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Effect of Organic Mulches on Weed Dynamics and Productivity of Super Napier Grass

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ABSTRACT

Background: The current practice of weed control in grass planting relies on the use of inorganic materials. This approach has the potential to damage the environment and is an inefficient method for controlling weeds in the cultivation of Super napier grass. This study aims to examine the use of organic mulch as a means of controlling weeds in the cultivation of forage, particularly Super napier grass.

Methods: The experiment employed a randomized block design with four treatments and five replications. The treatments were as follows: no mulch (NM) served as the control treatment, rice straw mulch (RSM), rice husk mulch (RHM) and sawdust mulch (SDM). Each of these treatments was plotted with 3.5 m × 2.8 m in size. The experiment was conducted during the summer season, from April to September 2023, in Macorawalie, Panca Rijang, Sidenreng Rappang, South Sulawesi, Indonesia. The observed parameter consisted of fresh weight, dry matter, growth, production and chemical soil.

Result: The experimental results revealed that the use of organic mulch resulted in significant effect on soil chemical properties as it was proven to increase the N and C-organic contents of the soil. Sawdust mulch resulted in significant decrease in weed population as compared to other treatments of organic mulch.

Key words: Organic mulching, Super napier grass, Weed control, Weed dynamic.

INTRODUCTION

Super napier grass, known as pakchong grass, becomes one of the superior forage grasses with high genetic variability and high productivity available throughout the year (Khaerani *et al.,* 2024; Mohamad *et al.,* 2022). Compared to other varieties, the nutrient content and productivity of this grass are among the highest obtained at early harvest, 45 days after planting (Bangprasit *et al.,* 2017). However, forage productivity can decline due to various biological factors, including plant diseases, insect pests and weeds. The presence of weeds can reduce the quality of the cultivated grass, as the absorption of nutrients in the grass competes with the weeds (Zhang *et al.,* 2018).

To control weeds, farmers typically use physical methods by pulling weeds growing around crops. However, this method could be more efficient because it requires a lot of time and energy. Meanwhile, the use of chemicals in the form of herbicides is not recommended because they contain toxins that are harmful to livestock and can increase the cost of maintenance (Utamy *et al.,* 2012). Therefore, the application of organic weed control, such as the use of cover crops or mulch, is necessary. One of the recommended techniques for suppressing weed growth and development is mulching. Mulch can be applied to the soil surface by using organic materials (Telkar *et al.,* 2017).

The materials used as organic mulch are affordable, available and environmentally friendly (Thakur and Rakesh, 2021). Previous study, organic mulch in the form of rice straw, rice husk and sawdust has been applied to tomato cultivation and has been proven to be able to control weeds and provide positive results on the main crop (Sharma *et al.,* 2023). However, studies on the use of organic mulches in the cultivation of forage crops, mainly Super napier grass, remain limited. Therefore, this study was carried out to analyze the effects of weed control using various organic mulches on weed dynamics and productivity of Super napier grass.

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MATERIALS AND METHODS

Study site

This experiment was conducted from April to September 2023 in Macorawalie, Panca Rijang, Sidenreng Rappang, South Selatan, (3°50′44.22″S 119°48′44.65″E), Indonesia. The study was conducted during the dry season with rainfall of 50-100 mm/month (below normal), average temperature of 33°C and average humidity of 48.75%.

Land preparation and experimental design

The experimental plot was arranged in a size of 17 m ×18 m (306 m^2). Before planting, the area was cleaned and plowed. Subsequently it was divided into 20 plots, each plot measuring 3.5 m × 2.8 m, with a distance of 1 m between plots (Fig 1). Organic mulches of rice straw, rice husk and sawdust were applied to each plot 1 day before planting with a thickness of 5 cm above the soil surface. Subsequently, super napier grass cuttings of 25 cm stem length (3 internodes, 2 nodes) were planted at 70 cm × 70 cm spacing (Fig 1). Each plot contained 20 elephant grass cuttings. This study was conducted according torandomized block design with 4 treatments and 5 replications (Gomez and Gomez, 2007). The treatments were as follows: no mulch (NM) served as the control treatment, rice straw mulch (RSM), rice husk mulch (RHM) and sawdust mulch (SDM). All plots were leveled 14 days after planting by mowing the grass at a height of 10 cm above the soil surface.

