between the two choices of host. Results showed that *S. dorsalis* preferred flushes to flower, flushes than dormant leaves, and favored flower over dormant leaves. The host preference was determined by color, water and nutrient contents; diameter of stomata, and morphological surface of the host. The research implies that control strategies should be applied in the early emergence of young shoots to avoid initial population build up.

Keywords: mango, phenological stages, *Scirtothrips dorsalis*, preference

1. INTRODUCTION

Regular insecticide spray is the most common practice farmers use to keep their orchard free from pests. This activity does not only increase pesticide cost but also labor. Reducing input cost such as pesticides and labor is one of the ways to increase farmer's benefit. Hence, effective and efficient pest control strategies should be developed based on insect abundance and behavioral observation associated with the growth stage of the host. Insect host selection sequence includes habitat location, host location, host acceptance, and host use. Several sensory cues were utilized in host selection including visual, olfactory, gustatory, and tactile stimuli as well as humidity and light intensity (Bernays & Chapman, 1994). These cues stimulate receptors, generating sensory input, and finally behavioral responses.

Recently, the production and quality of mango as Indonesia's national commodity has declined due to the infestations of *Scirtothrips dorsalis* Hood. The thrips rasp and suck up cell content that cause in discoloration of young shoots due to the cell's exposure to air. Heavy incursions lead to curly shoot leaves, a result of unbalanced development among healthy and damage cells. Furthermore, the flush will dry and wither leaving only twigs. Twigs will never produce flowers and fruits. Attacks on flowers will prohibit the pollination process due to the pollen being consumed by thrips as a source of protein (Tsai *et al.,* 1996). It also causes a decline in fruit setting as the young fruit drops. The effects of *S. dorsalis* infestation on immature and mature fruits are peel scarring. Affandi *et al.* (2018) revealed that economic losses on 'Arumanis 143' mango caused by *S. dorsalis* was estimated at USD 1.040–USD 1.300/ha.

S. dorsalis has been reported to prefer buds, tender leaves, as well as flowers (Seal *et al.*, 2010; Kumar *et al.*, 2013; Mannion *et al.*, 2013; Mannion *et al.*, 2014). However, there is no information yet about its preference on several phenological stages associated with 'Arumanis 143' mango. Different insect species express high specificity at different stages in the host selection (Heard, 2018). Hence, investigation on partiality and all factors which support greater liking over another is an inevitable need for preventive strategic control programs.

The objective of the research was to identify the preference of *S. dorsalis* on several phenological stages of 'Arumanis 143' mango.

2. MATERIALS AND METHOD

Using the choice and no-choice tests, S. dorsalis was subjected to food at different growth stages of 'Arumanis 143' mango to determine its preference towards growth stage. The methodology of Bora *et al.* (2012) on host plant selection of Muga silkworm, *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae) was modified and used in this study. In the choice test, *S. dorsalis* was subjected to choose between two growth stages of mango (dormant and young shoots). A Petri dish (9 cm in diameter) was used as an arena for testing. It was padded at the bottom with a moistened Whatman filter paper. A rounded dormant leaf and young shoot of mango leaves (3 cm in diameter) were placed in opposite sides of the Petri dish, maintaining a 3 cm space between them. Ten female *S. dorsalis* were placed at the center of the petri dish. The number of *S. dorsalis* that moved and chose a certain growth stage versus those without any movement was counted every four hours until all of them died. In the no-choice test, a similar procedure was repeated, however providing only one growth stage of mango per Petri dish. This choice test was done using a combination of flush leaves and flower, flush leaves and dormant leaves, as well as dormant leaves and flower. Ten (10) trials were done for each of the tests.

Complimentary data such as number of leaf pores and its diameter was observed on flush and dormant growth stages. Surface characters of the host were also observed descriptively. T-test analysis was used to determine significant difference between the two growth stages.

3. RESULTS AND DISCUSSIONS

The choice tests indicated that the order of preference of *S. dorsalis* on the phenological stages of mango was as follows: flush>flower>matured. Given two choices at a time, flush stage was preferred over flower; flush stage was preferred over dormant stage of leaf; and flower was preferred over dormant stage. Variation in the number of adult thrips moving to a certain phenological stage in a time series of observation is presented in Figures 1, 2, and 3.

