

Growth And Yield of Two Varieties of Sorghum (*Sorghum bicolor* L. Moench) Through Rice Husk Organic Fertilizer Application

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Abstract

*The study aims to determine the effect of organic rice husk fertilizer on the growth and yield of sorghum plants (*Sorghum bicolor* L. Moench). This study used a Randomized Block Design (RBD) with the first factor being sorghum plant varieties (V) consisting of 2 levels: the Numbu variety and the Kawali variety. The second factor was rice husk fertilizer (P) consisting of 3 levels: no fertilizer (control). 25 tons ha⁻¹ of rice husk fertilizer. and 50 tons ha⁻¹ of rice husk fertilizer. repeated 3 times. The results of the study showed that there was an interaction between the treatment of variety type and organic fertilizer dose on the parameters of plant height. number of leaves and seed weight of sorghum planting and there was no interaction on panicle length. but singly the treatment of variety type and organic fertilizer dose did not provide a significant effect on the parameters of plant height. number of leaves and panicle length. but did provide a significant effect on sorghum seed weight. The best sorghum plant production results were found in the treatment of the Numbu variety type with an organic fertilizer dose of 50 tons ha⁻¹.*

Keyword: Rice Husk Fertilizer. Numbu Variety. Kawali Variety. Sorghum Plants

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is an important cereal crop with significant potential as a source of food, feed, and energy. This crop is known for its good adaptation to dryland conditions and drought stress, making it a strategic choice for food diversification, especially in areas with limited rainfall (Rooney, 2019). However, to achieve optimal productivity, adequate nutrient availability is key. Nutrient limitations in the soil, particularly in drylands that are generally poor in organic matter, are often a major constraint in sorghum

cultivation (Al-Ahmadi et al., 2021).

Rice husks, a common agricultural waste product, have great potential to be processed into organic fertilizer. A study by Rasyid et al. (2020) found that rice husks contain macronutrients like potassium (K) and silica (Si), which are vital for plant growth. These components can improve soil structure, increase the cation exchange capacity, and enhance the availability of water and nutrients for plants. Utilizing rice husks as organic fertilizer also offers a solution for reducing agricultural waste and supports the concept of sustainable agriculture.

Various sorghum varieties exist, each with different characteristics and yield potentials. Numbu and Kawali are two superior local varieties that have been officially released by the government. The Numbu variety is known for its high tolerance to drought and large biomass production, while the Kawali variety is distinguished by its high grain yield (Pramono et al., 2021). The combination of using organic fertilizer from rice husks with these superior varieties is expected to optimize sorghum growth and yield.

The objectives of this study are to determine the effect of organic fertilizer doses from rice husks and two sorghum varieties and their interactions on sorghum growth and yield, and to determine which treatment will have the best effect on sorghum growth and yield.

METHOD

Research Location

This research was conducted in Iloheluma Village, Tilongkabila District, Bone Bolango Regency, Gorontalo Province, from June to October 2021.

Materials dan Tools

The materials used in this study were sorghum seeds, rice husks, fine bran, EM4, molasses, and water. The tools used in this study consisted of hoes, shovels, measuring tape, stationery, stakes, raffia rope, scales, colored HVS paper, and a camera.

Research Methods

This study used a 2-factor Randomized Block Design (RBD) with 6 treatment combinations. Each treatment was repeated 3 times to obtain 18 experimental units. One experimental unit was a plot measuring 2.5 m × 1.5 m and a planting distance of 75 cm × 25 cm so that there were 24 plants in 1 experimental unit. The variety treatments used in this study were: V1 = Numbu Variety, and V2 = Kawali Variety. The organic fertilizer treatments used in this study were: P0 = Control/without organic fertilizer, P1 = Organic fertilizer 25 tons ha⁻¹ = 9.375 kg

plot⁻¹. P2 = Organic fertilizer 50 tons ha⁻¹ = 18.75 kg plot⁻¹. The treatment combinations obtained were:

