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Development and Survivorship of *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) in Different Growth Stages of Mango and Selected Weeds

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ABSTRACT

The research objective was to quantify the development and survivorship rate of *S. dorsalis* in different phenological stages of mango and selected weeds. The research was conducted in the laboratory of PT. Trigatra Rajasa, Mango plantation in Ketowan, Arjasa, Situbondo, East Java, Indonesia from February to September 2015. The development and survivorship rate were done through observation of life span of *S. dorsalis* from egg to pupa. Analysis of Variance and Duncan Multiple Range Test (p = 0.05) with 5 replications were applied to ensure the significant differences among the treatments. The result showed that development and survivorship of *Scirtothrips dorsalis* were supported by mango flushes and flower as well as some weeds such as *Leucania leucochepala*, *Ipomoea triloba*, *Achalypha indica*, *Desmanthus leptophyllus* and *Azadirachta indica* as source of food. *Achalypha indica* was the most suitable host with development time (12.82 ± 0.21 days) and survivorship (33 %). Weed *Tridax procumbent*, *Momordica charantia* and *Mimosa pudica* were unable to provide the living requirement for immature developmental stage of *S. dorsalis.*

INTRODUCTION

Mango is one of the fruit commodities that has been given serious attention by Indonesian Ministry of Agriculture to be developed. The impact, Indonesia is being one of the mango production countries after India, China, Thailand, Philippines, Pakistan, Brazil and Australia. Among hundreds variety developed, Arumanis 143, a very sweet yet fiberless variety, is the most prefered mango variety of domestic consumers.

Insect infestation poses serious constraint for high mango production and quality standard. One of the most damaging pests on mango is thrips *Scirtothrips dorsalis* Hood (Affandi & dela Rosa Medina, 2013). It sucks the liquids and cell contents inside the tissues that will lead to curly and undeveloped flush. Feeding on pollen will cause damage that decreases fruit set, young fruit drop and scarring of the immature and mature fruits (Kirk, 1997). *Scirtothrips dorsalis* is categorized as invasive plant pests and nominally considered as polyphagous pest (Dickey et al., 2015; Toda et al., 2014). It is also reported as an opportunistic generalist species that is able to feed on a variety of host plant species including weeds (Kumar, Kakkar, McKenzie, Seal, & Osborne, 2013; Mound & Palmer, 1981; Mound, 2005).

In order to develop management strategies against *S. dorsalis*, basic information on development and survivorship in different growth stages of mango and weeds that usually used as alternate host is needed. Kumar, Kakkar, McKenzie, Seal, & Osborne (2013) stated that crop phenology plays a significant role in determining the level of thrips infestation. This basic information expected can be utilized for developing strategies to manage *S. dorsalis* in pre-emptive and reactive strategy control as well.

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Development and survivorship of insects are results of species and the quality of host plant (Bernays & Chapman, 1994; Facknath & Lalljee, 2005). The host plant can obviously affect the population dynamic of associated insect (West & Cunningham, 2002). Therefore, it is crucial to thoroughly understand the development and survivorship of a pest on different growth stages and host species including weeds. The development and survivorship of insects are usually measured by the Life-spans. Life-spans summarize the survival and reproductive potential of insect population on different host and under various environmental conditions (Akköprü, Atlıhan, Okut, & Chi, 2015; Tuan, Lee, & Chi, 2014; Yang et al., 2015). Suitable host plant gives short life spans and high survival rates (Schowalter, 2016). Hence, certain phenological stage of mango and weeds species associated with mango orchard that categorized as suitable host plant must be given attention for *S. dorsalis* pre-emptive and reactive control.

The objective of the research was to quantify the development and survivorship rate of S. dorsalis in different phenological stages of mango and selected weeds.

