Hasanuddin J. Anim. Sci.Vol. 4, No. 1: 20-29
pISSN 2621-9182 eISSN 2621-9190
DOI:10.20956/hajas.v4ij.20594

The Effect of Manure Combination and Liquid Organic Fertilizer (LOF) on Livestock-Integrated Maize Farming Production (*Zea Mays L*)

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ARTICLE INFO

Article history:
Submission: April 3, 2022
Accepted: May 9, 2022
Published: May 22, 2022

ABSTRACT

This study aims to analyze the reaction in the doses of manure combination and liquid organic fertilizer and their response to the increase in farmer's revenue in a livestock-integrated farming system in Gorontalo. This study was performed in Gorontalo from March to July 2021. The study used a randomized block design with 2 factorials. The first factor is the cow manure dose, and the second factor is the liquid organic fertilizer dose. Data were analyzed using ANOVA and the Tukey Honest Significant Difference (HSD) test. The study results concluded that the most optimal cow manure dose was 10 tons/ha to produce maize at a rate of 5.70 tons/ha, and 20 cc/14 L liquid organic fertilizer was able to generate the most optimal production of 5.67 tons/ha. Integrating 10 tons/ha of cow manure with20 cc/14 L liquid organic fertilizer can generate the most optimal production amounting to 6.83 tons/ha.

Keywords: Integration, maize production, cow manure, liquid organic fertilizer

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INTRODUCTION

Intensive agricultural activity has caused environmental damage and a more devastating natural resource exploitation. This has contributed to serious environmental issues such as soil and water contamination due to excessive use of agricultural chemicals and soil erosion because of the conversion of forested land [1]; [2]. One emerging agricultural practice among the farmers in improving farming production and production rate is by applying an irrational quantity of chemicals that consequently promotes long-term land degradation [3]. A curative action in agricultural land management through eco-friendly and sustainable policy is considered necessary to deal with such challenges. One method to achieve a sustainable agricultural system is through eco-friendly farming and integrated crops livestock system [4]; [5].

Afifudding [6] reported that the implementation of integrated maize-ruminants farming could reduce annual crop fertilizer budget up to 47.78%/year and feed budget up to 8.87%/year. Recycling maize farming waste could support the implementation of integrated livestock-crop farming. The utilization of cow dung as liquid and solid organic fertilizer could reduce the harmful inorganic fertilizer use, and it could accelerate the adoption process of plant-integration technology at the farmer's level [7]; [8]. Cow manure could be reused as fertilizer to enrich soil nutrients. The used organic fertilizer may either be solid or liquid to improve the soil's physical and biological properties. Organic fertilizer contains more organic matter compared to its nutrient content [9]; [10].

Few previous studies have explicitly explained the development of livestock and crop commodity integration [11]; [12]; [13]; [14]. However, those studies did not involve the use of solid and liquid organic fertilizer. Therefore, this study will focus more on the integration of ruminants and corn crops. This study also attempted to observe the effect of treatment combination involving solid and liquid fertilizer from the perspective of parameter growth aspect and comparative analysis between organic and common NPK fertilizer used by maize farmers.

MATERIALS AND METHODS

This study was conducted for five months from March to July 2021 in Dumati Village, Telaga Biru District, Gorontalo, Gorontalo Province. The materials in this experiment included BISI-18 hybrid variety, 5 and 10 tons/ha cow manure, and 10 and 20 cc/14 L liquid organic fertilizer.

Organic Fertilizer Application

Cow manure was spread evenly based on the determined treatment and was applied two weeks before planting at a dose of 5 tons/ha and 10 tons/ha. Eco-farming organic fertilizer was applied on the third day before planting and 2, 4, 6, and 8 weeks after planting by spraying the liquid fertilizer evenly to the plants with a hand sprayer. The applied concentration during the application of eco-farming organic fertilizer was 10 cc/14 L and 20 cc/14 L. Therefore, the eco-farming organic fertilizer needs for each plot were varied. This relied on the plant's growth stage.

