E-2795-3248
P-2795-3222

GPH - JOURNAL OF AGRICULTURE & RESEARCH

10.5281/zenodo.7049682 Vol. 05 Issue 09 Sept - 2022 Manuscript ID: #0685

STEM FLOW ON SOME TYPES OF TREES

Zulkarnain*

Lecturer of Soil Science Study Program, Faculty of Agriculture University of Mulawarman Samarinda

Corresponding author: *Zulkarnain
Email: zulkarnain@faperta.unmul.ac.id

ABSTRACT

Excessive surface runoff can cause flooding and soil erosion. The existence of a vegetation canopy that is able to intercept rainwater at least can reduce surface runoff. Stem flow is rainwater that falls on the surface of the leaves, branches and stems, then flows through the stems to the soil surface. The size of the stem flow is strongly influenced by the structure of the trunk and the roughness of the bark of the tree. The research was carried out for 2 months in the Mixed Garden, BukuanUrban Village, Palaransub District, Samarinda City. The research activities carried out were: the preparation of materials and tools, field observations, determining trees as samples, installing rain gauges, and installing tools to accommodate stem flow. The data collected were: tree morphology, trunk diameter, canopy thickness, rainfall, and stem flow measurements. The results showed that the greatest stem flow occurred in acacia trees ranging from 0.0082 to 2.8600 mm; on mango trees, it ranged from 0.0363 – 0.4218 mm; on jengkol trees ranging from 0.0041 to 0.4282 mm; on the sengon tree ranged from 0.0013 to 2.2048 mm, and the smallest occurred in trembesi trees ranging from 0.0003 to 0.1351 mm.

KEYWORDS

Stem Flow, Tree.

1. INTRODUCTION

Precipitation is the outpouring or falling of water from the atmosphere to the earth's surface and the sea in different forms, namely rainfall in the tropics and rainfall and snow in temperate climates. Rain serves to restore evapotranspiration of water. The amount of water that enters agricultural areas (forests and or plantations) is the remainder of gross rain or rain measured in open areas after deducting the amount intercepted and evaporated by plants/crowns.

Interception is one of the factors in the hydrological cycle. Interception occurs when rainwater that falls on vegetation is held for a while, then evaporates back into the atmosphere or is absorbed by the vegetation. [1] states that whenever rain falls on vegetated areas, there is some water that never reaches the soil surface so it does not play a role in forming soil moisture, runoff or groundwater. The water will return to the air as the interception of the canopy, litter, and undergrowth. The interception process is influenced by the amount, direction, intensity, and pattern of rain. The size of the intercepted rainwater is influenced by the characteristics of the rain, the type, age, and density of plants, as well as the season of the year concerned [2].

Interception as one of the components in the hydrological cycle whose value is small and is often neglected, but has a very large impact on certain types of vegetation. Interception of tree stands can reduce runoff due to the shape of the leaves and at the same time produce clean and cool air in the surrounding environment. By reducing runoff in a large area, the danger of erosion and flooding can be prevented early on.

Each canopy of plants/trees has a different ability to intercept rainfall and this ability is related to the intensity of rain. [3] stated that the rainfall interception value of each plant is closely related to the character of the plant and weather factors.

One of the causes of water loss through interception is the flow of stems flowing and falling through surface runoff. According to [4] stem flow is rainwater that falls on the surface of the leaves, branches and stems, then flows through the stems to the soil surface. The size of the stem flow is strongly influenced by the structure of the trunk and the roughness of the bark of the tree. As stated [5], stem flow is water flowing down through the trunk, for smooth stems the stem flow is fast, while in rough and cracked bark the trunk flow is slow. .

