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Abstract. *Syzygium* genus is one of the abundant and naturally growing collections of Purwodadi Botanical Garden (KRP) with characteristics of strong and deep rooting with branching and complex crowns. So it has the potential to support water and soil conservation by reducing erosion and kinetic energy of rainwater to the ground. This study aims to determine the value of interception, throughfall, and stemflow in seven types of *Syzygium sp*. trees in the KRP collection. The research was conducted from January to February 2023 with the method of measuring tree physical factors, collecting, and calculating rainfall data, throughfall, stemflow, and interception values. The results of the study during 25 rainy days on seven types of *Syzygium sp.* trees showed that the value of throughfall ranged from 10.86 - 15.30 mm with the highest on *Syzygium malaccense* trees with dangling branching. The stemflow value ranges from 0.04 - 0.91 mm with the highest in *Syzygium acuminatisimum* trees whose stems grow upright. The interception value ranged from 2.3 - 5.8 mm with the highest in *Syzygium polycephalum* trees whose branching away from the ground surface. The variation values obtained are influenced by the characteristics of the branching crown of each tree.

Keywords: Interception, Purwodadi Botanical Garden, stemflow, Syzygium, throughfall

1. Introduction

Ecosystems with complex vegetation (forests) consisting of various types of trees are the best streamflow regulators in maintaining water availability on earth [1]. Dry lowland forest is one of the forest ecosystems in Indonesia that can maintain water supply and balance in various seasons [2]. Purwodadi Botanical Garden (KRP) is one of the botanical gardens in Indonesia located in Pasuruan, East Java, which is an artificial forest ecosystem and is tasked with collecting (ex-situ) various plant species from the dry lowland forest ecosystem [3].

Based on plant collection data at the Purwodadi Botanical Garden Registration Unit in 2022, it shows that the Syzygium genus is one of the most abundant plant groups in the Purwodadi Botanical Garden collection and is also found growing naturally in the surrounding environment. The distinctive characteristics of Syzygium trees are that they have varying tree heights, strong and very deep root systems, shady and complex crown shapes, and trunks with strong branching systems [4]. The vertical structure of Syzygium trees in the forest ecosystem is included in stratum C with the character of the crown and extensive stem branching [5]. So Syzygium trees have the potential to support water and soil conservation in the ecosystem [6].

The potential of Syzygium trees must be utilized properly, especially to maintain water balance on earth by measuring the ability of Syzygium trees in interception, canopy escape, and stem flow. Interception is the event when rainwater is temporarily accommodated by the earth's surface (vegetation canopy, soil surface, litter) which then evaporates sequentially [7]. Vegetation interception can be calculated by measuring rainfall, throughfall, and stemflow. Throughfall is rainwater that escapes to the ground by passing through the tree crown, while stemflow is rainwater that flows through the tree trunk to the ground surface [8].

Interception in tree vegetation is influenced by rain factors and tree crown factors. According to [9], rain factors consist of rain intensity, rain duration, and rain interval, while tree crown factors include tree architecture models, crown area, stem branching, vegetation age, and leaf arrangement morphology. The interception ability of a constant tree crown depends on each crown model [10]. If the storage capacity of the crown is greater than the rainfall, then interception occurs maximally. Meanwhile, if the rainfall that occurs is greater than the storage capacity of the crown, the crown will experience saturation and rainwater will flow through the trunk and the crown so that the interception value will be very small [11].

Research related to interception, crown escape, and stem flow has been conducted previously in forest ecosystems and several plant species [9] [12] [13]. However, the same research on local trees is still very rare, even though local tree species have an important role in land reclamation and rehabilitation programs. Tree characters with wide and strong crown layer criteria can prevent erosion and can optimally support water and soil conservation [14].

The potential of local trees with strong and complex crown branching and functions in supporting water and soil conservation should be optimally utilized. Syzygium trees as trees that have these criteria have great potential to support water and soil conservation efforts. So that the purpose of this study is to determine the ability of interception, crown escape, and stem flow of seven types of Syzygium trees in the collection of Purwodadi Botanical Garden.

2. Methods

The selection of *Syzygium* trees as the object of research was carried out by analyzing the age of Syzygium trees from the data of the Registration Unit of Purwodadi Botanical Garden to select trees that have a planting age of more than 15 years. In addition, measurements of tree physical factors (stem diameter, height, and crown area) that meet the criteria as the mature phase of Syzygium trees were also taken. The seven species selected are Syzygium trees that have different forms of tree crown branching and meet the criteria in this study (Figure 1) (Table 1).