Measurement and sampling

Measurements and sampling of Super napier grasss were carried out at 60 days after planting. Measurements were made by randomly selecting 10 Super napier grass plants for each plot and each treatment. Disturbed soil samples were collected before treatment and 60 days after treatment at depth of 0-20 cm and then taken to the laboratory for analysis of chemical contents (pH, C, N and C/N). The nitrogen content was measured using the Kjeldahl method, whereas the C-Organic content was determined using the Walkley and Black method. The observed parameters include growth characteristics such as plant height, stem length, stem diameter, leaf length, leaf width, number of leaves, number of tiller fresh weight and dry matter post harvested. In weed parameters were observed such as weed index and weed control efficiency. The examination of weed populations involved observing and recording the number of weeds thriving in each treatment plot, followed by cutting and weighing them to determine their weight.

Statistical analysis

The collected data were analyzed using one-way analysis of variance (ANOVA) to examine the effects of treatments. The IBM SPSS 27 application (IBM Corp. Armonk, NY, USA) was used to conduct the least significant difference (LSD) test and find any significant differences between treatments ($p \leq 0.05$).

RESULTS AND DISCUSSION

Soil chemical properties

Data from the chemical analysis of soil, namely pH, C, N and C/N ratio before treatment and 60 days after treatment with organic mulches are presented in Table 1.

Soil pH

The results of the statistical analyses demonstrated that soil acidity (pH) in treatments with RSM, RHM and SDM were not significantly different ($p > 0.05$) from control (NM). As shown in Table 1, there is a slight increase in soil pH value after the application of organic mulch from rice straw, rice husk and sawdust as compared to control, where the average acidity level is pH 6. A stable soil pH value is around 7.0 (Pan *et al.,* 2014), while a pH below 7 is acidic and a pH above 7 is basic or alkaline. Most plants require pH between 5.5 and 7.0, but some other plants can grow and adapt beyond the optimum pH (Salahudeen and Sadeeq, 2018). Soil acidity (pH) is directly and indirectly affected by changes in soil communitystructure (Zhang *et al.,* 2021) in the form of nitrogen fixation, ammonification, nitrification and denitrification with the participation of certain microorganisms (Hasan *et al.,* 2019).

