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Growth and Development of Maize-Peanut Intercropped: An Assessment of the Effect of Organic Fertilizers

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Abstract— *The main idea of intercropping is to improved productivity and a method to control weeds. A randomized complete block design (RCBD) with two by four factorial, (Factor A) maize (Zea mays) and Maize (Zea mays)-peanut (*Arachis hypogaea*) intercropped, and factor B application of different organic fertilizers, replicated three times, is used. The study aimed to determine the effect of various organic fertilizers (Goat manure, Chicken dung, vermicast) and the effects of intercropping peanut to maize on the growth and yield of maize. The results showed the number of leaves of factor A treated with vermicast has a significant effect. However, intercropping peanut to maize showed no significance among applications of organic fertilizers. For height, factor A applied with chicken dung revealed an appreciable interaction with maize-peanut intercropped. It means applying organic fertilizer (chicken dung) alone could significantly affect the height. However, intercropping of peanuts showed much higher than organic fertilizer application alone. For yield, sole maize appears no significant differences among treatments but, intercropping of peanut to maize, an additional application of chicken dung notably affects the harvest of maize. Conversely, there is no interaction between organic fertilizer with intercropping of peanut to maize in terms of yield. Intercropping of peanut to maize could significantly affect the harvest. Therefore, the intercropping technique has a beneficial effect on either crop or both with or without organic fertilizers.*

Keywords— *Intercropping, Organic Fertilizer, peanut, Maize, Basilan.*

I. INTRODUCTION

Intercropping is an act of growing at least two crops on a similar field at a time (Qiu-xiang et al., 2018). It is a common farming practice in the world (Yi-bo et al., 2021. It further creating rummage yield, quality has been in the middle stage over the years in the creature's sub-space of agriculture. Accomplishing this respectable objective is seen in numerous ways, which is intercropping cereals with vegetables. Intercropping is the concurrent development of an overwhelming editing framework in emerging nations. It is currently cultivating in many segments of the world (Francis, 1986). It is famous attention to that to create extra food from a small piece of land through more productive utilization with insignificant effect on the climate to meet the expanding populace demand (Amos et al., 2012). The fundamental thought of intercropping is to get further developed usefulness per unit land region and time, and unbiased and sensible abuse of land assets and cultivating inputs including work. It is also an option for an integrated weed management (Chen et al., 2012; Baumann et al., 2002; Aladesanwa, 2008).

Maize (Zea mays L) is a yearly crop. It is an oat crop to be utilized as a wellspring of starches to the two people (in emerging nations), and creature feed worldwide because of its high taking care of significant worth (Undie et al., 2012), it used in the creation of biofuel. Maize, similarly very much acknowledged as a feed fixing and can contribute up to 30% protein, 60% energy, and 90% starch in creature diet (Dado, 1999). It is one of the significant harvests possessing the third situation close to wheat and rice in oat creation on the planet.

Groundnut is the thirteenth most significant food crop. It is harvesting from 26.4 million hectares with an absolute creation of 37.1 million metric tons and the fourth-biggest oilseed crop on the planet (ONYUKA et al., 2017), known for its oilseed and food (Belel et al., 2014). The harvest is generally engaged, and responses to high temperatures vary with plant type and phenological periods (Ahmad et al., 2013) and most extreme plants, which lead to intensive harvest yield (Hamidou, 2013).

