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Original Paper

The Effect of Rainfall on Yellow Crude on Mangosis Fruit (*Garciniamangostana* L.)

Mardawilis[1] & Eddiwan[2*]

[1] BPAP Riau.Jln Kaharuddin Nasution 341, Marpoyan, Kota Pekanbaru, Riau, Indonesia

[2] Riau University.Jln. HR Soebrantas Km 12,5. Campusof Bina Widya, Kec.Tampan, Kota Pekanbaru, Riau, Indonesia

[*] Eddiwan, E-mail: eddiwan@lecturer.unri.ac.id

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Abstract

The research was carried out through case studies at six locations of mangosteen production centers in West Sumatra during the 2018 harvest season. The results showed that mangosteen fruit damage by yellow sap was distinguished from yellow sap in exocarp and endocarp with varying percentages between research locations. There was no correlation between yellow sap in exocarp and endocarp (r=0.0656). Yellow sap in exocarp and endocarp correlate with rainy days. The intensity of rainfall during the fruit development period does not correlate with yellow latex in the endocarp but the fluctuation in rainfall is very influential. Yellow sap at the lowest endocarp (15%) was found at the location of Station-5 with the lowest rainy day (44 days) and low rainfall fluctuations (40-240 mm/month) and the highest (47%) at Station-3 (104 days rain and rainfall fluctuations 96-512 mm/month). The Station-4 area with lower rainy days (80 days) but has high rainfall fluctuations (73-954 mm/month) also shows yellow latex at a higher endocarp (35%) compared to other locations. Yellow gum at the lowest exocarp (32%) found in Station-2 (63 rainy days, 00 m asl) and highest (69%) in Station-6 (94 rainy days, 490 m asl). Effect of rainy days and altitude on the sap yellow on the skin of the fruit can be explained through its relationship with environmental conditions needed for the proliferation of insects that cause yellow sap on the mangosteen rind.

Keyword

yellow sap, mangosteen (Garciniaangostana L.), rainfall, endocarp, exocarp

1. Introduction

Indonesian mangosteen exporters report that only 15% of mangosteen collected from various locations is of acceptable quality to the export market (Anonymous, 2006). The existence of a yellow sap in the mangosteen fruit is one important factor that affects the quality of the mangosteen fruit. This symptom is called gamboge disorder (Pankasemsuk et al., 1996; Sdoode & Chiarawipa, 2005) and affects the taste and appearance of the fruit. This damage is thought to be caused by environmental factors such as climate, nutrients, water stress, mechanical damage, pests, and diseases as well as genetics. This research was conducted through an approach with one of the climate factors, namely by observing the effect of rainfall on the presence of yellow sap on mangosteen fruit. Rainfall elements observed were rainfall intensity and fluctuation and the number of rainy days, especially during the fruit formation period. The purpose of this study was to compare the damage of mangosteen fruit by yellow sap at various locations with varying rainfall and determine the effect of rainfall on yellow sap on mangosteen fruit.

2. Materials and Methods

The study was conducted at six stations of mangosteen production centers in the Kampar District, province of Riau, namely Station-1, Station-2, Station-3, Station-4, Station-5, and Station-6 with varying altitude and rainfall (Figure 1). Five to eight mangosteen trees bearing fruit at each location were randomly selected with a total of 37 trees. The number of fruit samples observed was 100 per tree. Rainfall at each location is recorded from the nearest climatology station. The relationship between rainfall and yellow sap is determined through correlation analysis and presented descriptively through diagrams and graphs.