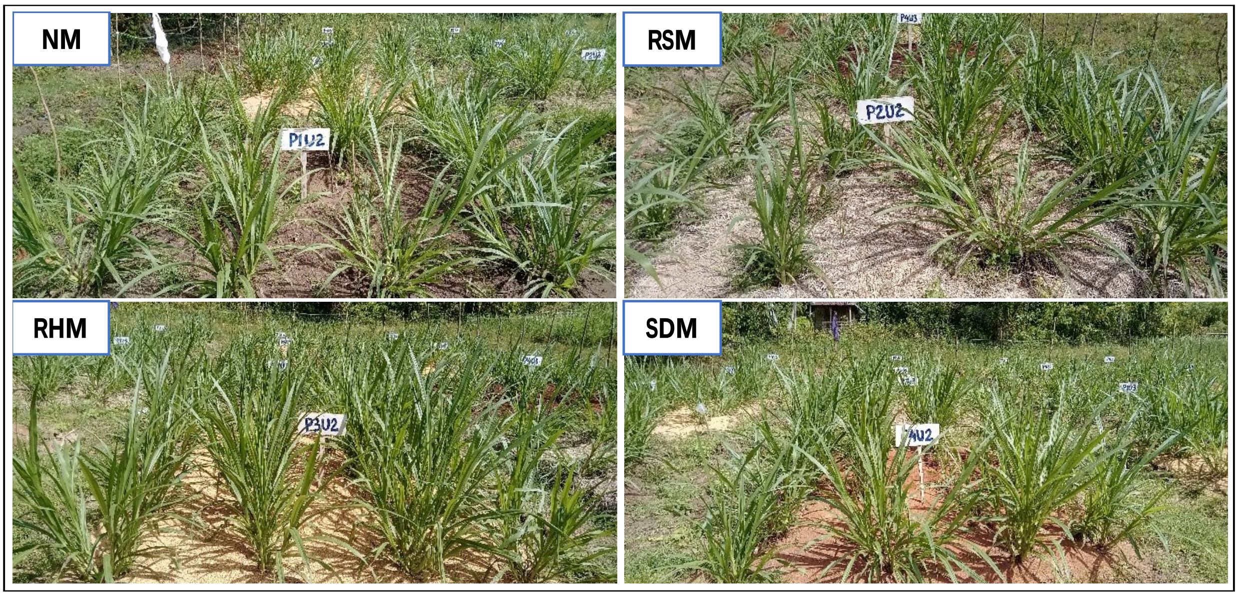

Fig 1: Super napier grass treated with no mulch (NM), rice straw mulch (RSM), rice husk mulch (RHM) and sawdust mulch (SDM).

Carbon (C)

Based on the statistical analyses, the average C content of the soil (Table 1) in treatments with RSM, RHM and SDM resulted in significant different results ($p<0.05$) as compared to control (NM), organic mulch with rice straw, rice husk and sawdust can increase the C content of the soil. This increase is influenced by organic matter from mulch containing carbon which can be utilized by soil microbes. Among all mulches sawdust takes the longest time decompose because of its high C/N ratio and nutrient status. These findings confirm by Peera *et al.* (2020) reported that sawdust contains high amounts of carbon and nitrogen and is prone to clumping, making it take long time to decompose compared to other mulch materials. According to Bajoriene *et al.* (2013), organic mulches in the form of sawdust and rice straw are able to increase the C-organic content of the soil. Lalruatsangi *et al.* (2018) also stated that organic mulches from rice straw and rice husk also contain carbon that can increase the population of soil microbes such as bacteria and fungi. C-organic content contributed to the soil in the decomposition process of organic mulch can help to improve soil structure.

Nitrogen (N)

The average N content value of the soil (Table 1) indicates that treatment with SDM is significantly different ($p<0.05$) from control (NM), whereas treatments with RSM and RHM are not significantly different ($P>0.05$). Data presented in Table 1, indicated that the average N content in the sawdust mulch treatment is higher than control. The rice straw and rice husk mulch treatments also demonstrates slightly higher average value than the control, although not statistically different. The organic matter content of the mulch resulted in the nitrogen level of the soil through microorganisms. These results corroborate with the findings of Paunovic *et al.* (2020) found that soil treated with sawdust mulch increase humus content (1.0%) and N content (0.05%). Korkanç *et al.* (2021) also reported that organic mulch can affect soil nutrients and effectively prevent nutrient deficiencies and improve nitrogen availability.

C/N ratio

The results of the statistical analyses showed that the C/N content (Table 1) in treatments with RSM, RHM and SDM was not significantly different ($p>0.05$) from the control (NM), with the average C/N content in all organic mulch treatments being slightly higher than the control. Carbon and nitrogen contents are the main components of organic matter for soil fertility (Swangjang, 2015). The quality of organic matter is determined by the ratio of carbon to nitrogen (C/N ratio) which is related to the utilization of organic N by plants as mineral N. After the decomposition of organic matter, soil microorganisms use nitrogen for enzyme production and growth. Abbasi *et al.* (2015) revealed that the mineralization process of nitrogen can occur at a C/N ratio below 15, while N inhibition occurs if the C/N ratio is above 25. The C and N content and lignin in the soil are the main drivers of the C/N ratio which affects soil quality, soil biology and the activity of decomposing microbes (Mueller *et al.,* 2015). Therefore, the selection of raw materials for organic mulching must pay attention to the C/N ratio, which ranges from 30:1 to 80:1 without acidic or alkaline, non-toxic and abundant materials (Peera *et al.,* 2020).

Effects of organic mulches on weeds

Table 2 showed data pertaining to weed population, fresh weight and dry matter across all treatments, wherein treatments involving RHM and SDM exhibit statistically significant differences ($P<0.05$) from the control treatment

Table 1: Soil chemical analysis before and after application of organic mulches.