The upside of intercropping is that the uninformed and high-danger environment of the smallholder farmer advantage enormously from intercropping (Rana and Pal, 1999). It is a feasible strategy in contrast to an escalated specific method that can expand usefulness and benefits without antagonistically affecting the climate, accessibility of an adequate amount of food with the fitting quality provided (Sekaran et al., 2021). Constant increment of food creation generally relies upon substance nitrogen (N) manure inputs (Zhu and Chen, 2002; Tai-wen et al., 2018)

The continuous use of chemical fertilizers to boost production might not be beneficial for the soil. These chemicals extreme uses synthetic compounds that caused serious ecological issues (Zhang et al., 2004), including nitrate contamination of groundwater (Ju et al., 2006), ozone harming substance discharges (Zhang et al., 2012), and soil fermentation (Blumenberg et al., 2013 as cited by Yi-tao et al., (2018). An intercropping method which beneficial to soil and promotes sharing of nitrogen to the other plant. Besides, it shows adaptability, expansion benefits, minimization of hazard, soil preservation, and soil fruitfulness improvement (Matusso & Mugwe, 2013). Therefore, this research study aimed to determine the effect of different organic fertilizers (Goat manure, Chicken dung, vermicast) and the effects of intercropping peanut to maize on the growth and yield of Maize.

II. Materials and Methods

2.1. Experimental Site

The study was implemented from March 2019 to June 2019 at the Basilan State College, College of Agriculture and Fisheries, Santa Clara Campus, Lamitan City, Basilan, Philippines ($60^0$40’52.24” N, $122^0$03’40” E). The area has a type III climate classification, where the seasons are not very pronounced, relatively dry from November to April, and wet during the rest of the year. Almost the entire area consists of Bulawan clay loam is (Bangsamoro Development Agency, 2016). The annual mean temperature and precipitation are 26.6^0C and 1,100 mm, respectively (Bangsamoro Development Agency, 2016). The fields were plowed and harrowed until they were ready for planting. The study has utilized four hundred eighty (480) square meters area, consisting of twenty-four (24) plots, where each measured four (4) meters wide by five (5) meters length.

2.2. Experimental Procedures and Design

The experimental area was laid out in a randomized complete block design (RCBD) using two (2) by Four (4) factorial, replicated three (3) times. The study has two factors (maize and maize with peanut) with four treatments (control, vermicast, chicken dung, and goat manure). Organic fertilizers such as chicken dung, vermicast, and goat manure (Table 1) were applied using the basal method in the field right after sowing. Irrigation performs daily using manual sprinklers. The maize seeds place at designated holes with a planting distance of 65 cm between hills and 1.0 m between rows. Plots for intercropped peanuts seeds sowed between rows. The blocking pattern (Figure 1) showed three blocks with 8 plots per block. All 24 plots were randomly assigned treatment. Removal of weeds performs every day to control the competition of water and nutrients.

TABLE 1. Treatment combination using two factors

Plot No.	Combination	Factor A	Factor B
1	A1B1	Maize	Control
2	A1B2	Miaze	Vermicast
3	A1B3	Maize	Chicken dung
4	A1B4	Maize	Goat manure
5	A2B1	Maize with Peanut	Control
6	A2B2	Maize with Peanut	Vermicast
7	A2B3	Maize with Peanut	Chicken dung
8	A2B4	Maize with Peanut	Goat manure

Block 1		Block 2		Block 3	
A_1B_4	A_2B_1	A_1B_3	A_2B_4	A_1B_1	A_2B_2
A_2B_3	A_1B_2	A_2B_2	A_1B_1	A_2B_3	A_1B_4
A_1B_1	A_2B_4	A_1B_4	A_2B_3	A_2B_4	A_1B_2
A_1B_3	A_2B_2	A_1B_2	A_2B_1	A_1B_3	A_2B_1

Fig. 1. Blocking arrangement of randomized factor/treatment combinations

2.3. Collection of Data

Twenty percent (20%) of the total population of crops per plot use as samples for the gathering of data. Initial data gather two weeks after germination (WAG) of the crops, and succeeding collections were done weekly up to harvesting with the following parameters. Harvesting was done ninety (90) to one hundred five (105) days after sowing (DAS) or determined by the following indication such as gradual and yellowing of the leaves of the majority of the plants.

