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The Application of Dry Rubber Latex and Vermicompost to Plant Water Consumption and The Growth of Paddy on Swampy Land

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Abstract

Swampy land is an alternative for rice plant cultivation where the amount of rainfall has an impact on the amount of inundation. In order to provide appropriate water for rice plants, especially during the dry season, an irrigation water system is required for its control.Alternative materials such as dry rubber latex and vermicom-post can be utilized to reduce water use and ensure that water is delivered as efficiently as possible. The goal of this study was to see how dried rubber latex on the soil surface and vermicompost in the soil affected rice plant water demand and growth. This research was conducted from November 2020 – February 2021. The study used a factorial randomized block design (RAKF) with 2 treatments, covered dry rubber latex variations (K), K0 (0%), K1 (25%), K2 (50%), K3 (75%), and vermicompos (V), V0(0 g), V1(58.82 g), V2(117.64 g), V3 (176.46 g)with 3 rep-licat. So that the total treatmentsare 48 treatments.The results showed that the application of dry rubber latex and vermicompost significantly affected the number of leaves and the number of tillers. The K3 treatment (75%) was the best because it had the smallest evapotranspiration rate with an average of 1.2 mm day-1. The K3 treatment (75%) had the smallest average water requirement of 1.6 mm day-1 with an average number of 37.07 leaves. The high yield of K3 treatment was due to the wider the area covered by 75% (K3), the higher the water content, nutrients, and the lower the soil temperature. Closure using dry rubber latex can reduce sunlight so that the process of water loss is lower, and the available nutrients are higher.

Keywords: Evapotranspiration, Irrigation, Soil, Water System

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1. Introduction

Due to the conversion of a large number of paddy fields to non-agricultural activities, swampy land can be used as an alternative area in the development of rice production [1]. This marginal land could be transformed into agricultural land in the future. South Sumatra has a population of roughly 2.98 million people, however, only 0.37 hectares are utilized for rice plants. This swampland has been flooded for at least three months and the inundation height is at least 30 cm [2]. In rice farming, the need for irrigation water must be considered to meet the plant's needs. The irrigation system is designed to prevent water shortages from reducing rice production, especially during the dry season.

According to[3],the problem that will arise due to a decrease in water availability is that many technically irrigated rice fields cannot be planted with rice because of insufficient water, especially in the downstream irrigation area. Dry rubber latex on the surface and vermicompost can be utilized as alternatives to alleviate water scarcity since they act as mulch and reduce evapotranspiration while also increasing plant output.Latex rubber, according to [4]is excellent as a soil enhancer that helps to build aggregates and is an organic material that can be digested by soil microbes without polluting the environment.Because rubber latex is hydrophobic, it can be used to reduce plant evapotranspiration and hence increase the amount of water required by plants[5]. When put to land in areas with high rainfall, such as moist tropical climates, hydrophobic polymeric materials like natural rubber can help minimize the amount of water required.

It is also possible to prevent evaporation by injecting water into the soil.Vermicompost can promote soil infiltration, increase the quantity of water held in soil aggregates, aeration, root penetration, and microbial activity[6]. Evapotranspiration has an impact on soil moisture and temperature.According to research[7], applying one compost briquette per plant at a dose of 20 tons ha^{-1} (117.64 $gplant^{-1}$) had a substantial impact on milled dry grain weight (GKG) In comparison to no mulch, silver plastic mulch and straw mulch applied 7 tons ha^{-1} above the soil surface had a substantial effect on cucumber growth, including plant height, leaf area, number of leaves, and number of male and female flowers, according to research[8]. As a result, the goal of this research was to see how dry rubber latex on the soil surface, as well as vermicompost in the soil, affected water demand and rice plant growth.