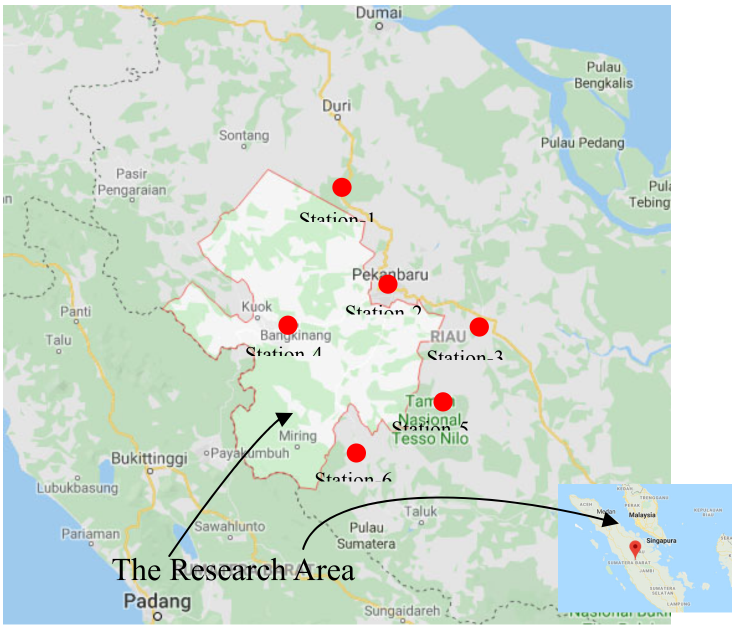

Figure 1. Map of Research Locations (6 Stations) in Kampar Regency, Riau Province

3. Results and Discussion

3.1 The Percentage of Yellow Sap from a Different Location

Based on observations, damage due to yellow latex on mangosteen can be distinguished from yellow latex on exocarp and endocarp with varying percentages between study sites (Figure 2). Yellow sap in endocarp varies from 15% (Station-5) to 47% (Station-3) and at exocarp 32% (Station-2) to 69% (Station-6). The results of the correlation analysis showed that the endocarp latex did not correlate with exocarp (r=0.0656). The results of this observation are in line with the results of Indriani et al. (2002) who stated that the yellow sap in the fruit does not correlate with the sap on the fruit skin. Yellow sap on the skin of the fruit only affects the outer appearance of the mangosteen fruit and does not affect the taste and quality of fruit flesh. Instead, the sap in the fruit greatly affects the quality of the fruit, especially the taste. Henceforth the two types of damage are discussed separately. Added by Eberhardt (2000), Individual trees used for sap extraction did not have thinner bark, more moisture in bark samples, or larger crowns, but they did score lower in an index of overall tree health.

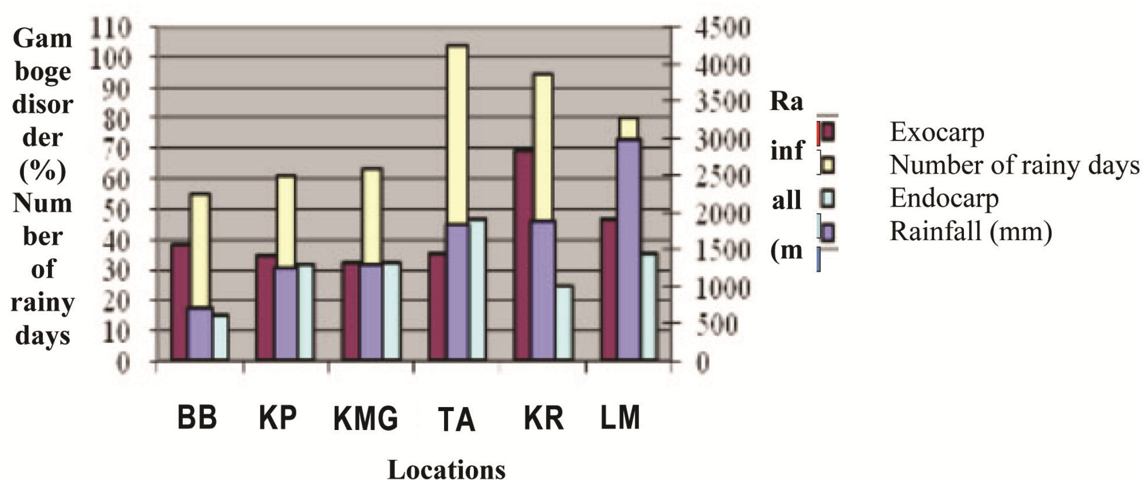

Figure 2. Mangosteen Fruit Damage due to Yellow Sap in Percentage Varies between Research Stations

