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Identification, Distribution and Abundance of Scale Insect Associate with Several Clones of Durian (*Durio zibethinus* Merr.)

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ABSTRACT

Durian contributes a high economic value in agribusiness of horticultural product. However, recently the attack of scale insect has devastated most of pre-production trees in Indonesia. A research with objective to know the basic information about the correct species, distribution and population abundance was done at Aripan Research Station of Indonesian Tropical Fruits Research Institute from July to August 2018. A proper identification and observation method were used to know the species identity, distribution and abundance of the insect. Biotic and abiotic factors in each clone such as nutrients content, tree morphological characteristic, light intensity, temperature and relative humidity under canopy were analysed. The result showed that *Aulacaspis vitis* Green was a scale insect identified associating with durian leaves. Clone Bintana and Sikapal were the most and the less preferred with the intensity of damage was 88.60 % and 38.30 %, respectively. Nutrient content especially nitrogen and water as well as canopy morphology were simultaneously the most contributed in the preference of a certain clone. The pest was preferred to clump in the East cardinal direction and no significant difference between upper and lower part of the tree including within and outside of the canopy.

INTRODUCTION

The health awareness of society is getting increased. More people demand for food which contributes their body fitness. Fortunately, durian has potential to be developed to fulfil that expectation. Durian contains most nutrients needed for the human health such as carbohydrate, protein, lipid, vitamins and minerals (USDA-ARS, 2018). It consists of high antioxidant, a compound that inhibits oxidation. Oxidation is a chemical reaction that can produce free radicals which lead to chain reactions that may damage the cells of organism called cancer (Aziz & Mhd Jalil, 2019). Those nutrients give positive impact to human health.

Durian contributes high economic value in Indonesia agribusiness of tropical fruits product. Up to now durian is categorized as an exotic fruit due to its high price. This high price is most possibly caused by little availability of fruit in the market. Kementerian Pertanian (2017) reported that durian harvested area and productivity declined significantly from year of 2013 to 2016 as many as 20.35 % and 7.27 %, respectively. That condition also rendered a negative impact to the decreasing of durian consumption that only reach 1.10 kg per capita per year.

To contribute in both, advance health and economic value for Indonesian society, the expansion of planting area to increase durian fruit production is inevitable needed. However, recently new planting durian trees were devastated by scale insect which attacked leaves. The invaded leave will exhibit yellow spot due to the cell liquid was sucked. Further, all part of the leaves will turn into yellow coincide with insect population development. Along with huge insect population, the leaves will

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fall down remaining trunk, branch and twig only. To avoid failing in escalation of durian planting area, an effective and efficient 7 control action must be done.

The basic information about an accurate identification, distribution and abundance of scale insect which assail durian including biotic (tree morphology, nutrients and water content) and a-biotic (temperature, relative humidity, light intensity) factors are needed for succeeding a pre-emptive and reactive strategic control.

Specifically, this research aimed to investigate a definite identity of scale insect which bombards durian including the distribution and abundance.

MATERIAL AND METHODS

The study was conducted in Aripan Research Station of Indonesian Tropical Fruits Research Institute from July to August 2018, located at Aripan Village, X Kota Singkarak Sub-district, Solok District, West Sumatra Province. The elevation is 457 m above sea level (asl) and the topography is little sloppy. The climate is wet low-land with rain in every 4 - 5 days especially during month of October to March.

The scale-infested samples of durian leave were collected from orchards then brought to the laboratory for next treatment. In the laboratory, the specimen attached on the leaves was put inside a bottle jar with ethanol 70 % contain. The bottle jar was tightly covered then sent to Plant Protection Department of Bogor Agricultural University for species identification. The specimens were slide-mounted for identification using 10 % sodium hydroxide for clearing, dehydration in alcohol, and Canada balsam (Sirisena, Watson, Hemachandra, & Wijayagunasekara, 2013). Then, the mounted specimen was identified following taxonomical published descriptions and keys (Suh, 2017; Watson, 2002; Williams & Watson, 1988).