2.3.1. Plant leaves

The average number of leaves was quantified by counting the number of leaves of maize for each hill at 15 days (DAS) interval until maturity at 105 days. Five samples (corn plant) were selected randomly from each plot, then took the average number of leaves using equation 1.

$$\text{Average number of leaves} = \frac{\text{Total number of leaves}}{\text{Total samples}} \quad (1)$$

2.3.2. Plant height

The average plant height per hill was measured by measuring the sample plant from the plant’s base to the tip of the shoot. Five random samples per plot were selected for plant height measurement. The average height was computed using equation 2.

$$\text{Average height} = \frac{\text{Total number of height}}{\text{Total samples}} \quad (2)$$

2.3.3. Plant yield

An average yield (kg) per hill was measured by weighing all the matured corn fruits of five randomly selected corn plants. Harvesting of the mature maize was done after 105 DAS. The average yield was computed using equation 3.

$$\text{Average yield} = \frac{\text{Total yield}}{\text{Total samples}} \quad (3)$$

2.4. Data Analysis Plan

The experimental area was laid out in a Randomized Complete Block Design (RCBD) with eight treatments replicated three times. The data were subjected to analysis of variance (ANOVA) procedures appropriate for two factors in randomized complete block design. Fisher’s LSD test was used for mean comparison.

III. Results and Discussion

3.1. Number of leaves

The number of leaves of maize, sole maize treatment 2, which is the vermicast shows the highest average number of leaves with a mean of 8.98, followed by treatment 4 with 8.69, then treatment 3 with a mean of 8.5, and treatment 1 (control) has the lowest average number of leaves with 7.79. In intercropped with peanut, treatment (7) shows the highest average number of leaves with a mean of 8.32, followed by treatment 6 with an of 8.25, then treatment 8 with an of 8.20, and treatment 5 (control) has the lowest mean of 7.33 (Table 2).

TABLE 2. Average Number of leaves of Maize intercropped with peanut applied with different organic fertilizers.

Treatment	Repication			Total	Mean
	I	II	III		
T_1	7.63	8.26	7.5	23.39	7.79 C
T_2	8.5	9.43	9.03	26.96	8.98 A
T_3	8.26	8.96	8.3	25.52	8.5 B
T_4	8.54	8.73	8.8	26.07	8.69 AB
T_5	7.33	7.83	6.73	21.89	7.29 b
T_6	8.23	8.56	7.96	24.75	8.25 a
T_7	8.3	8.36	8.3	24.96	8.32 a
T_8	8.23	8.36	8.03	24.62	8.20 a
Block Total	65.02	68.49	64.65		
Grand Total				198.16	
Grand Mean					8.25
Significance: **					

NS-None Significant, *-Significant, **-Highly Significant
Means with the same letter are none significantly different (Factor A capitalize a letter, factor B small letter).
CV = 2.95%
LSD = 0.43

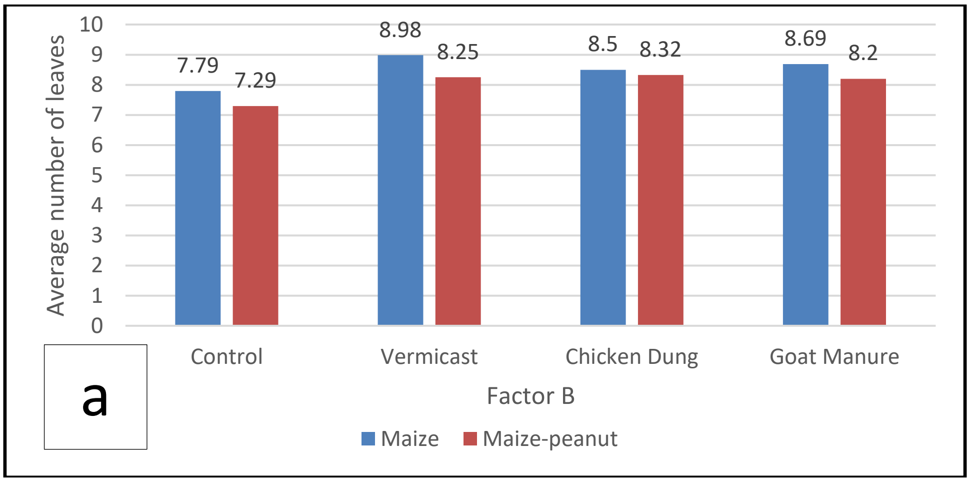
The number of leaves in all treatments (figure 2a) indicated that maize-peanut intercropped has fewer leaves than sole maize. There was no significant effect of intercropping in the leaves production. However, it has an increase in the leaf area as observed by the researchers.