According to [6] forest and plantation ecosystems have an important role in controlling ground water and as part of a system in regulating the water cycle. Rain that reaches the plant canopy, will be inhibited by leaves, branches and tree trunks before reaching the soil surface, and this speed inhibition reduces the kinetic energy of water to disperse soil aggregates. Rainwater that arrives at the soil surface after passing through the canopy of plants is called canopy outpouring or trough flow and water that passes through the stems is called stem flow or stem flow, plantation or food crop farming or agro forestry. [1] stated that, the amount of water that escaped from the canopy could be obtained by installing a rainwater collection device under a randomly placed tree, then the amount of water that escaped (through fall) could be determined by measuring the volume of water that was accommodated divided by the cross-sectional area of the tool gauge.

2. RESEARCH METHOD

2.1. Time and place

The research was carried out for 2 months in the Mixed Garden, BukuanUrban Village, Palaransub District, Samarinda Municipality.

2.2. Materials and tools

The materials used are: trees (trembesi, jengkol, acacia, sengon and mango), raffia rope, flour, glue. The tools used are: manual type ombrometer, plastic, rubber tires, duct tape, hose, bottle, meter, clinometer, GPS, compass, measuring cup, stopwatch, camera and stationery.

2.3. Research Activities

The research activities carried out were: preparation of materials and tools, field observations, determining trees as samples, installing rainfall gauges, and installing tools to accommodate stem flow.

2.4. Data collection

The data collected were: tree morphology, trunk diameter, canopy thickness, rainfall, and stem flow measurements.

To determine the amount of stem flow using the formula height:

Sf = (Sf') / Atajuk

Notes: Sf = stemflom;

Sf' = volume of stem flow accommodated in jerry cans (mm^3); andAtajuk = tree canopy area (mm^2)

3. RESULTS AND DISCUSSION

3.1. Tree Morphology

The results of observations on the shape of the canopy and trunk of the trembesi, jengkol, acacia, sengon, and mango trees are presented in Table 1.

Table 1. Observations of the Shape of the Canopy and Trunk of Trees

Tree Type	Shoot Shape	Tree trunk			
		Rod Shape	Rod Surface	Branching System	Branching Direction
Trembesi	Jambang	Round	Rooted	Monopodial	Lean up
Jengkol	Round	Round	Fine	Monopodial	Lean up
Akasia	Irregular	Round	Rooted	Simpodial	Lean upright
Sengon	Irregular	Round	Berlentisel	Monopodial	Lean upright
Mangga	Irregular	Round	Fine	Monopodial	Lean up

Source: Primary Data Processed

The results of observations on the shape of the leaves of the trembesi, jengkol, acacia, sengon, and mango trees are presented in Table 2.

Table 2.Observation Results of Tree Leaf Shape

Tree Type	Leaf	Leaf Edge	Leaf Base	Leaf tip	Leaf bone	Leafs arrangement	Leaf Composition
Trembesi	Jorong	Flat	Blunt	Pointed	Pinning	face to face	Compound
Jengkol	Memanjang	Flat	Pointed	tapered	Pinning	face to face	Single
Akasia	Memanjang	Flat	tapered	Pointed	Curved	Criss-cross	Single
Sengon	Memanjang	Flat	round	Blunt	Pinning	face to face	Compound
Mangga	Memanjang	Flat	Blunt	Tapered	Pinning	Criss-cross	Single

Source: Primary Data Processed

The results of observations on age, height, stem diameter, canopy area, canopy thickness and crown density are presented in Table 3.

Table 3.Observation results on age, height, stem diameter, crown diameter, canopy area, crown thickness and crown density

Tree Type	Age (years)	Tree Height (m)	Rod Diameter (cm)	Shoot Area (m^2)	Shoot Thickness (m)	Shoot Density
Trembesi	5	20,00	30,25	27,79	12,50	65% (medium)
Jengkol	6	13,58	28,85	13,34	10,46	80% (dense)
Akasia	3,5	13,17	25,16	14,31	11,03	70% (dense)
Sengon	3,5	17,78	27,07	22,61	10,31	30% (sparse)
Mangga	8	8,73	19,11	4,22	6,66	40% (medium)

Source: Primary Data Processed

3.2. Rainfall Condition

The results of the observation of each rain event during the study are presented in Table 4.