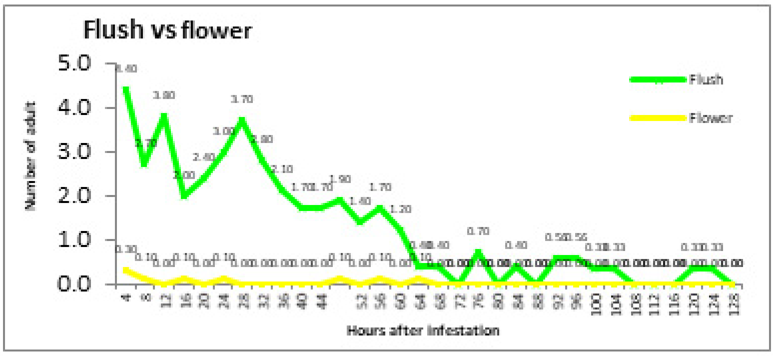

Figure 1. Preference of *S. dorsalis* on flower and flush growth stage of mango in two choices test.

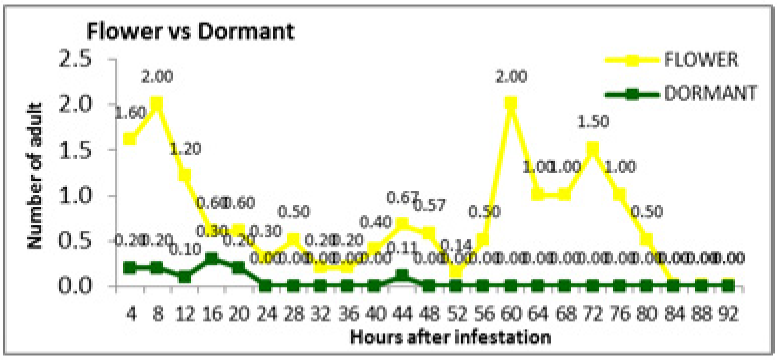

Figure 2. Preference of *S. dorsalis* on flower and dormant growth stage of mango in two choices test.

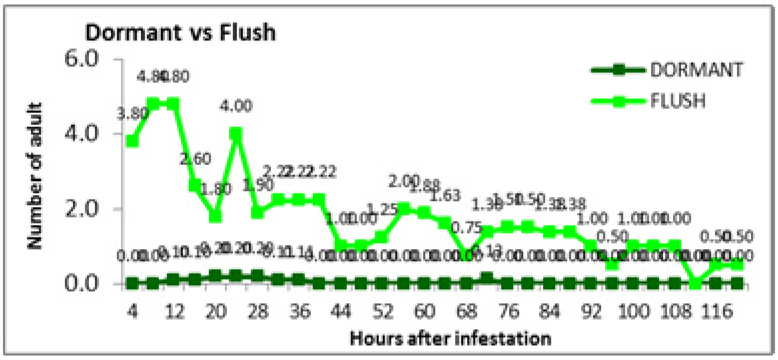

Figure 3. Preference of *S. dorsalis* on flush and dormant growth stage of mango in two choices test.

Thrips tended to move from one food choice to another in the duration of the study. The trend of their preference seemed to be observed 8–12 hours after infestation where about 50% of the test population remained on the phenological stage of their choice. The rest of the test population was either on the other choice (10%–20%) or on the surface of the Petri dish.

Results from the no-choice test further supported the result of the choice tests (Figure 4). The behavior of the population was the same in both choice and no-choice tests. Without any choice, the number of *S. dorsalis* on flowers and matured leaves did not increase. They were not forced to feed on the non-preferred stages even in the absence of an alternative. The proportion of feeding on flushes was higher than either flowers or matured leaves when offered alone. Similar to that of the no-choice test, the choice of most individuals in the test population became apparent around 8–12 hours after infestation.