- V1P0 = Numbu variety without organic fertilizer
- V1P1 = Numbu variety + 25 tons ha⁻¹ of organic fertilizer
- V1P2 = Numbu variety + 50 tons ha⁻¹ of organic fertilizer
- V2P0 = Kawali variety without organic fertilizer
- V2P1 = Kawali variety + 25 tons ha⁻¹ of organic fertilizer
- V2P2 = Kawali variety + 50 tons ha⁻¹ of organic fertilizer

Research Procedures

- Organic Fertilizer Preparation

Rice husk fertilizer is prepared by gathering all the ingredients: 150 kg of rice husks mixed with 32 kg of rice bran. Then, sprinkle with 350 ml of EM4 solution, 40 tablespoons of sugar, and sufficient water. Make a mound 20-30 cm high. Ensure the rice husk fertilizer is moist but not too wet. Then, cover tightly with a sack for two weeks. Remember to break up the fertilizer to prevent the temperature from exceeding 45-65°C.

- Land Preparation

Land preparation is carried out by plowing or breaking up the soil and clearing any remaining weeds. This is followed by the creation of 18 experimental plots measuring 2.5 m x 1.5 m with a spacing of 75 cm x 25 cm, so that each plot contains 24 plants.

- Organic Fertilizer Application

Rice husk fertilizer is applied to the soil at treatment doses of 0, 25, and 50 tons/ha, mixed directly and evenly with the soil a week before planting.

- Planting

Planting is carried out using the digging method, with 2-3 sorghum seeds planted in each hole at a depth of no more than 5 cm until a total of 24 plants are planted in one experimental unit. These plants are then covered with light soil or organic fertilizer.

- Maintenance

Plant maintenance includes watering, weeding, and pest and disease control. Watering is carried out when the plants are lacking water. Weeding is then carried out by carefully removing weeds down to the roots to avoid disturbing the sorghum roots. Pest and disease control is carried out if the plants show symptoms of attack. The method and timing of control depend on the type of pest and disease affecting them.



- Harvesting

Sorghum plants are harvested 80-100 days after planting. Determining the time for harvesting sorghum can also be seen from the physiological aspect of hard and mature seeds. Harvesting is carried out when the leaves have turned yellow and dried by cutting the panicle stalk 25-20 cm from the base of the panicle. It is then dried in the sun and threshed.

- Observation Variables

- Plant Height (cm)

Plant height was measured from the base of the stem (ground level) to the highest point of the plant using a measuring tape in centimeters (cm). Measurements were taken after the plants were 7 days after planting, followed by weekly measurements until the plants were 77 days after planting.

- Number of Leaves (leaflets)

The number of leaves was counted on each plant sample. Leaf counts began when the plants were 7 days after planting. Leaf counts were continued weekly until the plants were 77 days after planting.

- Panicle Length (cm)

Panicle length was measured after harvest. Panicle length was measured using a ruler from the base of the panicle to the tip of the panicle. Panicle length was measured from the longest panicle in each sample.

- Seed Weight (grams/plant)

Seed weight was measured by weighing the sorghum seeds in each sample plant using an analytical balance.

- Seed Weight (kg/plot)

Seed weight was measured by weighing the sorghum seeds in each plot after separating them from the panicles in grams.

- Seed Weight (tons/hectare)

Seed weight was measured by weighing the sorghum seeds per hectare of plants after separating them from the panicles in kilograms.

Data Analysis

Data analysis was performed using Analysis of Variance (ANNOVA). If the calculated F value was greater than the table F value, further testing with LSD at the 5% level was conducted.



RESULTS AND DISCUSSION

Plant Height (cm)

The analysis of variance results showed that during the 14-day after planting observation period. organic fertilizer treatment significantly affected plant height. while during the 7-day after planting observation period. 21-77 days after planting. it had no significant effect. The average sorghum plant height based on variety type and organic fertilizer dose. as well as the interaction between the two treatments. are presented in Tables 1 and 2.