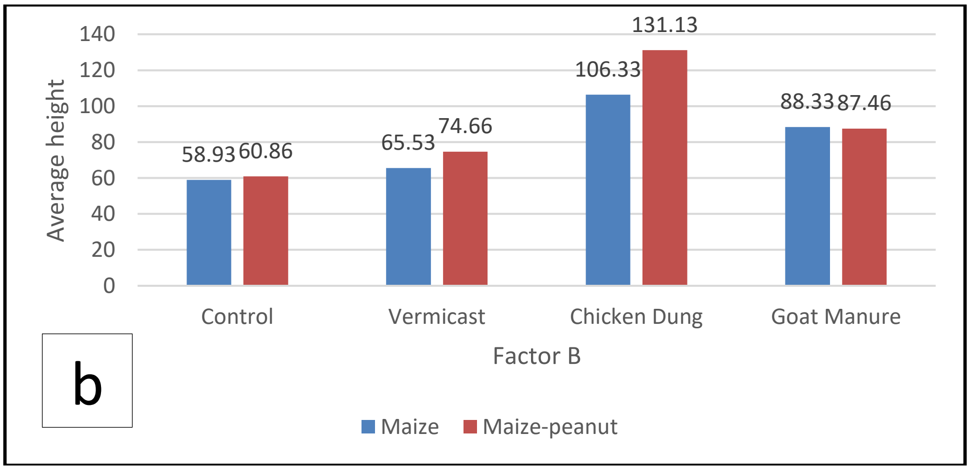
The analysis of variance resulted in highly significant in terms of blocking efficiency with the F-Value of 9.41. It implies that blocking was effective. Highly substantial treatment with the F-Value of 13.88, the null hypothesis is rejected, at least one means significantly different among means. In factor A, the application of organic fertilizer obtained the F-Value of 23.36 higher than F tabular at a 1 % level of significance. It indicates that at least one of the organic fertilizers has a substantial effect on the growth and yield of maize. For factor B, intercropping of Peanut to maize obtained the F-Value of 22.88 higher than F tabular at a 1% level of significance. It shows that intercropping peanut to maize affects the number of leaves of maize, increases the number of leaves of maize. But as far as the interaction of application of organic fertilizers and intercropping of peanut is showed none significantly, no interaction between application of organic fertilizer and intercropping of peanut.

3.2. The average height of plants

The average height of maize (Table 3), factor (A) treated with chicken dung shows the highest average plant height with a mean of 106.33, followed by treatment 4 with 88.33, then treatment 3 with 65.53, and treatment 1 (control) has the lowest average plant height with a mean of 58.93. In factor (B) maize intercropped with peanut, treatment (7) shows the highest average plant height with an average of 131.13, followed by treatment 8 with a mean of 87.46, then treatment 6 with an average of 74.66, and treatment 5 (control) has the lowest mean of 60.86.

Based on figure 2b showed that there was a height increment for maize under maize-peanut intercropped compared with sole maize, except that treated with goat manure. There was a substantial effect of intercropping of maize and peanut, given that peanut is a leguminous crop.