MATERIALS AND METHODS

To investigate the development and survivorship of *S. dorsalis* on mango and weeds, the suitability studies on several growth stages of mango and selected weeds were done in the laboratory through observation of its life span from egg to pupa. Weeds used in this research involved all plants growing under the canopy of mango where they were not wanted (Arcioni, 2004) including tree plant that usually grows from fall seed as a seedling. Dormant and flush leaves were cut and laid down on the Petri disk (9 cm in diameter) that was covered with moistened Whatman filter paper prior to laying down the leaves. The laid down mango leaf inside the Petri dish was infested with ten female adult of *S. dorsalis* for 24 hours for oviposition. The upper part of the leaves was observed every four hours for the emergence of first larval instar (Seal, Klassen, & Kumar, 2010). The twenty newly hatches larval instars were transferred to new leaves. The leaves were laid down on the object glass that was covered with moistened Whatman filter paper prior to laying down the leaves. Then, Munger cell was placed on the upper part of the leaves. The inside hole of the Munger cell was infested by newly hatched of first instar larvae. The larvae were also transferred to other leaves if the previous leaves were almost dry. The development of *S. dorsalis* from the first instar larvae to adult stage was recorded every twelve hours. The life cycle of the egg to adult was also observed on *S. dorsalis* that was fed on the pollen. Combinations of both feeds, at the dormant stage and pollen, including the flush stage and pollen were also recorded. The suitability study of *S. dorsalis* was also observed on the most abundant weed associated with mango plantation. Young leaves of weeds (perfectly open, color light green, tender, number 3-5 from the first shot) were used as arena for testing and treated mango leaves. The weeds were used such as *I. triloba* L., *T. procumbens* L., *M. charantia* L. and the most preferred weeds namely *D. leptophyllus* Kunth., *Az. indica* A. Juss., *Ac. indica* L. and including those of less associated but with high population of *S. dorsalis* i.e. *L. leucochepala* (Lam.) de Wit. Prominent nutrient contents that influenced the life cycle of *S. dorsalis* such as protein and nitrogen, including water dilution, were analyzed.

To ascertain the effect of nutrient on the development and survivorship of *S. dorsalis* in different host plants, biological parameters were observed for the first instar to pupa stage including the percentage of survival in each stage of *S. dorsalis* following the method from Kumar, Kakkar, McKenzie, Seal, & Osborne (2013).

The study on development and survivorship were based on 11 hosts offered from immature of *S. dorsalis* with 5 replications. To find out the mean duration of various developmental stages of *S. dorsalis*, Analysis of Variance (ANOVA) was also used in this research. Hereafter, Duncan Multiple Range Test (DMRT) ($p = 0.05$) was applied to ensure the significant differences among the treatments. Statistical Tool for Agricultural Research (STAR – IRRI) was utilized.

RESULTS AND DISCUSSION

Rearing of *S. dorsalis* on some selected weeds associated with mango was varied significantly in length of development time and survivability (Table 1). Three weed species: *T. procumbens*, *M. charantia*, and *M. pudica* were unable to provide the requirement for immature stage of *S. dorsalis*. No thrips reared on these species survived to the second instar. These weeds could have chemical and physical properties detrimental to the feeding and survival of the immature stages of thrips.

Table 1. Life history of *S. dorsalis* on mango and selected weeds.