Table 1. Average height of sorghum plants in the treatment of variety type and organic fertilizer dose

Treatment	Plant Height (cm)				
	7 DAP	14 DAP	21 DAP	35 DAP	42 DAP
Type of Variety					
Numbu	14.96	29.30	48.87	102.90	142.39
Kawali	13.06	26.52	41.85	99.02	120.91
LSD Test 5%	-	-	-	-	-
Organic Vertilizer Dosage					
Control	9.15	17.0 9a	29.73	62.39	75.38
25 ton ha⁻¹	9.62	21.57b	33.12	71.31	96.52
50 ton ha⁻¹	9.24	17.17a	27.88	68.21	91.40
LSD Test 5%	-	0.79	-	-	-

Note: Numbers in a column followed by different letters indicate significant differences based on the 5% LSD test.

DAP = Days After Planting; LSD = Least Significant Different

Table 1 shows that the single variety treatment did not affect the height of sorghum plants. nor did the organic fertilizer treatment. except at 14 days after planting. During the 14 days after planting observation period. the highest average sorghum plant height was 21.57 cm. found in the 25 ton ha⁻¹ organic fertilizer treatment. The lowest average sorghum plant height was found in the control treatment. at 19.09 cm. Plant height is supported by the availability of N. P. and K in the soil.

Nitrogen (N) is an essential nutrient that is very important for vegetative growth. including stem and leaf formation. N is a major component of protein. nucleic acids. and

chlorophyll. Adequate N availability will encourage cell division and cell elongation, which directly increases plant height (Hussain et al., 2019). Phosphorus (P) plays an important role in energy transfer, photosynthesis, and cell division. P is also essential for strong root development, which in turn improves water and nutrient uptake, including N and K. Potassium (K) plays a role in osmotic regulation, enzyme activation, and water and nutrient transport within the plant. Adequate K availability will make cells more turgid and stems stronger, thus supporting plant growth. Rice husk organic fertilizer at a dose of 25 tons ha⁻¹ likely provided better N, P, and K availability than the control treatment (without fertilizer), thus promoting optimal plant growth in the initial phase.

Table 2. Average height of sorghum plants in the treatment of variety type and organic fertilizer dose based on interaction

Observation Time	Type of Variety	Organic Fertilizer Dosage			LSD 5%
		Control	25 ton ha ⁻¹	50 ton ha ⁻¹	
28 DAP	Numbu	40.38b	55.94f	52.93e	2.14
	Kawali	46.80d	43.74c	33.78a	
56 DAP	Numbu	102.83a	155.72e	180.29f	4.02
	Kawali	136.13d	115.48b	127.55c	
63 DAP	Numbu	114.28a	170.26e	190.02f	4.03
	Kawali	145.69d	125.99b	138.32c	
70 DAP	Numbu	126.16a	189.08e	195.87f	4.00
	Kawali	160.13d	134.08b	152.66c	
77 DAP	Numbu	139.38a	202.30e	204.03e	4.04
	Kawali	172.63c	148.94b	163.71d	

Note: Numbers in columns and rows followed by different letters indicate significant differences based on the 5% LSD test.

DAP = Days After Planting; LSD = Least Significant Different

Table 2 shows an interaction between variety type and rice husk organic fertilizer dosage at 28 DAP, 56 DAP, 63 DAP, and 77 DAP. Generally, the best interaction was found with the Numbu variety with an organic fertilizer dosage of 50 tons ha⁻¹, and the lowest interaction was found with the Numbu variety with the no-fertilizer treatment. This interaction fundamentally reflects differences in genotypic response to the environment. Each variety has unique genetic characteristics that influence its ability to absorb and utilize nutrients from the environment

(organic fertilizer treatment). Varieties that are genetically more efficient at absorbing nutrients from organic fertilizer will exhibit better growth than less efficient varieties, especially at optimal fertilizer dosages.

The best interaction, generally found with the combination of the Numbu variety with an organic fertilizer dosage of 50 tons ha⁻¹, indicates that the Numbu variety has excellent responsiveness to increased nutrient availability from rice husk organic fertilizer. At a dose of 50 tons ha⁻¹, the availability of macronutrients (especially N, P, and K) and micronutrients has reached optimal conditions to support sorghum vegetative growth. Literature support shows that organic fertilizers, such as rice husks, work synergistically with the soil to improve the physical, chemical, and biological quality of the soil (Laila et al., 2021). Increased nutrient availability, improved soil structure, and increased microbial activity collectively create an ideal growing environment. The Numbu variety likely has a strong and efficient root system that can explore a larger soil volume, thus maximizing the available nutrients from this high dose of organic fertilizer.