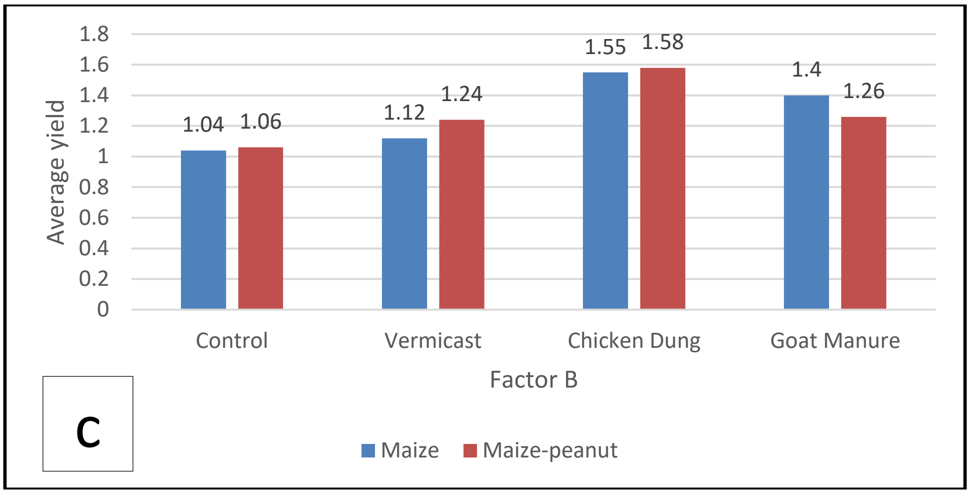


Fig. 2. Graphical presentation of maize and maize with peanut intercropped response to organic fertilizers in terms of a) Average number of leaves, b) Average height, c) Average yield

TABLE 3. Average plant height (cm) of maize intercropped with Peanut applied with different organic fertilizers.

Treatment	Block			Total	Mean
	I	II	III		
T_1	60	59.8	57	176.8	58.93C
T_2	69.6	65	62	196.6	65.53 C
T_3	110	98	111	319	106.33A
T_4	94	86	85	265	88.33 B
T_5	68.6	59	55	182.6	60.86 d
T_6	79	75	70	224	74.66 c
T_7	145	127	121.4	393.4	131.13 a
T_8	84.4	88	90	262.4	87.46 b
Block Total	710.6	657.8	651.4		
Grand Total				2019.8	
Grand Mean					84.16
Significance:**					

NS-None Significant, *-Significant, **-Highly Significant
Means with the same letter are none significantly different (Factor A capitalize letter, factor B small letter).
CV = 6.21%
LSD = 9.16

Based on the analysis of variance (ANOVA). There were significant blocking and intercropping with the F-Values of 4.82 and 16.79, respectively. The test also showed a highly significant treatment, application of organic fertilizers, and interaction between intercropping and application of organic fertilizer with the F-Values of 68.04, 145.90, and 7.25, respectively. Likewise, the significant difference among the treatments with the least significant difference of 9.16. Application of Chicken dung shows the best performance on maize intercropped with peanuts in terms of the height of maize.

3.3. The average weight of the yield

The average yield of maize (Table 4) showed factor A treatment 3 is chicken dung shows the highest Average average harvest, with a mean of 1.55, followed by treatment 4 with a mean of 1.4, then treatment 2 with an average of 1.12, and treatment 1 (control) has the lowest average yield with an average of 1.04. In factor (B) maize intercropped with Peanut, treatment 7 shows the highest average plant height with a mean of 1.58, followed by treatment 8 with an average of 87.46, then treatment 6 with an average of 1.24, and treatment 5 (control) has the lowest mean of 1.06.

According to figure 2c, as compared to sole maize, maize-peanut intercropped has increased yield, except for being treated with goat manure. Both figure 2b and 2c showed a similar trend which indicates the beneficial effect of intercropping.

TABLE 4. The average weight of yield (kg) of maize intercropped with Peanut applied with differentorganic fertilizers.