Parameters	Before mulching	After mulching			
		NM	RSM	RHM	SDM
pH	5.83	5.92±0.20	6.21±0.18	6.16±0.46	6.15±0.35
Carbon (%)	1.03	1.59±0.10	2.01±0.29*	2.21±0.32*	2.31±0.21*
Nitrogen (%)	0.10	0.15±0.01	0.17±0.03	0.19±0.03	0.21±0.04*
C/N	9.4	10.4±0.89	11.2±1.64	12±2.73	11±1.41

*Means value (Mean±SD) are significantly different at P<0.05.

Table 2: Effects of organic mulches on weeds.

Parameters	Treatment			
	NM	RSM	RHM	SDM
Fresh weight (kg/plot)	3.34±1.23	1.11±0.51*	0.51±0.15*	0.37±0.15*
Dry matter (kg/plot)	0.99±0.33	0.39±0.18*	0.18±0.04*	0.16±0.09*
Weed population (plant/plot)	2815±787.22	634±175.04*	497±215.09*	259±165.87*
Weed index (%)		60.61	81.82	83.84
Weed control efficiency (%)		66.77	84.73	88.92

*Means value (Mean±SD) are significantly different at P<0.05.

(NM). The average values of weed population, fresh weight and dry matter in plots treated with rice straw, rice husk and sawdust mulches were lower than those without mulch. This proves that organic mulch can suppress the growth of weeds around Super napier grass plants. These findings support previous studies which have proven that straw mulch and other organic mulches are successful in controlling weeds in the cultivation of lentil and other crops (Verma and Pradhan, 2024; Rhioui *et al.,* 2023) and blocking the light that weeds need for photosynthesis (Iqbal *et al.*, 2020).

The results showed that the highest percentage of weed index and weed efficiency control was found in the SDM treatment (Table 2). Organic mulch is able to suppress weeds, as shown by the percentage of weed index and weed efficiency in the control, which reached 83% and 88.92%, respectively, especially in the SDM treatment. According to Kumar *et al.* (2021), Organic mulch is effective in reducing weed growth with an average organic mulch weed efficiency control of 70% and resulted better crop growth. Organic mulch are effective alternatives for suppressing weed growth by 70-95% and tilling the soil between crops without using chemicals (Mairata *et al.,* 2023).

Effects of organic mulches on the growth of super napier grass

Table 3 shows that the plant height and stem length of Super napier grass in plots treated with RSM, RHM and SDM are significantly different ($p<0.05$) from the control (NM). Organic mulch maintain water content, prevent evacuation and increase soil nutrients, thus helping the growth of Super napier grass. These findings are in line with the results of Utamy *et al.* (2012) reported that weed control management resulted in significant effect on plant height and tiller density of dwarf Napier grass. Another study by Thakur and Rakesh (2021) also found that organic mulch increase plant height. In this study, the average plant height was found to be higher at 60 days after treatment, where RHM recorded significantly highest forage yield which was followed by highest yield, followed by RSM and SDM, while the lowest yield was obtained from the control (NM).

Data on the length and width of Super napier grass leaves in Table 3 showed that treatments with RSM, RHM and SDM are significantly different ($p <0.05$) from the control (NM). This indicates that these organic mulches influence the growth of Super napier grass. In line with Verma *et al.* (2022) stated that organic mulch treatment produces plants with excellent growth rates in higher average plant height and dry weight compared to the control. According to Shashikanth *et al.* (2022), organic mulch can improve growth attributes since it helps maintain soil water content, allowing the plant to absorb water. Mulch also prevents soil erosion and has a good impact on soil microbes, nutrient balance and plant growth (Iqbal *et al.,* 2020).

As displayed in Table 3, the results of the analysis of the number of leaves are not significantly different ($p>0.05$) in all treatments, with the highest average number of leaves obtained in the RHM treatment. These findings confirm the results of a study by Ikhsan *et al.* (2022) that treatment with rice straw mulch does not significantly influence the number of leaves of the plant. The results of another study by Pangaribuan *et al.* (2023) also indicate significant impact of rice straw mulch and cow urine on plant height, number of leaves, leaf greenness and N nutrient uptake. The number of tillers in plots treated with RSM and RHM is higher than those treated with SDM and NM. Treatment with sawdust mulch results in a smaller number of tillers because the hardened sawdust inhibits the growth of some tillers. This is in line with Peera *et al.* (2020) stated that sawdust contains high amounts of carbon and nitrogen which makes it easy to harden. In contrast, the results of Utamy *et al.* (2012) showed that the number of tillers increased significantly over time with paper mulch. Yang *et al.* (2020) also reported that mulching wheat plants can increase the number of tillers, as evidenced by the higher tillering capacity (TC) in mulch-treated plots compared to untreated plots.