Table 1. Seven *Syzygium* tree species of purwodadi botanical garden collection

	scientific name
1.	*Syzygium acuminatisimum*
2.	*Syzygium cumini*
3.	*Syzygium malaccense*
4.	*Syzygium nervosum*
5.	*Syzygium polycephalum*
6.	*Syzygium pycnanthum*
7.	*Syzygium sexangulatum*

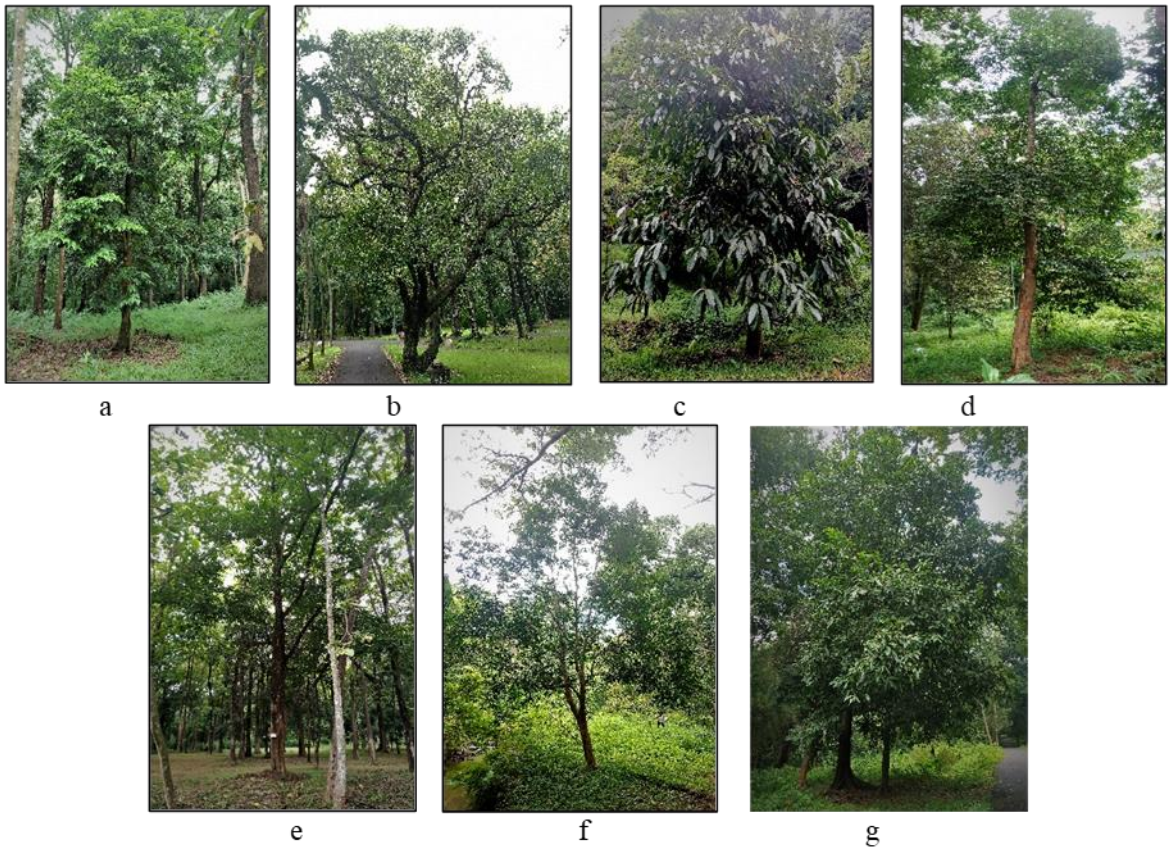

Figure 1. a)S*yzygium acuminatisimum*, b) *Syzygium cumini*, c) *Syzygium malaccense*, d) *Syzygium nervosum*, e) *Syzygium polycephalum*, f) *Syzygium pycnanthum*, g) *Szygium sexangulatum*

2.1. rainfall measurement

Rainfall was measured every 24 hours during 25 days of rainfall events in the morning using an ombromoter observatory placed in the open area of Purwodadi Botanical Garden.