Twelve clones of durian were planted with planting distance of 8 x 8 m^2. Each clone was cultivated 7 trees in a row. The distribution and abundance of scale insect were monitored from July to August 2018 at the middle of the row. Three trees were used as sample for each clone and each tree was utilized as replication. Subjective percentage of scale insect infested leaves was counted every 3 days. An infested leaf was defined as at least five dots of scale insect colony existed on each leave. The distribution was also determined by cardinal direction (East and West), upper and lower part of the tree, within and outside of the canopy.

T-test analysis was used to know the significant different between each distribution parameter. Meanwhile, Analysis of Varian (ANOVA) and Honest Significant Different (HSD) test were utilized to know the abundance significant different of scale insect among observed clones.

Biotic (tree morphology) and a-biotic (temperature, relative humidity, light intensity) factors were recorded during the observation. Nutrients and water content of each observed clones were also analysed.

RESULST AND DISCUSSION

Scale Insect Associate with Durian Leaves

Based on adult female morphological characters, the armored scale which attacked *D. zibethinus* identified as *Aulacaspis vitis* Green complex. This species complex associated with durian leaves and well known as polyphagous, cryptic and invasive species (Andersen et al., 2010; Beardsley Jr & Gonzalez, 1975; García Morales et al., 2016; McClure, 1990; Miller & Davidson, 2005; Miller, D. R., Miller, G. L., Hodges, & Davidson, 2005; Rehmat, Anis, Khan, Fatma, & Begum, 2011; Suh, 2017). The species of genus *Aulacaspis* are affiliated with various plants and commonly feed on woody trees (Takagi, 2015). However, several species of this genus are known to be economically important pests on ornamental plants (Miller, D. R., Miller, G. L., Hodges, & Davidson, 2005; Watson & Marler, 2014). The distribution of *A. vitis* involved Asia including in Sumatra, Java and Oceania (Green, 1899; Green, 1904). The species was characterized on slide mounted as follows: prosoma swollen and widest at mesothorax (A), lateral tubercles situated well anterior to anterior spiracles (B), posterior spiracles not associated with spiracular pores, gland spine and macroduct absent from thorax and head, pygidium with median lobes zygotic with no satae and spine between their bases (C, D), abdominal segment VI bearing 1 or 2 submedian macroduct, pores situated prominence between pygidial lobes well developed (E) (Wei, Jing, & Zhang, 2016) (Fig. 1).

Distribution and Abundance of Scale Insect

No single factor affects distribution and abundance of scale insect on durian. Biotic and a-biotic factors simultaneously influence the process of association, development and distribution within the plant. The distribution of *A. vitis* spreads evenly in upper and lower part of the tree including outside and within of plant canopy except based on cardinal direction whereas the insect preferred in East part of the tree (Table 1).