Experimental Design

The study used a randomized block design with 2 factorial involving first factor of cow manure and the second factor of organic liquid fertilizer. The applied research design is randomized block design (RDB) consisting of 9 combinations of treatments with each treatment having 3 replicates. Therefore, there were as many as 27 experimental plots used in this study. The 9 combinations of treatments includes:

B_0H_0 = 0 tons/ha cow manure + 0 cc/14L liquid organic fertilizer;
B_1H_0 = 5 tons/ha cow manure + 0cc/14L liquid organic fertilizer;
B_2H_0 =10 tons/ha cow manure + 0cc/14L liquid organic fertilizer;
B_0H_1 = 0 tons/ha cow manure + 10 cc/14L liquid organic fertilizer;
B_1H_1 = 5 tons/ha cow manure + 10 cc/14L liquid organic fertilizer;
B_2H_1= 10 tons/ha cow manure + 10 cc/14L liquid organic fertilizer;
B_0H_2 = 0 tons ha cow manure + 20cc/14L liquid organic fertilizer;
B_1H_2 = 5 tons ha cow manure + 20 cc/14L liquid organic fertilizer;
B_2H_2 = 10 tons ha cow manure + 20 cc/14L liquid organic fertilizer.

Observed Parameters

The observed parameters in this study encompass plant's height (cm), corn stem (mm), number of leaves (leaf), leaf area (cm), cob length (cm), cob diameter (mm), unhusked cob weight (kg), maize production (kg).

Data Analysis

The acquired data are analyzed using analysis of variance (ANOVA) at a 5% level of significance to identify the treatment affecting pest population, pest attack intensity, and unhusked cob weight. Any treatment identified with significant effect will be further analyzed using the post hoc Tukey Honest Significant Difference (HSD) test at a 5% significance level.

The data were also analyzed using Independent Sample t-Test to compare the significant effect in the use of organic and inorganic (NPK) fertilizer. Based on the decision criteria, hypothesis null (H0) is rejected if t-value is lower than table value at a significance level of 5% (0.05).

RESULTS AND DISCUSSIONS

The studies of maize and livestock farming integration in dryland could provide extra benefit by using cow manure as fine compost and maize farming waste, including leaves, stems, and cobs as feedstuff alternatives during the dry season. Integrating agricultural farming activities is one accurate method considering the limit of agricultural waste. In addition, integrating maize and livestock farming is a strategic integrated farming model to boost self-sufficiency in maize production. Close interaction among the cattle (organic fertilizer producers), maize (crops), liquid organic fertilizer, and land in a farming system where such interaction could contribute to maize productivity.

Maize Growth with Cow Manure and Liquid Organic Fertilizer Application

Means of Maize Growth with Cow Manure and Liquid Organic Fertilizer Application are presented in Tables 1 and 2.

The analysis of variance in Table 1 indicates that cow manure and doses and liquid organic fertilizer concentration had a significant effect. In contrast, their interaction had a significant effect on the means of plant height. Based on the Tukey HSD Test with α 0.05, the most optimal plant height of 239.39 cm was generated by applying 10 tons/ha cow manure and 20 cc/14L liquid organic fertilizer. There was no significant difference observed from the treatment with no cow manure (B_0) and liquid organic fertilizer (H_0). However, a significant difference was identified in the treatment of 5 tons/ha cow manure (B_1) and 10 cc/14L liquid organic fertilizer (H_1) application.

Table 1. Means of Plant's Growth Involving Cow Manure and Liquid Organic Fertilizer Application