Host Plant	Life history of *S. dorsalis* per stadium ± SE				
	Egg	**Larval Instar 1**	**Larval Instar 2**	**Pupa**	**Egg to pupa (Days)**
Mangifera indica (Flush)	4.05 ± 0.07 bc	0.5 ± 0.00 c	4.80 ± 0.32 a	3.20 ± 0.36 a	12.55 ± 0.41 abc
Mangifera indica (Flush + Flower)	4.13 ± 0.05 bc	0.5 ± 0.00 c	5.00 ± 0.65 a	2.84 ± 0.23 ab	12.46 ± 0.27 abc
Mangifera indica (Dormant + Flower)	4.38 ± 0.02 b	0.5 ± 0.00 c	5.00 ± 0.61 a	3.60 ± 0.43 a	13.48 ± 0.41 a
Leucania leucocephala	3.61 ± 0.19 cd	1.0 ± 0.00 a	4.70 ± 0.63 a	2.00 ± 0.32 c	11.31 ± 0.36 bc
Tidax procumbent	3.50 ± 0.00 d	1.0 ± 0.00 a	larva unable to develop, many and dense trichom		
Azadirachta indica	2.65 ± 0.38 e	0.5 ± 0.00 c	4.60 ± 0.09 a	3.10 ± 0.26 ab	10.85 ± 0.29 c
Momordica chalantia	5.50 ± 0.00 a	larva unable to develop, many and dense trichom			
Mimosa pudica	4.50 ± 0.00 b	larva unable to develop (artificial fresh leaf uncontrollable to open and close)			
Ipomoea triloba	4.22 ± 0.15 b	0.80 ± 0.24 b	3.70 ± 0.43 a	2.38 ± 0.34 bc	11.10 ± 0.12 bc
Achalypha indica	4.52 ± 0.05 b	1.00 ± 0.00 a	3.80 ± 0.32 a	3.50 ± 0.17 a	12.82 ± 0.21 ab
Desmanthus leptophyllus	4.00 ± 0.07 bcd	1.00 ± 0.00 a	4.63 ± 0.11 a	2.88 ± 0.11 ab	12.50 ± 0.09 abc

Remarks: Means value in each column with the same letter is not significantly different (p = 0.05) based on Duncan Multiple Range Test (DMRT).

Most probably, high trichome density of weed *T. procumbens* and *M. charantia* leaves trapped larvae of *S. dorsalis* from getting sufficient source of food, hence, the larvae died due to lack of food. Similar research on cotton cultivar with low pilosity and low densities of hairs sustained much more damage by *T. palmi* than those with many hairs (Bournier, 1983; Gopichandran, Gurusubramanian, & Ananthakrishnan, 1992). Kirk (1997) revealed that leaf hairiness was well known as a factor conferring insect resistance to a crop, either because of the dense hairs prevent access to the leaf surface for feeding and oviposition or because the hairs trapped or injured the insect. Avery, Kumar, Simmonds, & Faull (2015) added that the trichome density, type, and ability to express glandular exudates could affect adult whitefly Pelargonium cultivar preference and plays an important role in their host plant selection for oviposition.

The other weed species included in the experiment supported the life cycle of the *S. dorsalis* to adulthood. The shortest total development time of thrips among the weeds was observed in *Az. indica* (10.85 ± 0.29 days) and the longest in *Ac. indica* (12.82 ± 0.21 days). Statistical analysis shows that the development period of thrips in the weeds are comparable to those reared on mango. The data obtained from this study was shorter than those of the published development time of *S. dorsalis* and this could be because of the rearing conditions aside from the host as a factor. Chen, Lin, Chiu, & Shih (2013) and Kang, Lee, & Kim (2015) found that the development of *S. dorsalis* on mango decreased from 21.5, 14.8, 12.1, to 9.8 days at 20, 24, 28, and 32 °C , respectively. Seal, Klassen, & Kumar (2010) found that host as factor determined the developmental duration of *S. dorsalis* reared on bean, eggplant, pepper, rose, squash and tomato in a constant temperature of 26 °C had a mean duration of 20.3 ± 0.3; 19,9 ± 0,6; 17.8 ± 0.3; 18.8 ± 0.4; 20.2 ± 0.5 and 20.6 ± 0.3 days, respectively.

The various weed species must have met the suitability of nutrients required by *S. dorsalis* in terms of availability and balanced composition (Nation, 2001). Based on nutrient content analysis such as water, nitrogen, protein, cellulose, and lignin showed that *Az. indica* and *I. triloba* had high water content and relatively high nitrogen and protein including cellulose. Even, *Az. indica* had the highest content of lignin (Table 2). Beside, *Az. indica* and *I. triloba* leaves lasted long in fresh leaves condition.