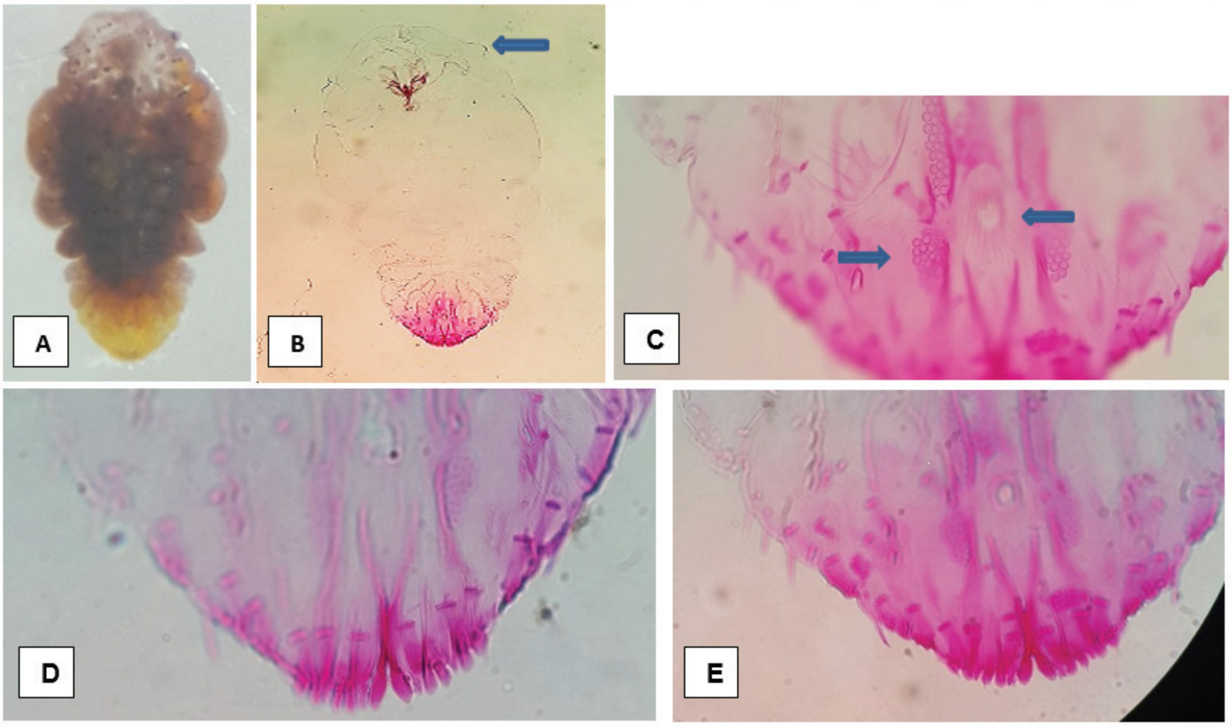

Fig. 1. Key character to genus *A. vitis* which associated with durian leaves

Table 1. Distribution of *A. vitis* on different cardinal direction, vertical and horizontal niche

No.	Clones	Distribution (%)					
		Cardinal direction		Vertical distribution		Horizontal distribution	
		West	East	Upper	Lower	Outside	Inside
1.	Kalumpang	34.87	43.77	44.73	33.90	39.17	36.92
2.	Sukun	19.73	27.13	25.67	21.20	16.17	31.08
3.	Matahari	31.33	47.27	35.33	43.27	34.67	42.50
4.	Sunan	38.30	46.80	44.53	40.57	53.00	34.42
5.	Sijantung kampar	29.23	34.27	36.47	27.03	42.17	22.25
6.	Selat	28.97	39.30	37.57	30.70	31.92	33.58
7.	Sitokong	32.83	43.80	35.90	40.73	35.42	43.33
8.	Petruk	36.03	46.07	50.67	31.43	42.92	37.75
9.	Sikapal	17.00	21.30	18.57	19.73	22.58	13.00
10.	Ginting	21.47	28.27	24.63	25.10	17.83	30.00
11.	Bintana	35.97	52.63	43.27	45.33	48.33	43.50
12.	Kani	23.90	24.63	23.33	25.20	33.75	17.17
	Average	**29.14**	**37.94***	**35.06**	**32.02**	**34.83**	**32.13**

East cardinal direction was presented as the most preferred direction which was evidenced by higher average percentage of *A. vitis* (37.94 %) compared to West (29.14 %). Apparently, a suitable a-biotic factor such as morning temperature influenced the side direction was chosen by *A. vitis*. Scale insect is categorized as poikiloterm insect, hence, the temperature determined an important role for growth and development. Low temperature and very high relative humidity are unfavourable climatic conditions for armored scale insect. Based on the observation the average morning temperature was in the range for a suitable development of *A. vitis* on durian (Table 2). The temperature between 25 – 30 ˚C is the most suitable for San Jose scale insect (Greathead, 1972). Kosztarab (1996) added that temperature is the main limiting factor for abundance of soft scales. Its developmental rate increases with ambient temperature until an optimal temperature is reached, after which the developmental rate declines.

Table 2. Temperature and relative humidity were recorded under the canopy of several clones of durian