2.2. Throughfall measurement

Measurement of canopy throughfall using a manual ombrometer with a 2000 ml capacity can that is given a peg and installed around the tree with the location following the direction of the tree crown. The number of manual ombrometers on each tree is 5 pieces. The throughfall formula is as follows [10]:

$$\text{Throughfall Formula} \quad : \quad Tf = [\frac{Pv}{A}] \times 10$$

*formula for each ombrometer installed
Tf = Canopy escape (mm)
Pv = Volume of rainwater in the meter (mL)
A = Surface area of the measuring device (cm^2)

2.3. Stemflow measurement

Measurement of stemflow using clear plastic wrapped around the trunk of the Syzygium tree object of research, with the position of the plastic towards the container in the form of a 10,000 ml bucket. The stemflow formula is as follows [10]:

$$\text{Stemflow formula} \quad : \quad Sf = [\frac{V}{LT}] \times 10$$

Sf = Rod flow (mm)
V = Volume of rainwater collected (mL)
LT = Sample crown area (cm^2)

2.4. Interception calculation

Measurement of interception cannot be done directly in the field, the calculation can be done if data on rainfall, throughfall, and stemflow have been obtained. The formula for calculating rainwater interception according to [8] is:

$$\text{Interception Formula} : IL = R - TF + SF$$

IL = Interception by tree crown (mm)
R = Daily precipitation (mm)
TF = Throughfall (mm)
SF = Stemflow (mm)

2.5. Data Analysis

This study has quantitative data in the form of data on tree physical factors and interception calculations using the calculation formula for each measurement. Graphs of the results of each type of tree observed are also presented to organize the discussion of the results of this study.

3. Results and Discussions

3.1. Physical factors of 7 Syzygium tree species in purwodadi botanical garden

The results of measuring the physical factors of the tree showed that the seven Syzygium species selected met the criteria as the object of research, namely meeting the criteria of trees with an age of more than 15 years and meeting the characteristics of the mature phase of the tree. In general, the height of Syzygium trees varies around 6 ± 21 meters. While the trunk diameter is about 16 ± 73 cm. Then the tree canopy area varied around 2.8 ± 57 meters (Table 2).

Table 2. Data physical factors of seven *Syzygium* species

No.	Scientific Name	Tree Physical Factor		
		Tree Height (m)	Stem Diameter (cm)	Tree Canopy Area (m)
1	*S. acuminatisimum*	8.7	20.7	2.8
2	*S. cumini*	10	57.4	57
3	*S. malaccense*	8	26.8	6.4
4	*S. nervosum*	13	30.3	6.7
5	*S. polycephalum*	20	73.3	10.53
6	*S. pycnanthum*	9	25.5	6
7	*S. sexangulatum*	12	29	17

3.2. Rainfall Value

Data collection in this study was carried out for 25 days of rainfall events. So that all data obtained is the value of rainfall, throughfall, stemflow, and an interception for 25 rainy days. The total rainfall value during the measurement was 430.350 mm with a total average of 17.21 mm. The dominating rainfall categories were 18 rainy days in the light category, 4 rainy days in the moderate category, and 3 rainy days in the heavy category (Figure 2). So the rainfall category in this study is rain with a general category of light.

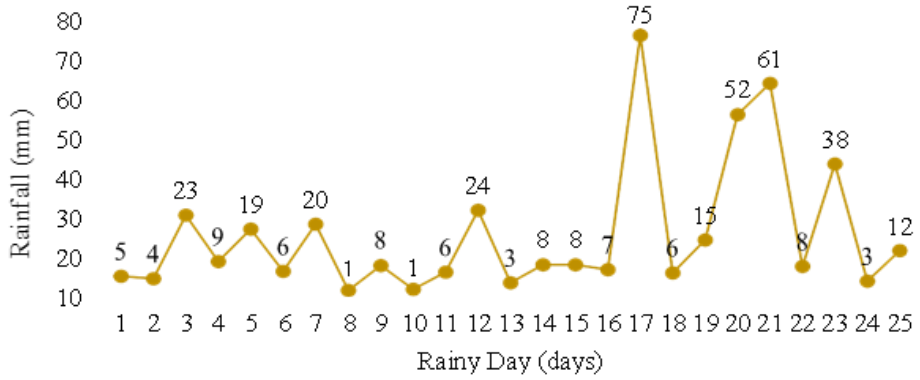

Figure 2. Rainfall Data Graph of 25 Days of Rainfall Events

The highest rainfall was measured on the 17th day with a rainfall value of 75.1 mm, while the lowest rainfall value was measured on the 8th day with a value of 0.67 mm (Figure 2). Variations in rainfall cause the value of canopy escape, stem flow, and interception received by the vegetation canopy to also vary. According to [13], variations in rainfall on vegetation canopies are influenced by the type of branching of the tree.

3.3. Throughfall

The average value of crown breakthrough measurements on seven Syzygium tree species can be seen in the graph in Figure 3. The results show that *Syzygium malaccense* trees have the highest crown breakthrough values on 25 rainy days.