Number of Leaves (Blades)

The analysis of variance results showed that the variety treatment alone had no significant effect on the average number of plant leaves. However, the organic fertilizer dose treatment had a significant effect on the average number of leaves only during the 28-day observation period. The average number of sorghum leaves is presented in Table 3.

Table 3. Average number of leaves of sorghum plants in the treatment of variety type and organic fertilizer dose

Treatment	Number of Leaves (Blades)				
	7 DAP	28 DAP	49 DAP	63 DAP	77 DAP
Type of Variety					
Numbu	4.83	11.31	16.08	18.33	19.04
Kawali	4.63	11.59	16.55	19.90	20.55
LSD Test 5%	-	-	-	-	-
Organic Fertilizer Dosage					
Control	2.07	4.69a	6.97	8.41	8.72
25 ton ha ⁻¹	2.14	5.38b	7.53	8.40	8.51
50 ton ha ⁻¹	2.10	5.20b	7.26	8.68	9.17

LSD Test 5%	-	0.33	-	-	-	
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Note: Numbers in a column followed by different letters indicate significant differences based on the 5% LSD test.

DAP = Days After Planting; LSD = Least Significant Different

Table 3 shows that the variety type and organic fertilizer dosage did not significantly affect the number of leaves, except for the organic fertilizer dosage observed 28 days after planting. In the fertilizer dosage treatment, it can be seen that the organic fertilizer dosage of 25 tons ha⁻¹ produced the highest average number of sorghum leaves compared to the control treatment, but was not significantly different from the 50 tons ha⁻¹ treatment. This is because the addition of organic fertilizer can increase nutrients in the soil, so that the assimilates produced by photosynthesis are also high. This causes leaf formation to be faster than in the control treatment. The nutrients needed for leaf growth are available at this treatment dosage. The release of nutrients in organic fertilizer occurs slowly (slow-release).

The role of slow-release nutrient delivery in plant growth is significant, particularly in maintaining a stable and sustainable nutrient supply. With a constant supply of nutrients, plants can avoid nutrient deficiencies or excesses that can inhibit growth. For example, a stable nitrogen supply is crucial for protein and chlorophyll synthesis, which are the foundation of photosynthesis and vegetative growth. Research by Adnan et al. (2021) shows that the use of slow-release fertilizers can increase plant biomass, plant height, and leaf area compared to conventional fertilizers. Furthermore, the controlled release of nutrients also stimulates the development of stronger and healthier root systems, allowing plants to absorb water and nutrients more efficiently from a larger soil volume. Ultimately, this strategy not only optimizes plant growth and productivity but also contributes to more sustainable agriculture by reducing the frequency of fertilization and minimizing environmental pollution.

Panicle Length (cm)

The results of the analysis of variance showed that the treatment of variety type and organic fertilizer dosage did not have a significant effect on panicle length. There was also no interaction between the two treatments. The average panicle length for the treatment of variety type and organic fertilizer dosage can be seen in Table 4. Table 5 shows that there was no interaction between the treatment of variety type and organic fertilizer dosage. Individually, the treatment of variety type and organic fertilizer dosage did not have a significant effect on panicle length growth. According to Andriani and Isnaini (2013), this occurs because during flower and

seed formation, all nutrients and water are utilized by plants to form carbohydrates so they do not affect panicle length.