Parameters	Cow Manure (B)	Liquid Organic Fertilizer (H)			CV HSD α 0.05
		H_0	H_1	H_2	
Plant's Height (cm)					
	B_0	197.39^{b}_{q}	224.24^{a}_{p}	218.79^{b}_{p}	14.39
	B_1	219.61^{a}_{p}	226.22^{a}_{p}	228.79^{ab}_{p}	
	B_2	223.78^{a}_{q}	234.79^{a}_{pq}	239.39^{a}_{p}	
CV HSD α 0.05	14.39				
Stem Diameter (mm)					
	B_0	18.43^{b}_{q}	22.82^{a}_{p}	21.83^{a}_{p}	2.44
	B_1	22.64^{a}_{p}	23.06^{a}_{p}	21.72^{a}_{p}	
	B_2	23.45^{a}_{p}	23.44^{a}_{p}	22.39^{a}_{p}	
CV HSD	2.44				
Leaf Area (cm)					
	B_0	8.49^{b}_{q}	10.06^{a}_{p}	9.66^{ab}_{p}	0.73
	B_1	9.22^{a}_{p}	9.88^{ab}_{p}	9.72^{a}_{p}	
	B_2	9.67^{a}_{p}	9.07^{b}_{pq}	8.96^{b}_{q}	
CV HSD	0.73				

Note: B_0=no cow manure; B_1= 5 tons/ha cow manure; B_2 = 10 tons/ha cow manure; H_0 = no liquid organic fertilizer; H_1 = 10 cc/14 liquid organic fertilizer; $_2$ = 20 cc/l4 L liquid organic fertilizer. Values followed by the same superscript letter in the row (p,1) and the column (a,b) are not significantly different on the Tukey HSD test at a significance level of α 0.05.

The analysis of variance indicates that cow manure, liquid organic fertilizer dose, and their interaction could significantly affect the stem diameter. Tukey HSD test with α 0.05 revealed that the highest generated means of stem diameter was 23.45 and was generated by the treatment of 10 tons/ha cow manure and no liquid organic fertilizer application. There was no significant difference observed in the treatment with no cow manure application (B_0). In contrast, no significant difference was also observed in the treatment of 5 tons ha^{-1} cow manure application (B_1). Based on Tukey HSD Test results with α 0.05 in Table 1, the treatment with no liquid organic fertilizer and with 10 tons/ha cow manure produces the most optimal plant height means of 23.45 mm. However, there was no significant difference among other treatments.

Analysis of variance indicated that the cow manure dose had a significant effect, while the liquid organic fertilizer concentration and their interaction had a significant effect on the leaf area means. Tukey HSD test with α 0.05 in Table 1 showed that the treatment with no cow manure and 10cc/14L liquid organic fertilizer could generate the most optimal leaf area means of 10.06 cm, and significantly different from 10 tons/ha cow manure (B_2), but there is no significant difference from the treatment of 5 tons/ha cow manure (B_1). Tukey HSD test with α 0.05 in Table 1 indicated that the treatment of 10cc/14 L liquid organic fertilizer with no cow manure could generate the highest leaf area means of 10.06 cm, but there was no significant difference among the treatments.

Table 2. Means of Leaf Numbers Involving Cow Manure and Liquid Organic Fertilizer Application

Cow Manure (B)	Liquid Organic Fertilizer (H)			Means	CV HSD
	H_0	H_1	H_2		
B_0	12.62	12.79	12.59	12.67^b	0.11
B_1	12.86	12.76	12.78	12.80^a	
B_2	12.81	12.88	12.88	12.86^a	

Note: B_0=no cow manure; B_1= 5 tons/ha cow manure; B_2 = 10 tons/ha cow manure; H_0 = no liquid organic fertilizer; H_1 = 10 cc/14 liquid organic fertilizer; H_2 = 20 cc/l4 L liquid organic fertilizer. Values followed by the same superscript letter in the row (p,1) and the column (a,b) are not significantly different on the Tukey HSD test at a significance level of α 0.05.

The analysis of variance indicated that the cow manure treatment had a significant effect on the leaf numbers. On the contrary, the concentration of liquid organic fertilizer and its interactions had no significant effect on the means of leaf numbers. Tukey HSD test with α 0,05 in Table 2 demonstrated that 10 tons/ha of cow manure could generate the highest means of 12.88 leaves and it is significantly different from the treatment with no cow manure application (B_0), but not significantly different from the application of 5 tons/ha cow manure (B_1).