No.	Clones	Climate factors						
		Temperature Morning (˚C)	Temperature Midday (˚C)	Temperature Evening (˚C)	RH Morning (%)	RH Midday (%)	RH Evening (%)	Light Intensity (Lux)
1.	Kalumpang	26.77	31.80	30.00	69.23	47.83	52.33	5557.33
2.	Sukun	27.00	31.80	30.03	68.80	48.30	52.60	9465.27
3.	Matahari	27.17	31.97	29.93	68.03	47.93	51.83	5877.73
4.	Sunan	27.17	31.83	29.83	69.40	47.80	52.27	5620.57
5.	Sijantung kampar	27.30	32.10	30.03	67.77	46.83	52.97	7220.43
6.	Selat	27.43	32.13	30.03	67.17	47.10	52.83	8110.90
7.	Sitokong	27.53	32.30	29.97	66.97	46.07	53.03	7093.87
8.	Petruk	27.43	32.37	29.73	67.60	46.53	53.43	7545.10
9.	Sikapal	27.67	32.03	29.90	66.77	47.47	53.40	8737.63
10.	Ginting	27.87	31.97	29.73	66.40	48.17	55.13	5426.20
11.	Bintana	27.80	32.10	29.47	66.90	46.83	55.80	5778.77
12.	Kani	27.77	32.13	29.50	67.20	47.50	56.33	3049.70

Table 3. Morphological characters of several durian clones based on Ministry of Agriculture Decision Letter about registration of durian as superior variety

No.	Clones	Morphological characters					
		Crown shape	Tree growth habit	Branching density	Leaf density	Leaves width (cm)	Leaves length (cm)
1.	Kalumpamg	Elliptical	Intermediate	Medium	Medium	4.0 – 6.3	12.0 – 17.0
2.	Sukun	Irregular	Intermediate	Medium	Medium	5.7 – 6.5	14.0 – 16.3
3.	Matahari	Semi-circular	Intermediate	Dense	Dense	3.0 – 4.1	9.8 – 14.2
4.	Sunan	Semi-circular	Intermediate	Dense	Dense	4.4 – 4.6	11.3 – 12.0
5.	Sijantung kampar	Semi-circular	Intermediate	Medium	Medium	4.4 – 5.1	12.1 – 12.4
6.	Selat	Semi-circular	Spreading	Dense	Dense	4.0 – 5.0	14.0 – 16.0
7.	Sitokong	Semi-circular	Spreading	Dense	Dense	4.1 – 4.9	12.5 – 16.7
8.	Petruk	Semi-circular	Intermediate	Dense	Sparse	3.2 – 4.2	11.7 – 13.0
9.	Sikapal	Irregular	Intermediate	Medium	Medium	4.5 – 5.0	14.0 – 15.0
10.	Ginting	Pyramidal	Spreading	Medium	Medium	5.0 – 6.0	12.0 – 16.0
11.	Bintana	Spherical	Spreading	Dense	Dense	5.5 – 6.5	15.0 – 18.0
12.	Kani	Elliptical	Spreading	Dense	Dense	4.5 – 5.4	12.0 – 15.5

Crawler is the primary dispersal phase in the life cycle of scale insect (Beardsley Jr & Gonzalez, 1975; Camacho & Chong, 2015; Gullan & Kosztarab, 1997; Mendel, Podoler, & Rosen, 1984; Ross, Pen, & Shuker, 2010). Wind and wandering are the main medium for dispersal of armored scale crawler (Washburn & Frankie, 1981). With small size measurement (< 0.5 mm) will make possible for wind to spread out in faraway distance. Fallen infested leaves which blown by wind was also important in spreading scale insect within orchard (Beardsley Jr & Gonzalez, 1975). Hence, morphological tree such as spherical of crown shape, spreading tree growth habit, dense branching and leaves density with high measurement of width and length leaves give high possibilities to be hit by wind which brings crawler of the scale insect. Bintana clone was fulfilled all the morphological characters required for those of high colonization possibilities (Table 3). Similar research on distribution of scale insect inhibited on apple showed that host phenological state did not affect spatial distributions but influenced the morphological characteristics of the host-plant (Nestel, Cohen, Saphir, Klein, & Mendel, 1995).

The observation based on abundance association of *A. vitis* on several clones of durian leaves was denoted varying in host susceptibility. Bintana was recorded as the most colonized clone, vice versa, clone Sikapal was less preferred inhibited (Table 4).

