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THE ANALYSIS OF ECOLOGICAL FUNCTIONS OF SAGOBARUK (*ARENGA MICROCARPHA* BECC) PLANTS FOR SUSTAINABLE USE

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Abstract

This study aims to analyze physical parameters such as infiltration of water into the soil through rooting, water holding capacity and its effect on the temperature and humidity of the land around the plant. The method used survey method and data analysis technique is descriptive analysis, t test, F test (ANOVA). The results showed that the infiltration rate near the sago cluster was higher than outside the cluster at different seasons, the water holding capacity does not differ significantly at different altitudes, soil moisture near the cluster of sago is higher than outside the cluster in different seasons, The soil temperature near the cluster is lower than the temperature outside the cluster. Sago baruk plants have excellent ecological functions and can be recommended to be conserved to ensure sustainable utilization.

Keywords: *Ecological function; Sago Baruk Plant; Sustainable use; ANOVA*

Introduction

The ecological function of a plant is a functional relationship between the plant and the environment in which it grows. Sago baruk plants (Arenga Microcarpha) are an endemic plant and carbohydrate producer that is used as staple food of the people of Sangihe Islands District from generations to generations. This plant is also known to the local community as a plant that is very useful for environmental conservation [1]. This can be seen, among others, on the surface of the land around the sago baruk soil is still better (compared to other vegetated land), as well as the source of the springs around the sago crop its relatively stable water presence in the dry season [2]. Sago barukis a type of sago growing on dry land encountered in Sangihe Island. This sago can grow at an altitude of 0-600m above sea level. The stem may reach a diameter of 14-25cm and between 6-16m in height at matrure Stage [3].

The name sagubaruk is a name that has been known in the District of Sangihe and Talaud Islands from generation to generation. The plant belongs to the family of Palma and the genus Metroxylon, because it contains starch on the stem but the difference with true Metroxylon. Sago baruk can grow well in dry land to form Cluster [4]. However, because the flowers structure is similar to the palm trees, the sago baruk is classified in the genus Arenga [5]. Baruk sago palms are the type of perennials that grow to form clusters with roots that have high enough porosity. Sago baruk palm has root systemwhich can withstand the layer of soil, so the palm can suppres soil erosion and minimize surface runoff [6]. Sago baruk has a long leaf strand between 2–4 meter and number of leaflets 42-75 [7]. Sago baruk plants have the

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privilege that can grow and multiply on a steep land though (600 -700) [3]. Plants are only found in Sangihe Island (endemic plants) that needs to be maintained [2].

The microclimate discusses atmospheres of space between rooting to the top of the plant canopy or the nature of the atmosphere around the ground. The climatic elements are susceptible to changes in warming and cooling the surface of the soil and local plants. The micro climate is a sensitive indicator of changes in forest ecosystems [8, 9], so it can be used for monitoring biotic conditions [10-12], abiotic [13, 14], and management of forest ecosystems [15, 16]. Physical parameters are important in evaluating the ecological function of vegetation in this case sago baruk.

The ability of plant roots to distribute rain water causes other crops to survive during the dry season. Infiltration capacity correlated with soil physical character, positively correlated to the porosity of the soil and organic matter content, while the content of clay and weight content of the soil negatively correlated.

Rainfall and water content affect infiltration capacity. Raindrops tend to damage the structure of the soil surface, the fine materials from the surface can be washed into the cavities of the soil, clogging pores, thereby reducing the rate of infiltration. Vegetated lands generally absorb more water due to organic matter and micro-organisms and plant roots tend to increase soil porosity and stabilize soil structure [17].

WaterHolding capacity of the soil depends on two factors i.e. soil texture and vegetation type. Soil binding/storing is only one or two centimeters of moisture per 30cm of soil depth, while dust or clay can bind ten or more soil moisture at the same depth. Differences in vegetation species will have different root zones. Deeper rooting zones store more water than shallow roots.

The determination of water holding capacity uses provisional water holding capacity tables [18]. Concluded that the cluster of sago baruk plants have high water saving ability. This is associated with the infiltration capacity, texture and porosity of the soil. rooting patterns (horizontal), horizontal depth and width, the presence of cover crops indicating that sago baruk plants have high water holding capacity, this is in accordance with the community's knowledge of the availability of water (wells or springs) on land located in the lower position of the cluster of sago baruk.

Vegetation growth requires a certain level of soil moisture. Drought events occurring in an area relate to how much moisture levels and vegetation functions control evaporation and channel water down the surface through rooting. The requirements of soil moisture to ensure the growth and endurance of plants vary. Factors affecting soil moisture include: ground surface temperature, wind speed, rainfall and light intensity.