Treatment	Block			Total	Mean
	I	II	III		
T_1 (A1-B1)	1.11	1.1	0.92	3.13	1.04
T_2 (A2-B1)	1.22	1.15	1	3.37	1.12
T_3 (A3-B1)	1.9	1.5	1.25	4.65	1.55
T_4 (A4-B1)	1.9	1.2	1.1	4.2	1.4
T_5 (A1-B2)	1.1	0.95	1.12	3.17	1.06
T_6 (A2-B2)	1.21	1.3	1.2	3.71	1.24
T_7 (A3-B2)	1.8	1.6	1.35	4.75	1.58
T_8 (A4-B2)	1.25	1.2	1.35	3.8	1.26
Block Total	11.49	10	9.29		
Grand Total				30.78	
Grand Mean					1.28
Significance:**					

NS-None Significant, *-Significant, **-Highly Significant
CV = 1.60%
LSD = 0.04

Based on the analysis of variance (ANOVA). There were significant blocking and treatment with the F-Values of 4.75 and 4.03, respectively. Likewise, it is highly significant for the application of organic fertilizer with the F-Value of 8.91. On the other hand, it is not significant in terms of intercropping of maize with peanuts and interaction between intercropping and application of organic fertilizer. The results implied significant differences in treatment 7, compared to all treatments with the least significant difference of 0.04. Application Chicken dung is best for maize in terms of yield.

3.4. Corralation of parameters

The corralation of factors A and B (Figure 3) indicated that, as plant height increases, the yield of maize both for maize alone and maize-peanut intercropped also increases from

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treatments 1 to 8. Conversely, there was no significant relationship with the average number of leaves. For maize intercropped peanut treated with chicken dung (Treatment 7), considered the highest yield and height.

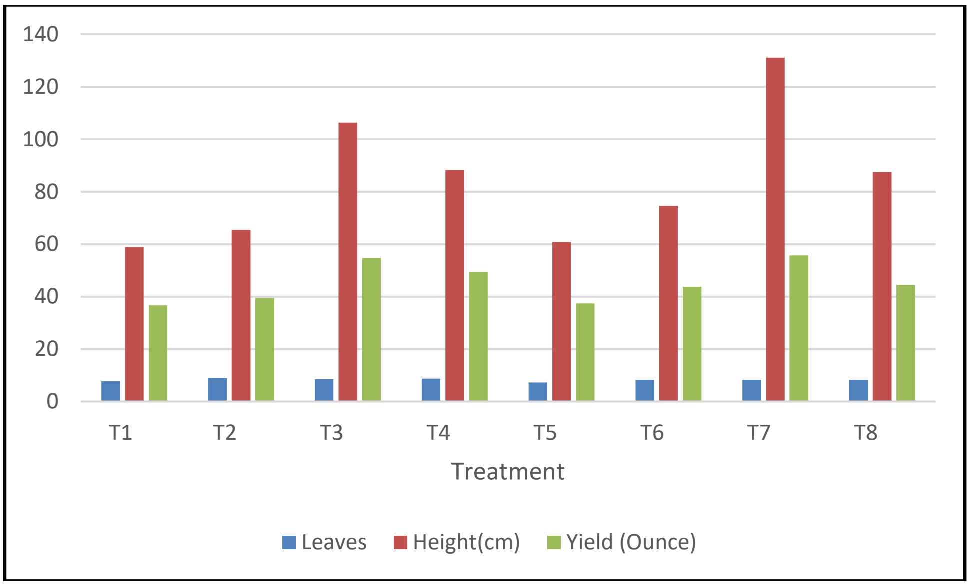

Fig. 3. Graph of number of leaves, height, and yield of factor A (maize and maize-peanut intercropped and factor B (Organic fertilizers and control)

IV. CONCLUSION

Based on the results, there was an increase in the average yield and height of maize intercropped with peanuts. Similarly, among the organic fertilizers chicken dung is much more effective both for maize and maize-peanut intercropped, while vermicast application was considered the least effective. On the other hand, the application of goat manure gave a better result in factor A than in factor B. Intercropping techniques proves to be beneficial to either crop or both with or without the application of organic fertilizers.

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