2. Materials and Methods

This research was conducted in RumahPlastik at JalanTerusan, Sukabangun, Sukarami Sub-district, Palembang City. The soil sample was taken at Sungai Pedado Village, Keramasan, Kertapati Sub-disctrict, Palembang. The analysis of the soil sample was conducted in Integrated Laboratory at PT. Sampoerna Agro (Tbk) on August 2020 until February 2021.

The characteristic of the soil sample was based on the assessment criteria according to the Bogor Soil Research Center (1983) showed that the soil in the study had a clay loam texture with 34.95% clay content, 34.77% sand and 30.29% dirt with H_2O 4.45 pH and KCl 3.90 pH which was classified as very acidic with a cation exchange capacity of 52.20 $cmolkg^{-1}$,C-organic content of 3.98% which was relatively high, N-total classified as moderate (0.38%), P_20_5 was high (14.71 ppm), K-dd classified as moderate which was 0.40 $cmolkg^{-1}$, Na was moderate with 0.40 $cmolkg^{-1}$, Caand Mg classified high (10.24 $cmolkg^{-1}$ and 3.02 $cmolkg^{-1}$), Al-dd 1.37 $cmolkg^{-1}$ and H-dd 1.25 $cmolkg^{-1}$were classifiedas relatively high.

Method used in this study was RAK Method with two treatment factors, namely rubber coverage (dry latex) above the ground (K), K_0 = control covered0%, K_1 = latex covered 25%, K_2 = latex covered 50%, K_3 = latex covered 75% and application of vermicompost in the soil(V), V_0 = 0 ton ha^{-1} (0 g) , V_1= 10 ton ha^{-1}, (58.82 g), V_2= 20 ton ha^{-1} (117.64 g), and V_3 = 30 ton ha^{-1} (176.46 g). Each treatmentwas repeated 3 times, so the total number of repetition was 48 repetitions. If the results of the variance showed a significant effect, it would be continued with the Least Significant Difference Test between treatments.

Table1. Preliminary analysis of soil research

Parameter	**Unit**	**Result***	**Criteria****
pH H_2O		4.45	Very Acidic
pH KCl		3.90	-
C-Organik	%	3.98	High
N- Total	%	0.38	Moderate
P_2O_5 Bray	ppm	14.71	High
P_2O_5 HCl 25%	$mg100g^{-1}$	39.65	Moderate
K-dd	$cmolkg^{-1}$	0.40	Moderate
K_2O HCl 25%	$mg100g^{-1}$	127.37	Very High
Na	$cmolkg^{-1}$	0.40	Moderate
Ca	$cmolkg^{-1}$	10.24	High
Mg	$cmolkg^{-1}$	3.02	High
KTK	$cmolkg^{-1}$	52.20	Very High
Al-dd	$cmolkg^{-1}$	1.37	Very High
H-dd	$cmolkg^{-1}$	1.25	Very High
Tekstur :	%		Clay Loam
Liat	%	34.95	
Pasir	%	34.77	
Debu		30.28	

Note:

*) Data was based on the analysis result at Laboratory of PT. Sampoerna Agro Tbk

**) Soil Chemical Properties Assessment Criteria of Bogor Soil Research Center Staff (1983)

The research activity was carried out by collecting rubber sap into jerry cans, later 10 ml of ammonia was added for every 1 L to keep it in form of liquid. The sap that had been collected was put into trays and later be formed with a latex thickness of 5 cm × 5 cm × 1 cm then it would be air-dried at room temperature. The dried latex was next be cut with the size of 5 cm × 5 cm using scissors in order to cover the soil surface of the paddy. Dried rubber latex was later placed on the soil surface with treatment of 0% soil covering, 25% soil covering, 50% soil covering, and 75% soil covering.Vermicompost was added by mixing the soil with a dose of (0 g, 58.82 g, 117.64 g, and 176.46 g) before planting. According to [9]for the paddy, organic fertilizer was given at 7-10 days before planting.