The results of the previous year's study showed that soil moisture in cluster with outside cluster of sago baruk was significantly different in both rainy and dry seasons [19]. This shows that the overgrown land of sago plants has an advantage for intercropping plants that require relatively stable soil moisture. Soil moisture varies depending on land cover (e.g. between artificial grasses, bushes or overgrown land) [20].

Soil temperatures play an important role in biotic and abiotic processes associated with tree growth [21], above and below ground biomass [22], crop productivity [23], diversity and plant distribution [24].

Ideal soil temperature accompanied by good air circulation, stimulates acceleration of decomposition of organic materials to form humus, and allows the development of microorganisms that improve soil fertility.The results of the previous study concluded that ground surface temperatures in clumps are similar or not significantly different from ground surface temperatures outside the clump [19].

The aim of this research was to analyzethe physical parameters such as infiltration of water into the soil through rooting, water holding capacity and its effect on the temperature and humidity of the land around the around sago baruk plants in different seasons and different altitude.

Materials And Methods

The research was conducted in Gunung Village of Tabukan Tengah Sub-district of Sangihe Regency in May to June 2018. The materials of the experiments from mixed farmland with an altitude of ± 600m above sea level.

The tools used for this experiment were GPS, clinometers, set of four in one, soil tester, Set of double ring infiltrometer and stop watch. The altitude in this research was divided into 3 levels, namely high altitude (400 - 600m), the medium altitude (200 - 400m), and the low altitude (0-200m). The method of this research was a survey with a purposivesampling method (Surybrata, 1983) [25]. Data analysis techniques included descriptive analysis, T test and F test (ANOVA) used SPSS 16.00.

The infiltration ratesnear the cluster (< 0.5m) and outside the cluster (2.5m) were calculated using Horton equation model of

$$f_t = f_c + (f_0 - f_c)e^{-kt} \text{........(1)}$$

where: ft is infiltration capacity at time t, fc is infiltration capacity when the price reaches a constant value; fois the value of the initial infiltration capacity (at t = 0); k is a constant that varies according to soil conditions and the factors that determine the infiltration; t is time; and e is natural logaritme 2.71828 [26].

The rate of infiltration and infiltration constant were obtained using descriptive analysis, which is a table the average value of the infiltration rate and infiltration constant based on season and altitude position. T test at Sig t <0.05 (level of error 5%) was performed to compare values observed in the rainy and dry seasons. Differences in infiltration rates and infiltration constants of the three altitudes (508m, 330m and 44m) were tested using F test or ANOVA at Sig F <0.05 (level of error 5%).

To determine the water holding capacity of a field, soil texture data and vegetation depth data are required to grow on the surface of the soil. Waterholding capacity analysis (using provisional water holding capacity (Thornthwaite and Mather 1957) [27].Soil samples were analyzed in the soil laboratory of the Faculty of Agriculture, Sam Ratulangi University and Root depth data measuring directly in the field.

Measurements of temperature and soil moisture were performed on three variations of depth ie surface, 30cm and 60cm below surface. Measurements are carried out at 2 hour intervals, so that mathematical changes in moisture and soil temperature can be generated throughout the day.

Results and Discussion

Infiltration Rate

In the dry season, there were no significant differences in the initial infiltrations rates of outside the cluster, the final infiltration rates of outside the cluster, and the final infiltration rates of near and outside the clusters at three altitudes. However, the initial infiltration rate of near the cluster and the infiltration constant of near the cluster at the low altitude were significantly greater than those observed at the high and medium altitudes (Table 1)

In the rainy season there were differences in all infiltration rate parameters between three altitudes, except for the final infiltration rate of outside the cluster (Table 1). Those differences can be attributed to the difference land covers and soil texture classes as reported by previous researchers [26]. Results of a preliminary survey conducted prior to this study indicated that land covers of the high, medium and low altitudes weregedi (*Abelmascusmoscatus*), Java sweet maize, and maize, respectively. Soil texture classes of the study area are sandy clay loam, silty loam, and sandy loam for high, medium and low altitudes, respectively. The lower infiltration rate parameters in the rainy season than those observed in the dry season were merely due to the wetness of soil.

Table 1. Comparison on the positions of the infiltration rate in the dry and rainy seasons

Variable	**Dry season**			**Rainy season**		
	Altitude			**Altitude**		
	High	**Medium**	**Low**	**High**	**Medium**	**Low**
f_o* near cluster	130.51 a	130.52 a	131.02 b	6.15 b	6.13 a	6.35 c
f_o outside cluster	12.27 a	12.36 a	12.26 a	1.74 c	1.71 a	1.73 b
f_c* near cluster	2.20 a	2.24 b	2.24 b	0.0100 c	0.0042 a	0.0043 b
f_c outside cluster	1.24 a	1.24 a	1.24 a	0.0077 a	0.0080 a	0.0077 a
f* near cluster	102.57 a	103.49 a	102.63 a	55.21 c	49.54 b	48.83 a
f out cluster	11.96 a	11.91 a	12.03 a	7.08 c	6.72 b	5.52 a
k* near cluster	0.245 a	0.245 a	0.264 b	0.2827 a	0.2832 b	0.8233 c
k outside cluster	0.168 b	0.165 b	0.164 a	0.1975 c	0.1970 b	0.1963 a