Table 4. Average panicle length of sorghum plants in the treatment of variety type and organic fertilizer dose

Treatment	Panicle Length (cm)
Type of Variety	
Numbu	24.17
Kawali	27.30
LSD Test 5%	-
Organic Fertilizer Dosage	
Control	10.66
25 ton/ha	11.27
50 ton/ha	12.38
LSD Test 5%	-

There is no effect of organic rice husk fertilizer on sorghum panicle length can be scientifically explained by several factors, although organic fertilizers generally play an important role in soil fertility. Rice husks, while containing essential nutrients, have a relatively low nutrient composition and release nutrients very slowly. The nitrogen (N), phosphorus (P), and potassium (K) content in raw rice husks is much lower than that of other organic fertilizers such as manure or compost (Prasetyo & Suryantini, 2019). Furthermore, most of the nutrients in rice husks are bound in complex compounds such as cellulose and lignin, which are difficult for soil microorganisms to break down. This slow decomposition process causes nutrient release to be out of sync with the critical phases of sorghum growth, particularly during panicle formation and filling. During this generative phase, plants require rapid and adequate nutrient availability. If nutrient availability, particularly N and P, is insufficient, panicle initiation and panicle elongation will be inhibited, resulting in no significant difference in panicle length between plants treated with rice husks and the control (unfertilized) crop.

Although rice husks are known to improve soil physical properties such as aeration and water retention, their effect on sorghum panicle length may be indirect. Improvements in soil physical properties require a long time and large doses to have a significant impact on plant growth. On a limited scale or within a single growing season, changes in soil physical properties due to the application of raw rice husks may not be optimal (Setyorini et al., 2020). If the soil

conditions at the research site already have good physical properties, the addition of rice husks will not have a significant effect. Furthermore, environmental factors such as adequate water availability from irrigation or rainfall are also key determinants of panicle length. When water availability is optimal, the role of rice husks in increasing water retention becomes less crucial, resulting in no visible difference in sorghum panicle length. This indicates that the effect of organic rice husk fertilizer on panicle growth can be overshadowed by other more dominant factors.

Seed Weight

The results of the analysis of variance showed that the treatment of variety type and organic fertilizer dose significantly affected the parameters of seed weight per plant (g), seed weight per plot (kg), and seed weight per hectare (tons). The average value of sorghum seed weight based on fertilizer treatment and variety is presented in Table 5.

Table 5. Average weight of sorghum seeds in the treatment of variety type and organic fertilizer dose

Treatment	Seed Weight Per Plant (g)	Seed Weight Per Plot (kg)	Seed Weight Per Hectare (ton)
Variety of Type			
Numbu	95.17b	1.87b	4.99b
Kawali	72.63a	1.60a	4.26a
LSD 5%	7.01	0.12	0.33
Organic Fertilizer Dosage			
Control	27.36a	0.67a	1.78a
25 ton ha⁻¹	42.25b	0.77a	2.05a
50 ton ha⁻¹	42.25b	0.88ab	2.34b
LSD 5%	5.72	0.10	0.27

Note: Numbers in a column followed by different letters indicate significant differences based on the 5% LSD test.

DAP = Days After Planting; LSD = Least Significant Different

The data in Table 5 shows that the Numbu variety has a higher seed weight than the Kawali variety. The seed weight per Numbu variety is 95.17 g, the seed weight per plot is 1.87



kg, and the seed weight per hectare is 4.99 tons. This difference in seed weight is due to the differences in seed size produced by each variety. High-quality seeds can be determined by several factors, including genetic and physical factors. Genetic factors include varieties with good genotypes, such as high production, resistance to pests and diseases, and responsiveness to better growing conditions (Samanhudi et al. 2020). Regarding organic fertilizer doses, it can be seen that the 50 ton ha⁻¹ fertilizer treatment provided the best results in terms of seed weight per plot and per hectare compared to the 25 ton ha⁻¹ treatment and the control treatment. Further testing with a 5% BNT showed no significant difference compared to the 25 ton ha⁻¹ treatment in terms of seed weight per plot and per hectare.

In terms of seed weight per hectare, the 50-ton ha⁻¹ organic fertilizer treatment yielded the best yield, at 2.34 tons, compared to only 1.78 tons in the control treatment. This was due to the higher NPK content in the organic fertilizer compared to the control treatment. The increase in yield per hectare can be attributed to increased nutrient availability and favorable climatic factors for plant growth during the generative phase. During this generative phase, plants require water and nutrients. During this phase, all photosynthesis is diverted to seed formation. According to Zubaidi et al. (2021), nutrients are needed to form proteins, carbohydrates, and amino acids, which are essential compounds for stimulating further seed development. Higher levels of protein, carbohydrates, and amino acids result in increased seed weight due to the high levels of these compounds in the seeds. Arvan and Aqil (2020) stated that the continuity of seed formation is influenced by the assimilation of photosynthesis and the remobilization of nutrients. The role of the nutrients Nitrogen and Phosphorus is translocated in the early generative phase and is supported by the nutrient Potassium in seed development.