Hampered soil sample was taken with a hoe at the depth of 0 – 20 cm while thick plastic was air-dried and sieved through a W41 sieve. Nursery was conducted in trays with a spacing of 2 cm x 2 cm. The nursery media used a mixture of soil and compost in a ratio of 1:0.5. After 12 days, the nursery was transferred to a plastic bucket. In one bucket there were 2 paddy seeds, so the total of all paddy seeds needed were 96 plants. Maintenance was done during planting which was starting from replanting, weeding, eradicating pests, and watering.

According to [10]the SRI water supply system was able to save 25% - 50% of water and could increase production. Determination of field capacity was obtained by analyzing the water content using the free drainage method.The water that was given to plants was the result of water reduction in field capacity with the water content which obtained by the gravimetric method.According to [11]the value of the water content of the field capacity which obtained from laboratory analysis experiments (% MPA) was used as the basis for giving water in the pot:

Water content that must be added

= (% KAKL) – (% KA initial)

Note:
% KAKL = water content of field capacity
% KA initial = water contentinitial

The evapotranspiration rate was measured by weighing the soil and plants before and after the activity of giving irrigation water using a digital balance. The difference in weight loss was the evapotranspiration value.According to research [3]the value of evapotranspiration could be calculated using the formula:

ΔS = Input – Output

The calculation of potential water loss was obtained by using an evaporation pan. According to [12] observation data of the ET_0value could be estimated using evaporation data from the Evaporation Pan, by multiplying the evaporation data with the pan coefficient number.

T_0 = Evaporation Pan x Pan Coefficient

According to [12]the value of the pan coefficient ranges from 0.65 – 0.85 since Indonesia had weak to moderate wind speeds and the average humidity was above 70%. Measurement of humidity and temperature as supporting data was done every day using a digital thermo-hygrograph. Measurement of crop consumptive water needs (Etc) was put into the formula. According to [13] the water requirement for plants which is a plant evapotranspiration (ETc) was calculated using Equation (Doorenbos and Pruitt (1984)):

$$ET_C = K_C \times ET_0$$

Note:
ETc = Plant consumptive water needs
Kc = Plant Coefficient with values of 1.25 and 1.0 According to FAO recommendations, (1977)
ET_0 = Evapotranspiration Rate (mm/hari)

According to [14] the coefficient value of the plant could be obtained by comparing the standard evapotranspiration rate (ET_0) with the plant evapotranspiration rate (ETc). Measurement of paddy plant height was done at intervals of once a week using a ruler. The number of leaves was counted per clump for once a week during the vegetative growth phase until it entered generative growth. Calculation of the number of tillers was done by counting the tillers that grow in each treatment.

3. Results and Discussion

Evapotranspiration of Plants

The application of dry rubber latex and vermicompost had no significant effect on plant evapotranspiration, according to the results of the analysis of variance in Table 2. The K_0 treatment had aevapotranspiration value of 1.58 mmday^{-1}, according to Table 2. The K_3 treatment had the lowest evapotranspiration value, with an average of 1.21 mm day^{-1}. The high rate of plant evapotranspiration at K_0 was because the plants were not covered with dry rubber latex on the soil surface in the K_0 treatment (0% cover area). Dry rubber latex on the soil surface helps to reduce evapotranspiration, allowing more water to reach the plants. According to research [15] mulch helps to reduce evaporation and minimize evaporation losses, ensuring that water is available for plant growth and development. [16] mulching reduces plant evapotranspiration and improves water efficiency.