The average value of throughfall on seven types of Syzygium trees (Table 1) can be seen in the graph in Figure 3. The results show that *Syzygium malaccense* trees have the highest canopy escape value compared to other trees on 25 rainy days. The average value of *S. malaccense* canopy escape in Figure 2 is 15.30 mm with a canopy escape ability of 77.55% of the total 17.21 mm of rainfall for 25 days. The smallest crown escape value is *S. polycephalum* with the ability of 54.7% of the total 17.21 mm of rainfall for 25 days.

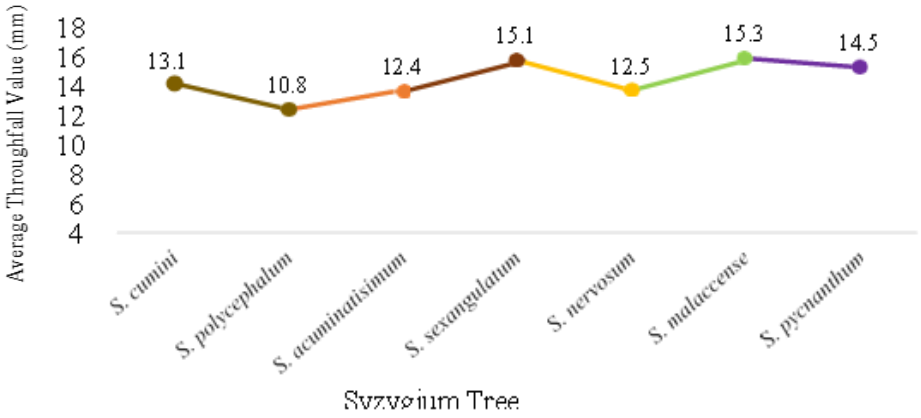

Figure 3. Variation value of canopy throughfall

Syzygium malaccense has the highest throughfall value because the branching pattern dangles and curves towards the ground surface. This branching condition makes it easier for trees to pass rainwater in larger amounts. *S. malaccense* forms a fairly sparse crown so that its crown escape value is the highest. According to [15] explained that the high crown escape value in *S. malaccense* is due to its wide leaves, pointed leaf tips, and location opposite.

3.4. Stemflow

The average value of stemflow measurements on seven Syzygium tree species can be seen in the graph in Figure 4. The results of stem flow measurements show that *Syzygium acuminatisimum* has the highest stem flow value in 25 rainy days.

The average value of stem flow on seven Syzygium trees (Table 1) can be seen in the graph of Figure 3. The average value of stem flow is 0.91 mm with the ability of 4.36% of the total 17.21 mm of rainfall for 25 days. The tree with the smallest stem flow value is *S. cumini* with the ability of 0.19% of the total 17.21 mm of rainfall for 25 days.

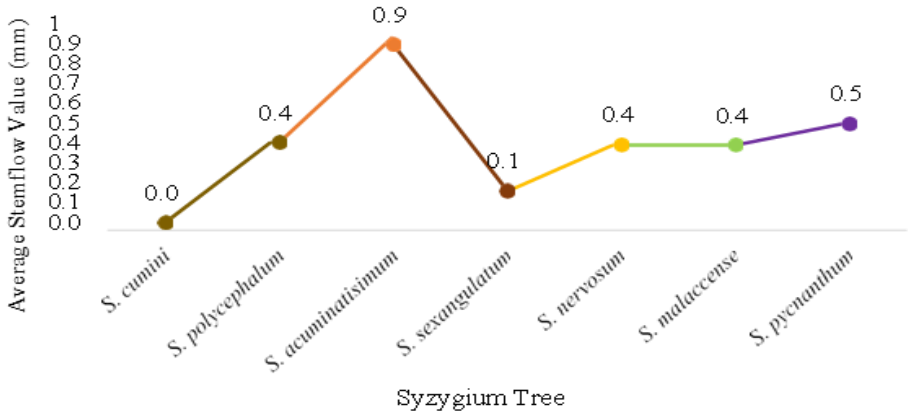

Figure 4. Stemflow Variation Values

Syzygium acuminatisimum trees have the highest stemflow values compared to other species. *S. acuminatisimum* trees have the smallest crown area size compared to other species. The trunk of *S. acuminatsisimum* grows upright making the flow of rainwater on the trunk of *S. acuminatisimum* a greater amount. The non-dense crown of *S. acuminatisimum* makes it easier for rainwater on the crown to flow directly through the stem to the soil surface. Straight and upright stems produce greater stem flow compared to bent stems [16]. Trees with sparse crowns can distribute stem flow more than trees with tight crowns [17].