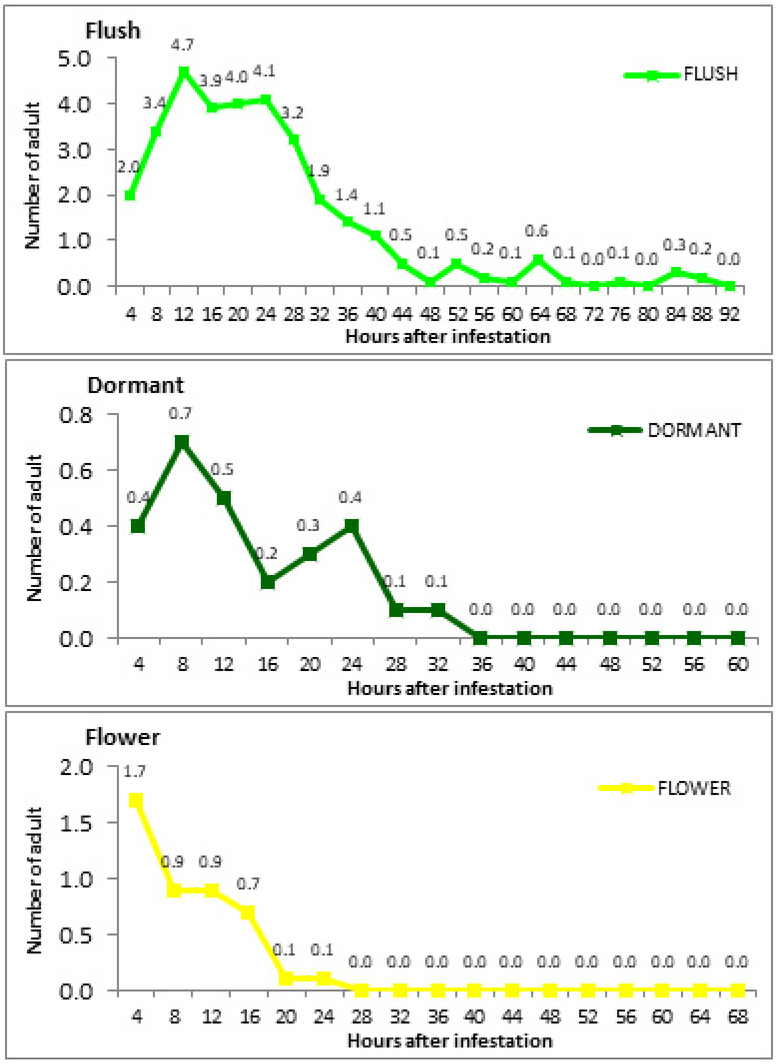

Figure 4. Mean number of *S. dorsalis* occupying the flush, flower, and dormant leaves in the no-choice test.

Preference is a behavior shaped by evolution. Understanding the behavioral processes involved in selection of a host plant can be used to improve the accuracy of host preference. The sequence of steps in host selection includes habitat location, host location, host acceptance, and host use. Insects use a number of sensory cues in host selection including visual, olfactory, gustatory, and tactile stimuli as well as humidity and light intensity (Bernays & Chapman, 1994). The food choices of insects are affected by factors like nutrition, freedom from natural enemy threat, host plant cues, and availability that promote their development, survival and reproduction. Both flush and flowers of mango became matured almost at the same time (10 days) as shown in Figures 1 and 2. The flushes nevertheless must be a more stable unit of food and habitat than the flowers considering that most parts of the florets fall off after anthesis and are transformed into a fruit. Also, there are other insect pests and diseases that attack the flowers than the leaves, hence more competitors. The occupation time of the chilli thrips, *S. dorsalis* Hood, associated with flush and flower growth stages of mango indicated that *S. dorsalis* started to move into the mango canopy during early shoot emergence (Affandi *et al.*, 2017). Field observations presented that population fluctuation of *S. dorsalis* associated with mango increased in the early dry season during flushing stage (143 thrips/sampling unit), and density declined when the plant enters the flowering stage and is dormant (Affandi *et al.*, 2018).

Color of the host play an important role in host selection of *S. dorsalis*. We observed that *S. dorsalis* prefer mangoes which are yellowish green (Appendix 1). Similar research on mandarin oranges revealed that yellowish-green, green, and yellow color sticky trap board with spectral reflectance (SR) 400–450, 480–540, and 540–580 nm, respectively, were favored by *S. dorsalis* and attracted more adult thrips. Shoot leaves and young fruits of mandarin oranges were more attractive to adult *S. dorsalis* due to the spectral reflectance of mature leaves (Tsuchiya *et al*., 1995, Prema *et al*., 2018b).