Table 4.Conditions of Rainfall and Intensity During Research

Rain Event Date	Rainfall (mm)	Rain Intensity (mm hour^{-1})
30 July 2019	3,87	86,06
01 August2019	12,14	13,49
24 August 2019	1,69	30,42
25 August 2019	5,39	62,14
06 September 2019	27,39	123,24

Source: Primary Data Processed

Based on the results of observations on the state of rainfall and rainfall intensity (Table 4), it shows that: (1) the rain that occurred on July 30, 2019 was 3.87 mm and 86.06 mm hour-1 (heavy and strong winds); (2) the rain that occurred on August 1, 2019 was 12.14 mm and 13.49 mm hr-1 (then heavy drizzle and then drizzled again); (3) the rain that occurred on August 24, 2019 was 1.69 mm and 30.42 mm hour-1 (stable and normal rain); (4) rain that occurred on August 25, 2019 was 5.39 mm and 62.14 mm hour-1 (heavy rain); and the rain that occurred on September 6, 2019 was 27.39 mm and 123.24 mm hour-1 (very heavy rain compared to the previous rain).

3.3. Stemflow

The results of the study of stem flow values in various trees are presented in Table 5.

Table 5.Stemflow Values in Various Trees

Tree	Rainfall (mm)	Rain Intensity (mm jam^{-1})	Stem Flow (mm)	Stem Flow (%)
Trembesi	3,87	86,06	0,0137	0,3540
	12,14	13,49	0,0262	1,2161
	1,69	30,42	0,0003	0,0170
	5,39	62,14	0,0010	0,0193
	27,39	123,24	0,1351	0,4934
Jengkol	3,87	86,06	0,0508	1,3124
	12,14	13,49	0,1313	1,0817
	1,69	30,42	0,0041	0,2440
	5,39	62,14	0,1274	2,3623
	27,39	123,24	0,4282	1,5635
Akasia	3,87	86,06	2,8600	73,8511
	12,14	13,49	0,6744	5,5540
	1,69	30,42	0,0082	0,4770
	5,39	62,14	0,8071	14,9621
	27,39	123,24	2,5329	9,2488
Sengon	3,87	86,06	0,0902	2,3298
	12,14	13,49	0,0271	0,2233
	1,69	30,42	0,0013	0,0785
	5,39	62,14	0,5705	10,5764
	27,39	123,24	2,2048	8,0507
Mangga	3,87	86,06	0,3716	1,3568
	12,14	13,49	0,4173	7,7336
	1,69	30,42	0,0363	2,1456
	5,39	62,14	0,1597	1,3154
	27,39	123,24	0,4218	10,8919

Source: Primary Data Processed

Based on Table 5 shows that the flow of stems on trees that occur in various rain events is varied. The amount of rainfall (amount of rainfall and intensity of rain) will affect the flow of stems. It was reported [7] that the relationship between rainfall and stem flow was positively correlated, the higher the rainfall followed by the greater the amount of rain that became stem flow. This happens because the capacity of the stems to hold rainwater has been saturated, so that rainwater flows as stem flow. Furthermore, it is stated by [8] that the higher the intensity of rain, the greater the percentage of stem flow that occurs, but if the intensity of rain is low in a short time, there will be no stem flow.