CONCLUSION

1. There was an interaction between variety type and organic fertilizer dose on plant height and leaf number, but no interaction on panicle length and grain weight. However, both variety type and organic fertilizer dose had a significant effect on panicle length and grain weight of sorghum.
2. The best sorghum yield was found in the Numbu variety treatment with an organic fertilizer dose of 50 tons ha⁻¹.

REFERENCE

Andriani, A. dan Isnaini M.. 2013. Morfologi dan Fase Pertumbuhan Sorgum. Dalam Sumarno, Damardjati D. S., Syam M., dan Hermanto. 2013. Sorgum: Inovasi Teknologi dan





- Pengembangan. IAARD Press. Jakarta. Hlm.47.
- Adnan, S., Ashraf, M., Ghaffar, A., & Ahmad, M. (2021). Slow-release fertilizer improves growth and nutrient uptake of wheat under drought stress conditions. *Journal of Plant Nutrition*, 44(1), 1-13.
- Al-Ahmadi, M. J., Al-Amri, S. M., Al-Ghamdi, T. A., & Al-Qurashi, A. D. (2021). Effect of different organic amendments on soil properties, growth and yield of sorghum (*Sorghum bicolor* L.) under arid conditions. *Saudi Journal of Biological Sciences*, 28(3), 1957-1964.
- Hussain. S., Ma. J., Wang. Z., & Gao. Q. (2019). Roles of nitrogen and its assimilation in plant growth and development. *Journal of Plant Growth Regulation*. 38(1). 1-14.
- Laila, F. A., Arifin, M. D., & Purba, P. A. (2021). Pengaruh pemberian pupuk organik dari limbah pertanian terhadap sifat fisik dan kimia tanah. *Jurnal Ilmu Tanah dan Lingkungan*, 23(2), 1-8.
- Prasetyo, B., & Suryantini, R. (2019). Effect of Dosage and Application Method of Rice Husk Organic Fertilizer on the Growth and Yield of Sorghum (*Sorghum bicolor* L. Moench) Plants. *Journal of Tropical Crop Agronomy*, 1(2), 70-79.
- Pramono, E., Suparman, W., & Yuniarti, Y. (2021). Effect of GA3 (Gibberellin) Concentration and Soaking Duration on Post-Storage Germination of Sorghum (*Sorghum bicolor* (L.) Moench) Seeds. *Journal of Science Education Research*, 7(2), 263-269.
- Rasyid, A., Habibi, A., & Hariaji, I. (2020). Genotypic variability and relationships of Sorghum bicolor accessions from Java Island, Indonesia based on IRAP markers. *Biodiversitas*, 21(12), 5637–5643.
- Samanhudi, Puji Harsono, Eka Handayant, Rofandi Hartanto, Ahmad Yunus, Muji Rahayu, Syam Mahesa Iswara. 2020. Growth and Yield Response of Sweet Sorghum (*Sorghum bicolor* L.) to Organic Fertilizer Application in Dry Land. *Virtual National Seminar: Integrated Farming Systems for Farmer Empowerment*. Payakumbuh State Agricultural Polytechnic. Sorghum as Feed. Sam Ratulangi University, Manado.
- Setyorini, D., Husnain, & Dadi, A. (2020). The Effect of Organic and Inorganic Fertilizer Application on Sorghum Growth and Yield in Dry Land. *Journal of Soil and Climate*, 44(1), 1-10.
- Zubaidi, A., Suwardjindan W. Wangiyana. 2021. The Effect of NPK and Phytosan Fertilizer Application on Stem Brix Levels and Yield of Sorghum (*Sorghum bicolor* L. Moench) in Sandy Dryland Soil of North Lombok Regency, NTB. *Agros Agriculture*, 23(1): 157-166