Table 2. The effect of giving effect of dry rubber latex and vermicompost on evapotranspiration rate (mm day^{-1})

Dry rubber latex covered area (%)	Doses (ton ha^{-1})				Average
	V_0 (0)	V_1 (10)	V_2 (20)	V_3 (30)	
	Evapotranspiration rate (mm day^{-1})				
K_0 (0)	1.6	1.7	1.6	1.5	1.6
K_1 (25)	1.2	1.4	1.3	1.3	1.3
K_2 (50)	1.4	1.2	1.3	1.4	1.3
K_3 (75)	1.3	1.2	1.2	1.2	1.2
Average	1.4	1.4	1.3	1.3	-

Consumptive Water Used for Rice Plants

The application of dry latex and vermicompost had no significant influence on consumptive water used for rice plants, according to the results of the analysis of variance in Table 3. Table 3 shows that the K_3 treatment requires the least amount of water from the plants (75% closure).Plants' low water requirements are owing to the application of dry rubber latex above the soil surface, which can store water and prevent it from evaporating too quickly. The property of dry rubber latex to float above the soil surface can be employed as mulch that can withstand plant water availability. Because evaporation from the soil is limited by the mulch and falls back to the ground, mulch has features that can reduce evaporation and increase the ability to keep water capacity [13].

Table 3. The effect of giving effect of dry rubber latex and vermicompost Consumptive Water Used for plants (mm day^{-1})

Dry rubber latex covered area (%)	Doses (ton ha^{-1})				Average
	V_0 (0)	V_1 (10)	V_2 (20)	V_3 (30)	
	Consumptive Water Used plants (mm day^{-1})				
K_0 (0)	1.9	2.0	1.8	1.7	1.9
K_1 (25)	1.7	1.7	1.9	1.7	1.8
K_2 (50)	1.9	1.8	1.8	1.9	1.8
K_3 (75)	1.7	1.7	1.6	1.5	1.6
Average	1.8	1.8	1.8	1.7	-

Height of the Plant

The treatment of dry rubber latex and vermicompost had no significant effect on the height of paddy, according to the analysis of variance. Based on Figure 1. The average plant height in Treatment K_0 is 78.32 cm. The K_1 treatment had the shortest plants, with an average height of 74.86 cm. Because the soil in the study region is characterized as a shallow swamp with high nutrient content, the high control treatment (K_0) was chosen.

According to [17] lowland swampland with shallow typology has high C-Organic content, moderate total N, moderate available P, low and medium CEC of Ca and Mg, and medium and high Na and K.This is evidenced by the results of the initial soil analysis (Table 1) that the soil in the research location has a high C-Organic content of 3.98%, N-total is classified as moderate (0.38%), P_2O_5 is high (14.71 ppm), K-total is classified as high dd is classified as moderate 0.40 cmolkg^{-1}, Na is classified as moderate 0.40 cmolkg^{-1}, Ca and Mg are classified as high (10.24 cmolkg^{-1} and 3.02 cmolkg^{-1}). The high content of C-Organic in the soil can increase the nitrogen content in the soil which affects the vegetative growth of plants.

According to [18] nitrogen fertilizer functions to form protoplasm, multiply, and multiply cells to increase plant height. Furthermore, paddy require a lot of water at the start of their growth, therefore the application of dry rubber latex on the surface does not affect plant height. According to [19] consumptive water needs of paddy can increase with the growth phase and peak in the vegetative phase. The vegetative growth phase according to [20],is the initial phase that necessitates a lot of water.

Number of leaves

The application of dry rubber latex and vermicompost had a substantial effect on the number of leaves of paddy, according to the results of the BNT test in Table 5. According to Table 5, the best treatment is K_3 (75% rubber coverage area), which has a value of 37.1 pieces, which is significantly different from the other treatments.The high K_3 treatment was owing to the 75% rubber covered area being able to provide enough water for the paddy to grow a suitable number of leaves. When dry rubber latex is applied to the soil surface, it helps to reduce evapotranspition, lower soil temperature, and increase plant water availability.