Effects of organic mulches on the production of super napier grass

As shown in Table 4, the average fresh weight production of Super napier grass (kg/plot) is not significantly different in all treatments, with the fresh weight of stems in plots treated with RHM, RSM and SDM being higher than the control (NM). Meanwhile, the fresh weight of leaves in the RHM treatment shows significant difference compared to control (NM). The production of fresh weight and dry matter

Table 3: Effects of organic mulches on the growth of Super napier grass.

Parameters	Treatment			
	NM	RSM	RHM	SDM
Plant height (cm)	222.6±8.29	248.8±10.98*	256.4±15.94*	241±22.17
Stem length (cm)	99.8±10.68	122.8±8.73*	131.6±11.01*	117.1±11.9*
Stem diameter (cm)	1.96±0.08	2.10±0.12*	2.18±0.21	2.12±0.17
Leaf length (cm)	101.2±5.35	111.8±9.68*	110.7±5.45*	109.3±3.27
Leaf width (cm)	3.7±0.20	4.3±0.70*	4.2±0.21*	4±0.21
Number of leaves (blade/clump)	84.8±9.65	83.6±15.32	91.4±5.27	81.6±26.88
Number of tillers (plant/clump)	14.8±2.95	15.4±3.51	16.6±1.34	14±4.89

*Means value (Mean±SD) are significantly different at $P<0.05$.

Table 4: Effects of applying organic mulches on the production of Super napier grass.

Parameters	Treatment			
	NM	RSM	RHM	SDM
Fresh weight (kg/plot)				
Stem	36.1±12.40	42.41±8.06	50.13±6.14	47.84±20.49
Leaves	14.78±3.18	18.14±3.13	19.44±1.56*	17.08±3.95
Dry matter (kg/plot)				
Stem	10.21±3.87	13.03±2.36	14.39±3.51	12.42±5.13
Leaves	3.98±1.07	4.69±2.08	4.49±0.73	4.27±1.36
Leaf stem ratio	0.42±0.14	0.35±0.11	0.33±0.11	0.36±0.08

*Means value (Mean±SD) are significantly different at $P<0.05$.

of Napier grass increases as the plant ages (Samarawickrama *et al.,* 2018). The biomass production yield of Super napier grass aged 70 days is 60 tons/ha (Liman *et al.,* 2020).

The results of the dry matter of the stems and leaves of Super napier grass are not significantly different in all treatments (Table 4). The dry matter production of the stems and leaves of Super napier grass in the RSM, RHM and SDM treatments is found to increase, even though not significantly different from the control (NM). Increase in the dry matter of Super napier grass is influenced by the contribution of mulch organic matter which can increase soil nutrients through decomposition by soil microorganisms. In addition, mulch can retain soil moisture and suppress weed growth around plants, positively affecting the main crop. Even though it is not commonly used in the cultivation of grass, the use of mulch in controlling weeds have positive impact on the growth and dry matter content of dwarf Napier grass (Utamy *et al.,* 2014). The dry matter of Napier grass will increase as the plant and the accumulation of fibrous tissue and cell wall structures increases (McDonald *et al.,* 2022). Dry matter production is a vital indicator of forage production as it is considered a representation of all processes and events that occur in plant growth (Budiman *et al.,* 2012).

CONCLUSION

The conclusion of this study was that the sawdust treatment (SDM) showed the best effect on soil chemistry and weed control. Conversely, the rice husk treatment (RHM) showed the best results on the growth and productivity of Super napier grass. This research provides a valuable reference for the control of pests on Super napier grass through the use of environmentally friendly organic mulches.

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Conflict of interest

All authors declared that there is no conflict of interest.

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