Table 4. Abundance of *A. vitis* on several clones of durian

No.	Clone	Observation										Average Colonization (%)
		1	2	3	4	5	6	7	8	9	10	
1.	Kalumpang	85.67	81.67	84.67	81.67	73.33	75.00	80.00	79.33	71.00	74.00	78.63 **ab**
2.	Sukun	65.00	63.33	39.67	33.33	45.00	33.33	30.33	66.67	46.67	45.33	46.87 **ef**
3.	Matahari	87.67	85.00	77.67	76.67	75.00	75.33	80.67	63.67	77.67	86.67	78.60 **ab**
4.	Sunan	82.33	80.00	86.33	85.67	87.67	79.33	85.67	84.67	86.00	93.33	85.10 **ab**
5.	Si jantung kampar	68.33	58.33	60.67	63.00	64.33	62.67	64.33	61.67	65.67	66.00	63.50 **d**
6.	Selat	88.33	76.67	70.67	61.67	73.33	50.00	60.00	63.67	55.00	83.33	68.27 **cd**
7.	Sitokong	80.33	81.67	75.00	70.00	66.00	78.33	75.00	73.33	81.33	85.33	76.63 **bc**
8.	Petruk	87.67	76.67	83.67	80.00	87.00	83.33	85.33	80.67	83.33	73.33	82.10 **ab**
9.	Sikapal	54.33	35.00	46.67	36.67	40.00	28.00	43.33	30.33	33.67	35.00	38.30 **f**
10.	Ginting	66.33	54.00	57.67	44.00	40.00	44.00	48.33	52.67	43.33	47.00	49.73 **e**
11.	Bintana	90.67	85.00	85.00	83.33	86.00	88.67	91.00	90.00	92.33	94.00	88.60 **a**
12.	Kani	57.00	53.33	48.33	43.00	53.33	26.67	52.67	50.00	43.33	57.67	48.53 **e**

Remarks: Means value with the same letter are not significantly different (p = 0.05) based on Honest Significantly Different (HSD) test (CV = 10.07 %)

Table 5. Water and nutrients contain of several clones durian

No.	Clone	Nutrient Analysis			
		Water content (%)	Carbohydrate total (%)	Nitrogen content (%)	Protein
1.	Kalumpamg	62.74	5.40	0.78	4.88
2.	Sukun	64.90	4.73	0.66	4.13
3.	Matahari	65.91	4.90	0.71	4.44
4.	Sunan	62.90	4.71	0.93	5.81
5.	Sijantung Kampar	62.31	4.47	0.97	6.06
6.	Selat	64.49	5.90	0.79	4.94
7.	Sitokong	63.94	4.62	0.75	4.69
8.	Petruk	67.36	4.47	0.68	4.25
9.	Sikapal	66.62	6.03	0.75	4.69
10.	Ginting	60.41	6.56	0.83	5.19
11.	Bintana	68.31	6.14	0.60	3.75
12.	Kani	62.82	8.03	0.65	4.06

Abundance of *A. vitis* on several clones of durian was likely influenced by nutrient contain and abiotic factor i.e. light intensity. After the crawler settle on a certain host, nutrient and abiotic factors will determine the survival, development and reproduction. Similar research on *Coccus viridis* (Green) scale insect exhibited that the host plant with high nitrogen, potassium and organic compost amendments contain showed a more rapid development (Fernandes et al., 2012; Gonthier, Dominguez, Witter, Spongberg, & Philpott, 2013). Scale insects are phloem-sucking pest which pierce the host plant tissue with modified stylets until reaching the phloem vessels, from where they suck plant sap (Juárez-Hernández et al., 2014; Ross, Pen, & Shuker, 2010). Phloem feeders need to ingest large amount of sap to meet their nutritional requirements because phloem sap is rich in carbohydrates but poor in soluble nitrogen compounds (Malumphy, 1997). Based on the nutrients analysis, the clone Bintana was presented high water contain including carbohydrate but low in nitrogen and protein (Table 5). Hence, suitable morphological characters, water and balanced nutritional contains are needed for early infestation, growth and development. Those factors will determine the abundance and host susceptibility of *A. vitis* on Bintana clone.

CONCLUSION

A. vitis was the scale insect which associated with durian leaves. Bintana clone was the most susceptible for *A. vitis*, in the contrary, Sikapal clone which less preferred. The distribution of *A. vitis* was mostly in East part cardinal direction and spread evenly in upper and lower part of the tree including outside and within plant canopy.

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