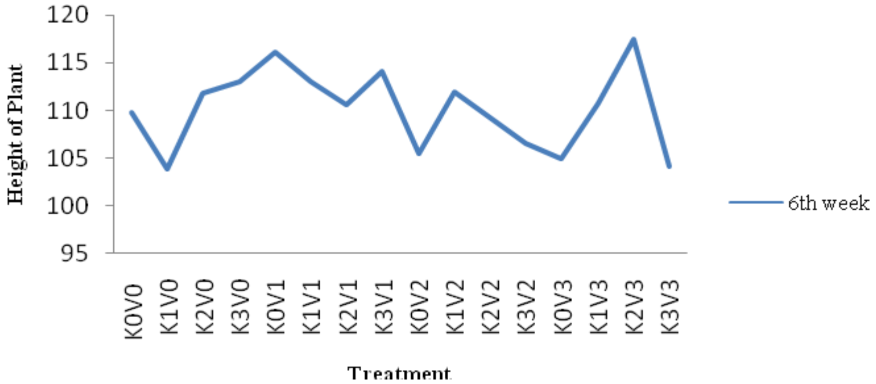

Figure 1. The effect of dry rubber latex and vermicompost on height of paddy (*Oryza sativa*)

According to studies [21] using organic mulch can lower soil temperatures, enhance water content, and minimize evaporation rates. Table 5 shows that the maximum dose that plants can absorb is 20 tons ha^{-1} (117.64 g). This is consistent with studies [4], which found that using compost briquettes at a dose of 117.64 can boost rice plant development.

Table 4. The effect of dry rubber latex and vermicompost on amount of leaves $clump^{-1}$

Dry rubber latex covered area (%)	Doses (ton ha^{-1})				Average
	V_0 (0)	V_1 (10)	V_2 (20)	V_3 (30)	
	Number of leaves ($clump^{-1}$)				
K_0 (0)	32.7	43.2	34.1	35.1	36.3 b
K_1 (25)	28.0	33.1	34.4	24.2	30.0 a
K_2 (50)	36.0	31.5	37.7	43.0	37.0 b
K_3 (75)	32.8	33.9	46.0	35.6	37.1b
Average	32.4	35.5	38.0	34.5	-
$BNT_{0,05}$ Dry rubber latex covered area		5.7			

Note: Numbers followed by the same letter show significant differencesreal at 5% level

Maximum Tiller

The effect of giving dry rubber latex and vermicompost on the maximum number of tillers of paddy are presented in Table 7. Based on Table 7. that the results of the analysis of the variance of giving dry rubber latex and vermicompost did not significantly affect the maximum number of tillers of paddy. The highest maximum number of tillers was found in K_3 treatment (75% coverage area) with an average value of 34.33 stems, and the highest dose of vermicompost was found in V_2 treatment of 20 tons ha^{-1} (117.64 g). The mulch cover was able to improve the water content, nutrients, and evaporation rate, resulting in a high K_3 treatment with a cover area of 75%. Because of the high availability of nutrients in the soil and the water supply system provided by macak-macak, soil aeration and drainage can be improved, allowing roots to create more tillers. Mulching can lower soil temperature and enhance soil moisture.according to research [23], Microbes can degrade organic matter at the correct temperature, resulting in more nutrients being available to plants and better plant growth.

Table 5. The effect of dry rubber latex and vermicompost on the maximum tillers clump^{-1}

Dry rubber latex covered area (%)	Doses (ton ha^{-1})				Average
	V_0 (0)	V_1 (10)	V_2 (20)	V_3 (30)	
	Maximum tillers per clump				
K_0 (0)	21.3	26.0	22.7	21.7	22.9
K_1 (25)	26.0	23.0	29.0	21.7	24.9
K_2 (50)	25.3	28.0	26.0	29.7	27.3
K_3 (75)	25.0	25.0	34.3	26.0	27.3
Average	24.4	25.5	28.0	24.8	-

4. Conclusion

The application of dry rubber latex 75% (K_3) on the surface and vermicompost had a significant effect on the rate of evapotranspiration, water requirements, and some leaves. The application of 50% dry rubber latex (K_2) on the surface and vermicompost significantly affected the number of tillers per clump. The best treatment was the application of 75% dry rubber latex (K_3).

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