*Remarks: f_o is initial infiltration rate (mm/minute); f_c is the final infiltration rate (mm/minute); f is the average infiltration rate (mm/minute); k is infiltration constant; numbers followed by the same letter (a, b, or c) at the same line are not significantly different at p = 0.05. (a, b, and c are the symbol that state the difference in the value of the variables in the statistical test results at 3 different elevations)

Table 2. Results calculation of water holding capacity

Position/Location (m asl)	**Depth of Rooting (cm)**	**Land Texture Class**	**Water Availability (mm/m)**	**Water holding capacity Value Results (mm)**
600	0 – 20	loam	250	50
600	100 cm	Clay	300	300
600	250 cm	Clay	300	750
300	0 – 20 cm	loam	250	50
300	100 cm	Clay	300	300
300	250 cm	Clay	300	750
40	0 – 20 cm	loam	250	50
40	100 cm	Clay	300	300
40	250 cm	Clay	300	750

Table 3. Results comparative analysis Water holding capacity value at each position

Position (m asl)	**WHC average**	**Sig F**	**Conclusion**
600	37.7		
300	37.7	1.000	Non Significant
40	37.7		

Water Holding Capacity Data

Tables 2 and 3 are show that at the high, medium, and low position, water holding capacity values exactly the same that is 37.7mm. The test results show the value of Sig F of 1.000 > 0.05 (error rate 5%) so it can be concluded that there is no significant difference in water holding capacity values between the three positions. That is, the low position, medium or high, will give water holding capacity values tend to be almost the same. The results of data analysis of water holding capacity (Table 5) indicate that the capacity to water holding around the sago baruk plants is high, which equal to the capacity of water is holding in enclosed adult forest [1, 27].

This causes the soil moisture around the sago baruk plant is higher than the soil mosture that land no sago baruk, also supported the results of research on infiltration around the sago baruk which shows that the infiltration rate and infiltration capacity is higher than the land without sago baruk [1]. Therefore sago baruk plant is very suitable for the conservation of critical land. Sago baruk plants have excellent ecological functions and can be recommended to be conserved to ensure sustainable utilization [17].

Soil Moisture and Soil Temperature Data

Soil Moisture and Soil temperature Data, divided into two seasons namely rainy and dry. There are four variablesobserved in soil moisture and soil temperature data that is soil moisture near cluster, soil moisture outside cluster, soil temperature near cluster, soil temperature outside cluster.

Table 4 shows the value of the variable each season. Soil moisture variable near the cluster and within the cluster: the average of the second variable, in the rainy season is 68.14%, 52.33% and 68.01%, 48.18% in the dry season. From the results of different tests using the t-test Sigt obtained respectively 0.936 and 0.017. Karen Sig value <0.05 shows that there is no visible difference in soil moisture near the clusters in the two seasons, while significant differences in soil moisture outside the clusters in both seasons. Variable soil temperature near the cluster and soil temperature outside the cluster: the average of the two variables in the wet season is 25.26 - 25.47°C, and in the dry season is 25.37 - 25.47°C. From the results of the different tests, use the t-sigt test obtained 1000 and 0.211, respectively. Because Sigt t > 0.05 indicates that there are no differences seen in the soil cluster inside or outside the cluster. This means that both the wet and dry seasons, the soil temperature inside the cluster and outside the cluster is the same.

Table 4. Comparison of soil moisture and soil temperature across seasson

Variable	Rainy Season	Dry Season
SM near cluster (%)	68.30 a	67.8 a
SM outside Cluster (%)	52.30 b	49.18 a
ST near cluster (°C)	25.46 a	25.45 a
ST outside cluster(°C)	25.26 a	25.37 a

*Remarks: SM is soil moisture (%); ST is soil temperature (°C); numbers followed by the same letter (a, b, or c) at the same line are not significantly different at p = 0.05 (a and b are the symbol that state the difference in the value of the variables in the statistical test results at 2 different seasons)

Analysis Results in Rainy Season

The study sites were divided into three positions. First is the high position with a height of 600 m above sea level. Second is the medium position with a height of 300m above sea level. Third is the low position with a height of 40m above sea level. There are four variables observed in soil moisture and soil temperature data that is soil moisture near cluster, soli moisture outside cluster, soil temperature near cluster, soil temperature outside cluster.