Based on the result of the research analysis, the most accurate cow manure dose for optimal maize plant height, stem diameter, leaf number, and leaf area is 10 tons/ha. Cow manure application is performed considering its good nutritional content and organic matter that is capable of revitalizing physical, biological and chemical soil properties [15]; [16]. Organic fertilizer is a good fertilizer source for the plants due to its high organic matter rates that can promote plantgrowth above the ground and play an important role in regulating P and K nutrients while supplynutrient. Organic fertilizer can also improvedry weight This correlates with the nutrient sufficiency for the plants. During the maize's initial growth, maize requires a large amount of nitrogen as a nutrient for boosting early vegetative growth [17]. According to [18]; [19] cow manure can play an important role in improving the soil's chemical and physical quality. It could stimulate granulation and contribute to organic soil nutrient ions. Soil organic matter could stimulate the cellular walls of stem diameter [20]. Nitrogen is a very essential soil nutrient for stem diameter growth [21].

Cow manure also improves the soil water holding capacity that helps in mineralizing organic matter into nutrients for the plant's direct absorption during the growth phase [22]. Therefore, the application of cow manure could develop maize growth and production, primarily leaf growth and seed-filling, accelerating the maize spikelet primordia and cob growth, and increasing yields. Gardner et al. [23] stated that the existing sufficient nutrient could enable both young and old leaves to fulfill their nutritional needs. Limited nutrient frequently leads to the nutrient distribution to the young leaves to reduce photosynthesis in old leaves. With nutrients, the growing leaves will grow wider. From the analysis of this research, it can be observed that the most optimal doses in integrating cow manure and liquid organic fertilizer for maize are 10 tons/ha cow manure and 20 cc/14 L liquid organic fertilizer.

Post-harvest maize production with cow manure and liquid organic fertilizer application

Means of post-harvest maize production with cow manure and liquid organic fertilizer can be seen in Tables 3 and 4.

Table 3. Means of corn cob length and diameter affected by the cow manure and liquid organic fertilizer doses.

Parameters	Cow Manure	Liquid Organic Fertilizer			Means	CV HSD α 0,05
		H_0	H_1	H_2		
Cob length (cm)						
	B_0	16.87	15.51	17.42	16.6	-
	B_1	17.17	17.64	17.39	17.4	
	B_2	17.70	17.51	17.89	17.7	
Cob Diamater (mm)						
	B_0	43.57	44.22	44.54	44.11^b	1.26
	B_1	45.64	46.73	46.01	46.13^a	
	B_2	45.78	45.71	46.21	45.90^a	

Note: B_0=no cow manure; B_1= 5 tons/ha cow manure; B_2 = 10 tons/ha cow manure; H_0 = no liquid organic fertilizer; H_1 = 10 cc/14 liquid organic fertilizer; H_2 = 20 cc/l4 L liquid organic fertilizer. Values with the same superscript letter in the row (p,1) and the column (a,b) are not significantly different in the Tukey HSD test at a significance level of α 0.05.

Analysis of Variance indicated that the cow manure treatment, liquid organic fertilizer, and its interaction had no significant effect on the means of cob length. Application of 10 tons/ ha cow manure with 20 cc/14L liquid organic fertilizer generated the highest cob length mean of 17.89 cm, while the lowest cob length can be observed in the treatment with no cow manure and 10 cc/14 L liquid organic fertilizer application.

Analysis of variance indicated that cow manure application had a significant effect on the cob diameter. However, liquid organic fertilizer use and its interaction had no significant effect on the cob diameter. Tukey HSD test with α 0.05 in Table 3 indicated that the 5 tons/ha cow manure application generated the highest cob diameter mean of 46.73 mm and this treatment was significantly different from the treatment with no cow manure use. However, no significant difference was observed from the treatment with 10 tons/ha cow manure.

Analysis of variance indicated that cow manure, liquid organic fertilizer, and its interaction had a significant effect on the means of unhusked cob weight. Tukey HSD test with α 0.05 in Table 4 indicated that the treatment of 10 tons/ha cow manure on the treatment of 20 cc/14L liquid organic fertilizer could produce the highest unhusked cob weight mean of 3.37 kg, and significantly different from the other treatments. Tukey HSD test with α 0.05 in Table 2 indicated that the treatment of 20 cc/14L liquid organic fertilizer on 10 tons/ha cow manure treatment could generate the highest unhusked cob weight mean of 3.37 kg.