The various growth stages of mango must have met the suitability of nutrients required by *S. dorsalis* in terms of availability and balanced composition (Nation, 2001). Nutrient content analysis indicated that flush had high water, nitrogen, and protein content including cellulose as well as lignin (Table 1). The rasping-sucking mouth type of *S. dorsalis* requires high water content to acquire soluble nutrients and this is fulfilled by flush leaves than flower and dormant growth stages. Affandi *et al.* (2018a) stated that mango flush supported the development and survivability of *S. dorsalis* which develops from egg to pupa at 12.55±0.41 days with a survival rate of 47 %. High water and nutrition content on flush growth stages apparently influence the feed suitability. Runagall-McNaull, Bonduriansky, & Crean (2015) narrated that sufficient protein in the neriid fly, *Telostylinus angusticollis* affected the short larval life-span. Larvae also depended on high moisture content in its diet for survival. The presence of lignin was crucial to maintain physiological activities of the lower termite, *Coptotermes formosanus* Shiraki, and increased the survival rate significantly (Tarmadi *et al*., 2017). Moisture content on leaves is mostly affected by the spacious circle of the stomata and thickness of the leaves. Laboratory observation showed that flush has a higher spacious circle of stomata compared to dormant leaves (Appendix 1) as well as thickness of the leaves (Appendix 3). Therefore, the high moisture content provided a more suitable environment for *S. dorsalis* to survive, develop, and reproduce.

Table 1. Analysis of nutrients content in several mango growth stages

MANGO GROWTH STAGES	WATER	NITROGEN	PROTEIN	CELULLOSE	LIGNIN
Dormant	60,39	0,51	3,19	13,24	14,43
Flush	79,64	0,77	4,82	18,86	18,98
Flower	79,86	0,71	4,42	14,68	18,84

Note: The analysis was done at Laboratorium Chem-Mix Pratama, Jl. Kretek, Jambitan, Banguntapan, Bantul, Jogyakarta, Indonesia.

Physical conditions such as the presence of hairs on flower stalks lessened the preference of *S. dorsalis* on the flower stage due to difficulties or inconvenience in reaching the pollen as an additional source of protein. Similar research on cotton discovered that much more damage was caused by *T. palmi* on cultivars with low densities of hairs than those with many hairs (Bournier, 1983; Gopichandran *et al*., 1992). Kirk (1997) revealed that hairiness is beneficial to plants, barring insects access to parts of the plant as source of food and oviposition as the hairs trap or injure the insect.

CONCLUSIONS

Host preference of *S. dorsalis* was determined by growth stages of the host. Flush growth stage was the most preferred, followed by flower, and dormant leaves. Determination of the preferences was deeply influenced by color, water and nutrient contents, diameter of stomata, thickness of the leaves, and morphological surface of the host.

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APPENDIX

Appendix 1. Population of *S. dorsalis* on several color of mango flush leaves.

No.	Clone	Repli-cation	Color of flush leaves	Number of thrips		No.	Clone	Repli-cation	Color of flush leaves	Number of thrips	
1.	Agrigardi-na 45	1	Greyed-Orange Group 177 A	0	0.00	6.	Garifta orange	1	Greyed-Orange Group 166 A	1	1.00
		2	Greyed-Orange Group 165 A	0				2	Greyed-Orange Group 166 B	1	
		3	Greyed-Orange Group 177 B	0				3	Greyed-Orange Group 165 A	1	
2.	O	1	Greyed-Orange Group 165 A	2	2.33	7.	Mang-gasari	1	Greyed-Orange Group 164 A	3	2.33
		2	Greyed-Orange Group 166 A	2				2	Greyed-Orange Group 166 C	3	
		3	Red Group 51 B	2				3	Greyed-Orange Group 165 B	3	
3.	Keitt	1	Yellow-Green Group 152 C	2	2.00	8.	Ken-layung	1	Greyed-Orange Group 164 A	1	1.00
		2	Yellow-Green Group 144 A	2				2	Greyed-Orange Group 164 A	1	
		3	Yellow-Green Group 144 A	2				3	Greyed-Orange Group 164 A	1	
4.	Garifta kuning	1	Greyed-Red Group 180 B	1	1.00	9.	Marifta	1	Yellow-Green Group 152 A	1	1.00
		2	Greyed-Red Group 180 B	1				2	Yellow-Green Group 152 A	1	
		3	Greyed-Orange Group 175 A	1				3	Yellow-Green Group 152 A	1	
5.	Arumanis 143	1	Yellow-Green Group N144 A	1	1.33	10.	Saigon kuning	1	Greyed-Purple Group N 186 C	3	2.67
		2	Yellow-Green Group 152 B	1				2	Greyed-Purple Group N 186 C	3	
		3	Yellow-Green Group 152 B	1				3	Greyed-Purple Group N 186 C	3	
No.	**Clone**	**Repli-cation**	**Color of flush leaves**	**Number of thrips**		**No.**	**Clone**	**Repli-cation**	**Color of flush leaves**	**Number of thrips**	
11.	Garifta merah	1	Red Group 38 A	2	1.33	14.	Kraton	1	Greyed-Orange Group 177 A	2	2.00
		2	Red Group 38 A	2				2	Greyed-Orange Group 195 A	2	
		3	Red Group 38 A	2				3	Greyed-Orange Group 174 A	2	