In general, the results showed that the greatest trunk flow occurred in acacia trees ranging from 0.0082 to 2.8600 mm; on mango trees it ranged from 0.0363 – 0.4218 mm; on jengkol trees ranging from 0.0041 to 0.4282 mm; on the sengon tree ranged from 0.0013 to 2.2048 mm; and the smallest occurred in trembesi trees ranging from 0.0003 to 0.1351 mm. The amount of stem flow in acacia trees is caused by single leaf acacia, elongated and tapered and the direction of branching is upright. Meanwhile, the small stem flow in the trembesi tree was caused by the surface of the trembesi tree with deep grooves, small leaves, medium-sized crown density and thickest canopy thickness. It was stated [9] that the amount of rainwater intercepted by plants varied depending on the type of plant leaves, canopy shape, wind speed, solar radiation, temperature and humidity. Different types of plants will affect differences in the structure and architecture of the canopy, and will affect the interception behavior of plants to rainwater. Furthermore, it is stated by [10] that the components that make up rainwater interception by plants are of two kinds, namely stem flow and through fall. Stem flow is a process where rainwater is directly passed by the stems and branches of plants to the ground. Water from this stem flow will increase the moisture content of the soil. The amount of water that becomes stem flow is influenced by the shape of the stems and leaves of the plant as well as the shape/architecture of the branching of the plant. In general, broadleaf plants are able to produce more stem flow than conifers. Through fall describes the process of rainwater falling through the plant canopy. This process is influenced by various factors, including the density of stems and leaves of plants, the type of rain, the intensity of the rain and the duration of the rain. The amount of water that becomes through fall varies depending on the type of plant vegetation. [11] stated that the size of the trunk flow in each tree is influenced by the condition of the surface of the trunk and its branches, the better the condition of the surface of the tree, the more water falls through the trunk, and the branching of the tree that is inclined downwards makes it harder for water to fall. through the stem, while the branches that point upwards make it easier for rainwater to fall through the stem.

4. CONCLUSIONS AND SUGGESTIONS

4.1. Conclusion

Based on the results of the research and discussion, conclusions can be drawn, namely the largest stem flow occurs in acacia trees ranging from 0.0082 to 2.8600 mm; on mango trees it ranged from 0.0363 – 0.4218 mm; on jengkol trees ranging from 0.0041 to 0.4282 mm; on the sengon tree ranged from 0.0013 to 2.2048 mm; and the smallest occurred in trembesi trees ranging from 0.0003 to 0.1351 mm.

4.2. Suggestion

Further research is needed on rainfall with a greater magnitude and the occurrence of more rain on different tree vegetation or with the same tree vegetation but in different locations to add information about the ability of trees to intercept rainwater which plays a role in water and soil conservation.

BIBLIOGRAPHY

[1] Asdak, C. 2004. Hydrology and Watershed Management.GadjahMada University Press, Yogyakarta.

[2] Pelawi, S.F. 2009. Interception in Various Age Classes of Oil Palm Stands (*Elaisguineensi*) [Undergraduate Thesis].

[3] Ramirez JA and Senarath SUS. 1999. A Statistical dynamical parameterization of interception and land surface-atmosphere interaction. Am. Meteorol.Soc. 13:4050-4063.

[4] Arsyad, S. 2012. Soil and Water Conservation. IPB Press, Bogor.

[5] Lee, R. 1990. Forest Hydrology.Gajah Mada University Press, Yogyakarta.

[6] Japar YS. 2000. Rainfall Interception on Inner, Hybrid, and Early Coconut. Thesis.Department of Geophysics and Meteorology.FMIPA-IPA.

[7] Chairani, S. and D.S. Jayanti. 2013. Interception of Rainfall in Pine Tree (*Casurianacunninghamia)*Stands. Rona TeknikPertanian 6 (1) : 405 – 412.

[8] Anwar, M. 2005. Impact of Land Use Change on Rain Interception (Case of Nopu Sub-watershed Central Sulawesi. Postgraduate Thesis IPB, Bogor.

[9] Herwitz, R.S. andSlye, R.E. 1992. Spatial Variability in the Interception of Inclined Rainforest by a Tropical Rainforest Canopy.Selbyana 13: 62-71

[10] Chanpaga, U. andWatchirajutipong, T. 2000. Interception, Throughfall and Stemflow of Mixed Deciduous with Teak Forest

[11] Irmas. F.A. 2010.Interception of trunk flow and canopy escape on various types of trees at the University of Lampung. Faculty of Agriculture.University of Lampung, Bandar Lampung.