3.2 Yellow Sap in the Endocarp

3.2.1 Effect of Rainfall Intensity and Fluctuation during the Fruit Development Period

The results of the correlation analysis showed that yellow latex in the endocarp did not correlate withrainfall. In Table 1 and Figure 2, it can be seen that the Station-3 area with lower rainfall during the fruit development period (1826 mm) has a higher yellow latex (47%) compared to Sweet Lime (35%) with higher rainfall (2971 mm). Another example can be seen by comparing the location of Station-3 with Station-6 which has almost the same rainfall intensity (1826 mm and 1873 mm respectively) showing a significantly different percentage of yellow latex (47% and 25%). The Station-5 area which has the lowest rainfall (703 mm) shows the lowest yellow sap (15%). Based on this data it can be said that in areas with rainfall intensity during fruit development below 1000 mm the percentage of yellow sap is quite low (15%) while above 1000 mm the percentage varies from 25% to 47%. This variation seems to be related to rainfall fluctuations in each location. In Figure 2, graphs of rainfall and rainy day fluctuations are presented at the six study locations. Station-5 area with fluctuations in rainfall during the period of fruit development that is not large (40-240 mm per month) shows the lowest yellow sap (15%). On the other hand, Station-3 and Station-4 have significant rainfall fluctuations (96-512 mm/month and 173-954 mm/month respectively, showing the highest yellow latex (47% and 35%). Efombagn et al. (2004) said Rainfall intensity greatly modified the incidence of the disease in 2001, with high yield losses occurring in all four clones (70-93%), but their ranking remained stable over the 3 years. Then Melke, and Fetene (2014), fruit quality is the result of a complex interaction of management and environmental factors. By understanding the impact of environment, culture, harvesting, handling and storage on fruit quality, growers should be able to improve both average qualities in their crop as well as improving the proportion of fruit in the highest quality grade.

Table 1. Percentage of Yellow Latex on Mangosteen and Rainfall at Six Study Sites

Location/place height (asl)	Rainfall *)					Yellow sap (%)	
	Total/year		Flowering period until harvest				
	Intensity (mm)	Rainy day	Intensity (mm)	Fluctuation (mm)	Rainy day	Eksokarp	Endokarp
Station-1	4154	160	1243	47-339	61	34	32
Station-2	2622	127	1288	62-520	63	32	32
Station-3	4278	226	1826	96-512	104	36	46
Station-4	6427	176	2971	173-954	80	47	35
Station-5	1838	146	703	40-240	44	38	15
Station-6	3516	194	1873	80-764	94	69	25

Note. *) Climate data Kabupaten Kampar for 2013.

3.2.2 The Effect of Rainy Days

Correlation analysis shows that yellow sap in the fruit correlates with rainy days. The percentage of yellow latex at the highest endocarp (47%) was found at the Station-3 location with the highest number of rainy days during flowering to harvest (104 days) and the lowest at Station-5 (15%) with the lowest number of rainy days (44 days). This tendency seems not always to be the case. Specific cases can be seen by comparing the percentage of yellow latex at the location of Station-4 with Station-6. Sweet lime which has a lower rainy day (80 days) than Station-6 (94 days) shows a higher percentage of yellow latex (35%) than Station-6 (25%). Based on this data it is known that if the rainy day during the fertilization period is more than 100 days the yellow sap is quite high (Station-3), and if it is around 50 days (Station-5). The yellow sap is quite low (Station-5). On rainy days between 50-100 days, the percentage of yellow latex varies depending on fluctuations in rainfall. Fujiwara, Meng, and Vogl (2016) said their estimate habit formation in voting-the effect of past on current turnout-by exploiting transitory voting cost shocks. Using county level data on US presidential elections from 1952-2012, they find that rainfall on current and past election days reduces voter turnout. Our estimates imply that a 1-point decrease in past turnout lowers current turnout by 0.6-1.0 points. Further analyses suggest that habit formation operates by reinforcing the direct consumption value of voting and that our estimates may be amplified by social spillovers.