Table 5 shows that soil moisture near the cluster and outside the cluster: seen from the average of each variable, the high and medium position have the same soil moisture value but the soil moisture near the cluster is at a slightly higher position, while outside the cluster in the lower position is slightly lower.

Tabel 5. Comparison of soil moisture and soil temperature among positions in rainy seasson

Variable	Position		
	Hight (600m dpl)	Medium (300m dpl)	Low (40m dpl)
SM near clump (%)	67.74 a	67.74 a	68.91 a
SMoutside clump (%)	52.82 a	52.82 a	51.31 a
ST near clump (°C)	25.48 a	25.48 a	25.48 a
ST outside clump (°C)	25.24 a	25.24 a	25.24 a

*Remarks: SM is soil moisture (%); ST is soil temperature (°C); numbers followed by the same letter (a, b, or c) at the same line are not significantly different at p = 0.05 (a is the symbol that state the difference in the value of the variables in the statistical test results at 3 different positions)

From the ANOVA results it can be seen that each Sig F variable is 0.834 > 0.05 so it can be concluded that there is no visible difference in soil moisture near the cluster or outside the cluster between these three positions. The soil temperature variable near the cluster and outside the cluster, seen from the average of each variable, the position of high, medium and low is almost the same. ANOVA results show that each Sig F variable is 1000 > 0.05, so it can be concluded that there is no visible difference in soil temperature near and outside the cluster between these three positions. It can be concluded that in the rainy season: Four variables, do not show significant differences between the three positions.

Analysis Results in Dry Season

The study sites were divided into three positions. First is the hight position with a height of 600m above sea level. Second is the medium position with a height of 300m above sea level. Third is the low position with a height of 40m above sea level. There are four variables observed in soil Moisture and soil temperature data that is soil moisture near cluster, soil moisture outside cluster, soil temperature near cluster, soil temperature outside cluster.

Table 6 shows the comparison of the variable values of each position in the dry season.The soil moisture variablenear the cluster, seen from the average, the hight and medium position has a soil moisture value near the cluster almost the same but the soil moisture near the cluster at the low position slightly higher. The result of ANOVA seen that Sig F equal to 0.985 > 0.05, so it can be concluded not seen difference of soil moisture near the cluster in third position.

Table 6. Comparison of soil moisture and soil temperature among positions in dry season

Variable	Position		
	Hight (600m dpl)	**Medium (300m dpl)**	**Low (40m dpl)**
SM* near clump (%)	67.73a	68.10a	68.15a
SM outside clump (%)	52.81c	45.52a	46.16b
ST* near clump (°C)	25.45a	25.45a	25.45a
ST outside clump (°C)	25.25a	25.43a	25.37a

*Remarks: SM is Soil Moisture; ST is Soil Temperature; The numbers followed by the same letter (a, b, or c) on the same line is not significantly different at p = 0.05. (a, b, and c are the symbol that state the difference in the value of the variables in the statistical test results at 3 different positions)

This indicates during the dry season, in all three altitude positions, soil moisture near the cluster tends to be almost the same. The soil moisture variable outside the cluster, seen from the average, the hight position has a higher soil moisture value of the outside cluster than the medium and bottom position, on the other hand in the medium position soil moisture value outside cluster is lowest. The result of ANOVA seen that Sig F equal to 0.025 < 0.05, so it can be concluded that there are differences of soil moisture outside cluster in third position. The average rating, it is seen that the hight position has the highest soil moisture of the outsidecluster, and the medium position of the outside cluster has the lowest; the soil temperature variables in cluster, seen from the mean, the hight, medium and low positions have a soil temperature value almost the same nearcluster. The result of ANOVA seen that Sig F equal to 1.000 > 0.05, so it can be concluded not seen difference of soil temperature near cluster in third position.

This indicates during the dry season, in all three altitude positions, the soil temperature nearcluster tends to be almost the same. The soil temperature variables outside the cluster, seen from the average, the hight, medium and low position have the value of soil temperature outside the cluster almost the same. The result of ANOVA seen that Sig F equal to 0.551 > 0.05, so it can be concluded not seen difference of soil temperature outside cluster in third position. This indicates during the dry season, in all three altitude positions, the temperature of the soil outside the cluster tends to be almost the same.

It can be concluded that in the dry season: the highest soil moisture outside thecluster in the hight position (600m asl). The highest soil moisture outside the cluster in the middle position (300m asl). While to the other variables, did not show a significant difference between the three positions.

Conclusions

The results of this research showed that the infiltration rate near the sago cluster was higher than outside the cluster at different seasons, the water holding capacity does not differ significantly at different altitudes, soil moisture near the cluster of sago is higher than outside the cluster in different seasons. The soil temperature near the cluster is lower than the temperature outside the cluster. So the sago baruk plants have excellent ecological functions such as preserving groundwater sources, reducing run off, and maintaining soil fertility.

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