Table 4. Means of unhusked cob weight and the post-harvest production per-plot affected by the cow manure and liquid organic fertilizer treatment.

Parameters	Cow Manure	Liquid Organic Fertilizer			CV HSD α 0,05
		H_0	H_1	H_2	
Unhusked Cob Weight					
	B_0	1.32^b_q	2.19^b_p	2.13^c_p	0.45
	B_1	2.18^a_q	2.47^{ab}_{pq}	2.68^b_p	
	B_2	2.36^a_q	2.71^a_q	3.37^a_p	
CV HSD	0.45				
Production Per Plot					
	B_0	5.66^b_q	9.39^b_p	9.14^c_p	1.92
	B_1	9.34^a_q	10.57^{ab}_{pq}	11.47^b_p	
	B_2	10.11^a_q	11.60^a_q	14.46^a_p	
CV HSD	1.92				

Note: B_0=no cow manure; B_1= 5 tons/ha cow manure; B_2 = 10 tons/ha cow manure; H_0 = no liquid organic fertilizer; H_1 = 10 cc/14 liquid organic fertilizer; H_2 = 20 cc/l4 L liquid organic fertilizer. Values followed by the same superscript letter in the row (p,1) and the column (a,b) are not significantly different on the Tukey HSD test at a significance level of α 0.05.

Analysis of variance indicated that the treatment of cow manure, liquid organic fertilizer, and their interaction are significantly different from the means of production per plot. Tukey HSD test with α 0.05 in Table 4 indicated that the treatment of 10 tons/ha cow manure on liquid organic fertilizer could generate the highest production per plot mean of 14.46 kg and the treatment is significantly different from the other treatments. Tukey HSD test with α 0.05 indicated that the treatment of 20 cc/14L liquid organic fertilizer on the treatment of 10 tons/ha cow manure could generate the highest production per plot of 14.46 kg and it is significantly different from other treatments.

Based on the result of the research analysis, it can be observed that the most optimal dose of cow manure for maize cob length, cob diameter, unhusked cob weight, production per plot is 10 tons/ha and 20 cc/14 L for liquid organic fertilizer as well as the interaction between both fertilizers. Mayadewi [13] reported that the increase of husked, unhusked, and good quality cob fresh weight is closely related to the quantity of the photosynthate allocated to the cobs. The greater the photosynthate translocated to the cob, the greater the fresh weight of the cob [24]. Cow manure could increase the production and cob fresh weight [25]. Interaction between the cow manure and liquid organic fertilizer could have different impacts on the increase of maize cob's length. Organic fertilizer application could supply soil nutrients that accelerate maize growth [26]. Phosphorus nutrient (P) can significantly affect cob's formation [27]. P nutrient can extend fruit and Adenosine Triphosphate (ATP) formation. Therefore, assimilation and the translocation to energy storage in plants could work effectively [28]. This also affects the cob diameter which results in bigger diameter. If P nutrient in maize is supplied well, cob formation will be better and corn kernel row formation will be completed.

Comparison Test Results

The comparison test aims to identify and analyze the effect of integrating cow manure and liquid organic fertilizer use compared to the NPK fertilizer application. The result of the test is presented in Table 5.

Based on the analysis of variance (ANOVA) results, integrating cow manure and liquid organic fertilizer has no significant difference compared to the application of inorganic (NPK) fertilizer use in the perspective of the plant's height, stem diameter, leaf area, cob length, and cob diameter. Meanwhile, there is a significant difference in cob weight and production per plot. Therefore, integrating cow manure and liquid organic fertilizer could improve farmers' income and promote maize and growth productivity comparable to the inorganic fertilizer (NPK).

CONCLUSIONS

Based on the result of the study, it can be concluded that the application of cow manure at 10 tons/ha dose combined with 20 cc/14 L liquid organic fertilizer could provide the best yield in the parameters of growth and production of maize.

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