Runagall-McNaull, Bonduriansky, & Crean (2015) stated that a sufficient protein in Neriid fly, *Telostylinus angusticollis* affected the short larval life-span. Larvae also depended on high moisture content in the diet for survival. Additionally, the presence of lignin was crucial to maintain the physiological activities of the lower termite, *Coptotermes formosanus* Shiraki, even it increased the survival rate significantly (Tarmadi, Yoshimura, Tobimatsu, Yamamura, & Umezawa, 2017).

Table 2. Analysis of nutrients contained in several mango growth stages and the most abundant and preferred weeds associate with mango orchard were used to host of *S. dorsalis.*

Mango growth stage and kind of weeds	Water (%)	Nitrogen (%)	Protein (%)	Celullosa (%)	Lignin (%)
Mango dormant	60.39	0.51	3.19	13.24	14.43
Mango flush	79.64	0.77	4.82	18.86	18.98
Mango flower	79.86	0.71	4.42	14.68	18.84
Tridax procumbens	87.87	0.75	4.69	16.60	25.19
Ipomoea triloba	83.10	0.74	4.63	17.34	21.50
Fassiflora foetida	82.63	0.90	5.60	20.75	18.07
Momordica charantia	81.48	0.71	4.45	22.37	20.48
Desmanthus leptophyllus	73.32	1.09	6.82	20.59	19.05
Achalypha indica	82.00	0.57	3.55	15.56	20.72
eucania leuchochepala	80.17	1.11	6.91	17.09	20.0
Azadirachta indica	77.34	0.91	5.68	10.64	34.09

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

Table 3. Percentage survival of *S. dorsalis* on mango and selected weeds.

Host Plant	Percentage Survival (%)			
	Larval Instar 1	Larval Instar 2	Pupa	Adult
Mangifera indica (Flush)	100.00	76.00	64.00	47.00 **a**
Mangifera indica (Flush + Flower)	100.00	92.00	35.00	31.67 **a**
Mangifera indica (Dormant + Flower)	100.00	34.00	15.00	15.00 **b**
Leucania leucochepala	85.00	52.00	6.25	5.00 **b**
Tridax procumbens	17.00	0.00	0.00	0.00 **b**
Azadirachta indica	100.00	74.00	34.00	21.00 **b**
Momordica charantia	00.00	0.00	0.00	0.00 **b**
Mimosa pudica	00.00	0.00	0.00	0.00 **b**
Ipomoea triloba	35.00	29.00	15.00	12.50 **b**
Achalypha indica	86.00	81.00	58.00	33.00 **ab**
Desmanthus leptophyllus	81.00	60.00	11.25	11.25 **b**

Remarks: Means value in each column with the same letter is not significantly different (p = 0.05) based on Duncan Multiple Range Test (DMRT).

Although most of the weeds supported the life cycle of *S. dorsalis*, the survival rate on them was very low. Only *Ac. indica* had a comparable survival rate to mango. The survivorship in the weeds and in mango dropped significantly from the second instar to pupa. It should be noted that the second instar was longer than the first instar (Table 3) and this is the stage where they fed the longest and nutrition could have played the critical role in the survival of *S. dorsalis* on to the pupal stage.

Based on the combined data of development time and survivorship, *Ac. indica* was the most suitable host among the weed species tested. The flowers of mango in combination with matured leaves were the least suitable, among the plant parts of mango, as food of *S. dorsalis*.

CONCLUSION

Mango flushes and flower supported the development and survivorship of *S. dorsalis* as well as some weeds like *L. leucochepala*, *I. triloba*, *Ac. Indica*, *D. leptophyllus* and *Az. indica*. *Achalypha indica* was the most suitable host among the weed species tested based on the combined data of development time and survivorship. Weed *T. procumbent*, *M. charantia* and *M. pudica* were unable to provide the living requirement for the immature developmental stage of *S. dorsalis* but they were found to harbor the thrips.

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