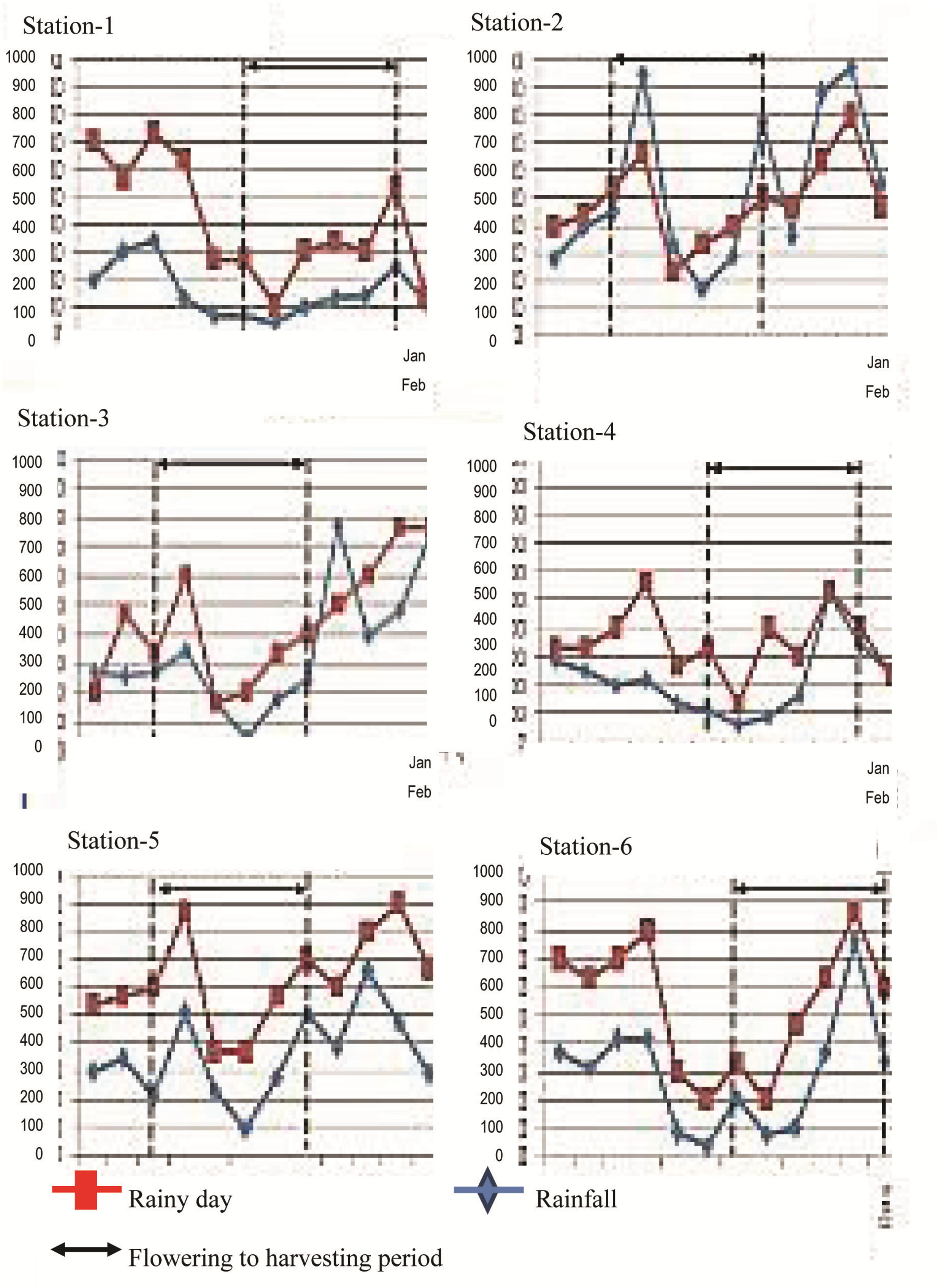

Figure 3. Intensity and Fluctuation of Rainfall and Rainy Days at Six Research Sites in Kampar District, Riau, 2018

The relationship between rainfall intensity and fluctuation with the percentage of yellow sap in the mangosteen fruit can be explained through groundwater conditions with plants. Fluctuations in the intensity of high rainfall cause instability in groundwater potential that can affect the potential of water plants as well as physiological and metabolic processes in plants. Groundwater potential will increase during the rainy season and vice versa. An important physiological process related to water in plants is cell enlargement, especially in developing tissues, including fruit. The speed of cell enlargement is more or less proportional to turgor pressure. If the leaf water potential decreases, leaf cell turgor will also decrease and vice versa (Slatyer, 1969). Sdoodee and Limpun-Udom (2002) state that yellow discharge is caused by a large difference in water potential between the soil and plants, and especially if after sudden irrigation. Boyer (1999) states that one of the mechanisms causing fluctuations in plant water potential is through changes in transpiration velocity. Rainfall and high rainy days cause turgor pressure in plant cells to increase and open stomata