3.5. Interception

The final value of the calculation of rainfall collected in the Syzygium tree canopy or interception has a variable value during the 25 rainy days measurement. The interception value of each Syzygium tree species is obtained from the daily rainfall value minus the value of daily throughfall and stemflow. The average value of interception calculations on the canopy of 7 Syzygium tree species that have different branching models can be seen in the graph in Figure 5.

The results showed that *S. polycephalum* has the highest interception value with an average total rainwater interception value of 5.8 mm and an interception ability of 45.04% of the total 17.21 mm of rainfall for 25 days. The difference in interception value between *S. polycephalum* and *S. acuminatisimum* is quite small because *S. acuminatisimum* has an interception value of 5.75 mm with an interception ability of 40.8% of the total 17.21 mm during the measurement. The tree with the smallest interception value is *S. malaccense* with an interception ability of 22.4% of the total 17.21 mm of rainfall for 25 days.

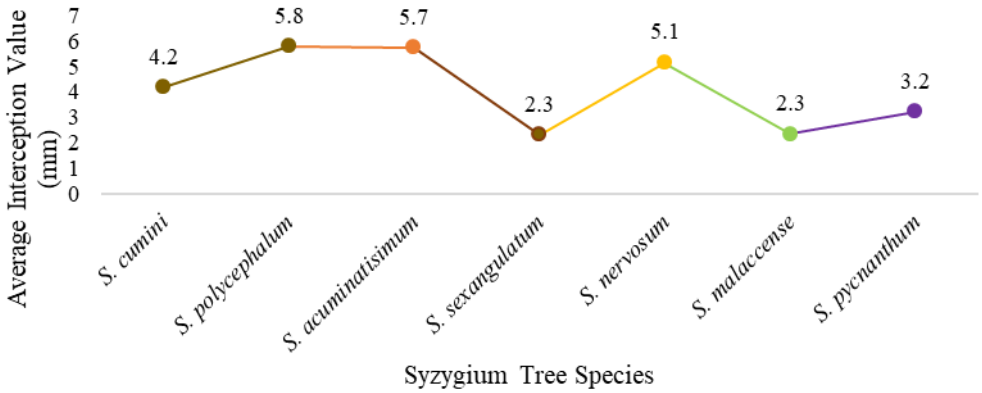

Figure 5. Interception Variation Value

Syzygium polycephalum trees had the highest interception values followed by *Syazygium acuminatisimum*. Both of them have monopodial trunks (distinguishable by branching), orthotropic branching (upward-facing branching), and patens trunk growth direction (the distance between the main trunk and branching forms a 45º angle). Trees with these characteristics have crowns that face upwards and away from the ground. This causes rainwater to evaporate immediately before falling to the ground. Evaporation that occurs at the branching of the upward-facing crown is faster than water in other place [18].

3.6. Environmental characteristics of Purwodadi Botanical Garden

The characteristics of vegetation stands and crowns cause rainwater interception values to vary and have quite complicated measurements [19]. Variations in interception in each tree are influenced by the value of the canopy and stem flow and the branching model of the tree crown. According to [16], rainwater on tree vegetation will be divided into two parts, some of which will evaporate and some will reach the ground through canopy escape and stem flow. The KRP environment during the measurement of 25 rainy days had an average temperature of 26.38 ºC and an air humidity of 95 RH. These two factors during the measurement did not have a large difference, so they did not affect the interception results.

The total value of interception in tree crowns in this study ranged from 22.4- 45.04%. The interception value is quite high in measurements in tropical rainforest areas. According to [20], the interception value in tropical rainforest vegetation ranges from around 10-35%. The high interception value in this study was due to rainfall during the 25-day measurement was 17.21 mm, falling into the light rain category. According to [21], light rainfall causes rainwater retained in the vegetation canopy to evaporate immediately and makes the interception percentage high. Although the research area (Purwodadi Botanical Garden) is an (ex-situ) lowland tropical rainforest, the dry climate in this area causes the interception value to have a higher value than other areas.

4. Conclusion

Rainfall measurements were conducted for 25 days of rainfall events. The highest total interception value occurred in *Syzygium polycephalum* with an interception ability of 45.04% of the total 17.21 mm of rainfall. *Syzygium polycephalum* tree crown that faces up and away from the ground surface produces the highest interception value. The highest throughfall value in *Syzygium malaccense* is because the branching pattern dangles and curves towards the ground surface with the ability of 77.55% of the total 17.21 mm of rainfall during the measurement. Furthermore, the highest stemflow value occurs in *Syzygium acuminatisimum* trees with an ability of 4.36% of the total 17.21 mm of rainfall during measurements.

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