Appendix 1. Population of *S. dorsalis* on several color of mango flush leaves. (continued)

No.	Clone	Repli-cation	Color of flush leaves	Number of thrips		No.	Clone	Repli-cation	Color of flush leaves	Number of thrips	
12.	Durih	1	Greyed-Orange Group 165 A	5	5.00	15.	Garifta gading	1	Yellow-Green Group 15 B	1	3.00
		2	Greyed-Orange Group 165 A	5				2	Yellow-Green Group 152 C	1	
		3	Grey-Brown Group N199 C	5				3	Yellow-Green Group 152 B	1	
13.	Gadung	1	Yellow-Green Group 152 B	1	1.00						
		2	Yellow-Green Group 152 B	1							
		3	Yellow-Green Group 152 B	1							

Appendix 2. Length, width and spacious stomata on flush and dormant leaves of 'Arumanis 143' mango

No. of stomata	Flush leaves			Dormant leaves		
	Length (micron)	Width (Micron)	Spacious (½P x ½ L) x π	Length (micron)	Width (Micron)	Spacious (½P x ½ L) x π
1	19	18	268.5	25	14	274.8
2	17	10	133.5	12	10	94.2
3	20	10	157.0	12	10	94.2
4	18	15	212.0	15	10	117.8
5	20	18	282.6	14	10	109.9
6	17	14	186.8	25	25	490.6
7	25	10	196.3	13	10	102.1
8	20	10	157.0	20	10	157.0
9	15	12	141.3	19	10	149.2
10	18	10	141.3	20	15	235.5
Total number	189	127	1876.2	175	124	1825.1
Average	18.9	12.7	187.6	17.5	12.4	182.5
1	25	27	529.9	20	15	235.5
2	18	14	197.8	18	15	212.0
3	27	24	508.7	19	15	223.7
4	22	19	328.1	18	16	226.1
5	20	15	235.5	18	15	212.0
6	21	15	247.3	18	15	212.0
7	15	14	164.9	19	16	238.6
8	20	20	314.0	15	13	153.1
9	20	15	235.5	15	14	164.9
10	15	10	117.8	19	15	223.7
Total number	203	173	2879.4	179	149	2101.4
Average	20.3	17.3	287.9	17.9	14.9	210.1

Appendix 2. Length, width and spacious stomata on flush and dormant leaves of 'Arumanis 143' mango

No. of stomata	Flush leaves			Dormant leaves		
	Length (micron)	Width (Micron)	Spacious (½P x ½ L) x π	Length (micron)	Width (Micron)	Spacious (½P x ½ L) x π
2	20	15	235.5	17	15	200.2
3	20	16	251.2	19	12	179.0
4	20	20	314.0	19	17	253.6
5	20	21	329.7	30	20	471.0
6	20	19	298.3	20	20	314.0
7	20	15	235.5	20	15	235.5
8	15	13	153.1	20	16	251.2
9	20	15	235.5	19	10	149.2
10	20	15	235.5	21	15	247.3
Total number	193	164	2500.2	218	170	3078.0
Average	20.3	17.3	287.9	17.9	14.9	210.1
Total average	19.5	15.5	236.7	19.1	14.9	221.02

Appendix 3. Thickness of flush and dormant leaves of 'Arumanis 143' mango

No. of leaves	Flush leaves (micron)	Dormant leaves (micron)
1.	1.63	1.51
2.	1.89	1.5
3.	1.7	1.59
4.	1.85	1.29
5.	1.58	1.38
6.	1.82	1.38
7.	1.50	1.45
8.	1.83	1.64
9.	1.85	1.60
10.	1.58	1.5
Total	14.2	14.77
Average	1.72	1.48