Following this explanation, it is suspected that the high percentage of yellow latex in areas with high fluctuating rainfall intensity is caused by fluctuating turgor pressure in the mangosteen pericarp that occurs during the fruit development period. When the intensity of rainfall is high, the turgor pressure of the developing pericarp cells increases sharply so that it can cause the cell to rupture and emit a yellow sap. Lakitan (2000) states that plant cells are believed to function optimally at a certain level of turgidity. If turgidity becomes higher or lowers the cell will decrease its function. If the cell’s internal pressure (turgor) exceeds the elasticity limit of the cell wall, then the cell will rupture.

3.3 Yellow Sap on Exocarp

Just like yellow sap on endocarp, yellow sap on exocarp is also positively correlated with rainy days. The Station-2 area with the lower number of rainy days (63 days), showed the lowest percentage of yellow latex on fruit skin (32%) and Station-6 with the higher rainy day (94 days) showed the highest percentage of yellow latex on fruit skin (69%). Areas with the highest rainy days (Station-3) yellow sap at lower exocarp (36%). The effect of rainy days on the yellow sap on the skin of the fruit can be explained through its relationship with the environmental conditions needed for the proliferation of insects that cause yellow sap on the skin of the mangosteen fruit. The results of Mansyah et al. (2018) showed that the yellow sap on the rind of the fruit was positively correlated with the presence of dotted mangosteen fruit. From the results of research by Jumjunidang et al. (2004) known causes of dotted include peststhrips (Scirtothis sp.) and mites (Tetranychus spp.). In this case, one of the causes of yellow sap in exocarp can be caused by the puncture of the pest.

Other information that can be obtained from this study is that altitude contributes to the yellow sap in exocarp. Locations at higher places show a lower percentage of yellow sap than lower locations. This is indicated by the mangosteen originating from the Station-2 region (800 m asl) having the lowest yellow sap on the outside (32%) and Station-6 (490 m asl) with the highest percentage (69%). The influence of the height of this place is thought to be related to certain temperatures and humidity that are suitable for the life cycle and the proliferation of insect pests that cause yellow sap which needs to be further studied. Balami, and Peter (2014) said the true density, bulk density, surface areas and the sphericity determined were 379.00 15.16 kg/m 3, 39.293 0.001 kg/m 3, 169.93 31.15 mm 2, 0.64 0.043 for the seed while for the kernel were 930.03 8.53 kg/m 3, 534.89 10.99 kg/m 3, 70.63 13.98 mm 2, 0.61 0.044 respectively at an average moisture content of 13.80 % for the seed and 11.9 % for the kernel on wet basis. The coefficient of friction determined on three different structural surfaces namely plywood, glass and mild steel for the seeds were 0.38, 0.42 and 0.33 respectively at an angle of repose of 34.52° while that of the kernels were 0.49, 0.56 and 0.43 respectively at an angle of repose of 42.47°. Also their report that the mean porosity obtained for the seed and kernel were 89.62 % and 42.47% respectively.

4. Conclusion

Damage due to yellow sap in mangosteen is distinguished from yellow sap in exocarp and endocarp and there is no correlation between the two. The intensity of rainfall during the fruit development period has less effect on yellow sap both in exocarp and endocarp. While the number of rainy days is positively correlated with both. In areas with rainfall intensity during fruit development below 1000 mm the percentage of yellow latex in the endocarp is quite low (15%) while above 1000 mm the percentage varies from 25% to 47% depending on rainfall fluctuations. Areas with higher rainfall fluctuations show higher percentages of yellow latex. Areas with several rainy days during the fruit development period of more than 100 days of yellow latex in the endocarp are quite high (reaching 47%) and if the rainy day is around 50 days the yellow latex is quite low (15%). On rainy days between 50-100 days, the percentage of endocarp yellow sap varies depending on fluctuations in rainfall. Areas with a lower number of rainy days show a lower percentage of exocarp yellow sap and vice versa. The effect of a rainy day on yellow sap in exocarp relates to the environmental conditions needed for the proliferation of insects that cause yellow sap on mangosteen rind. The height of the place contributes to the yellow sap in exocarp. At higher places, the exocarpyellow sap percentage is smaller than the location with a lower altitude.

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