Zea mays Intercropped with Different Legumes as Green Manure: Yield under Soil and Climatic Condition in Zamboanga Sibugay, Philippines

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Abstract. This study was conducted to determine the yield performance of sweet corn intercropped with different legumes as green manure under the prevailing soil and climatic condition of Mindanao State University Buug, Philippines. An area of 540 square meters excluding alley ways was utilized in the study. Only one factor was used in the study; the different legumes as green manure on the yield of sweet corn. The experimental area was laid out using Randomized Complete Block Design (RCBD). The different legumes were planted between the four rows of corn plants using quincunx method. Though the results of statistical analyses in all parameters shows that the computed "f" were lesser than the tabulated "f" at 5 % at level of significance, data shows that sweet corn intercropped with peanut and mung bean as green manure had longer ears with the length of 27.50 and 28.90 centimeters respectively compared to sweet corn without intercropped with the average length of 27.37 centimeters only.

Keywords: Intercropping, Legumes, Maize, Green Manure

Introduction

Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under varied agroclimatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. Maize is cultivated throughout the world (58°N latitude to 40°S latitude) in an area of 179.9 m.ha across 165 countries with a production of 1013.6 m.t and average productivity of 5.63 t/ha. It is largely grown in USA, China, Brazil, Argentina, Mexico etc. The highest productivity of 10.73 t/ha was achieved in United States, which was followed by China (5.81 t/ha) and Brazil (5.4 t/ha). India occupies 7th position in respect of area and production (USDA, 2016).

In India, maize is the third most important food crops after rice and wheat. Maize is cultivated in an area of 9.3 million hectares with a production of 24.2 million tonnes and productivity of 2564 kg ha-1 (Nadu, 2014). The major maize producing states are Andhra Pradesh (20%), Karnataka (17%), Maharashtra (11%), Bihar (9%), Tamil Nadu (8%), Madhya Pradesh (6%), Rajasthan (6%) and Uttar Pradesh (5%). The area and production of maize has increased remarkably from 1950-'51 to 2014-'15. As a result of recent technological interventions adopted by the farming community, the productivity has significantly increased to the tune of 368.7 per cent from 1950-'51 to 2014-'15.

In Tamil Nadu, maize is cultivated in an area of 3.4 million hectares with a production of 18.30 million tonnes and the productivity is 5359 kg ha-1 (FAO, 2006). In Tamil Nadu, maize is grown in an area of 0.1 lakh ha during 1970-71 with an annual production of 0.2 lakh tonnes, mainly concentrated in Tanjavur, Pudukkottai and Trichy districts. Due to rapid increase in the demand of maize for poultry and animal feed and for industrial uses, and popularization of high yielding varieties and hybrids, the area under maize has increased to 3.4 lakh ha with a production of 18.3 lac t during 2014-15. The major maize growing districts are Perambalur, Toothukudi, Dindigul, Erode, Karur, Ariyalur and Salem and smaller area in Southern districts of Tamil Nadu.

Maize is one of the oldest human-cultivated crops grown in tropical and temperate regions of the world. The center of origin is believed to be the Mesoamerica region, at least 7000 years ago when it was grown as a wild grass called teosinte in the Mexican highlands (FAO, 2011). Despite its high yield potential, it is giving low yields because of improper fertilizer management practices due to lack of appropriate information on fertilizer management and bio fertilizer application. Increasing productivity per unit area through agronomic management is one of the important strategies to increase the production of maize.

The importance of cereal grains in human nutrition is widely recognized, as they provide substantial amounts of energy and protein to millions people, especially in developing countries (Awa et al., 1991).

Intercropping is a common cropping system in developing countries such as India (Hirpa, 2014). It is the practice of growing two or more crops at the same time during the same growing season on the same piece of land (Ijoyah & Jimba, 2012). With the rapid population increase, the demand for food has been increasing while land availability has been declining. Thus, the only way to increase agricultural production is to increase yield per unit area (Kolawole et al., 2014).

In tropical regions, corn has been considered as the best component in most of intercropping system (Susan & Mini, 2005). Intercropping has recently been recognized as a potentially beneficial system of crop production (Okeke et al., 2004). This cropping system increased total productivity per unit land, per unit time and improves the judicious utilization of the land and other resources on farm (Okeke et al., 2004) reduces soil erosion and thereby helps to maintain greater stability in crop yield in okra/cowpea intercropping system (Vains et al., 2013).

Other advantages of intercropping include: insurance against crop failure thereby minimizing risk, better use of resources by plants of different heights, rooting depths and nutrient requirements and a more equal distribution of labour through the growing season. (Muoneke & Asiegbu, 1997; Sanginga & Woomer, 2009). Moreover, intercropping systems more efficiently used the growth factors because they capture more radiation and make better use of the available water and nutrients, reduce pests, diseases incidence and suppress weeds (Ocloo et al., 2011) and favour soil-physical conditions, particularly intercropping cereal and legume crops which also maintain and improve soil fertility (Olowokere et al., 2006).

Several scientists have been working with cereal-legume intercropping systems and proved its success compared to the monocrops (Pazhanivelan et al., 2006). Some studies have indicated that intercropping was more productive than sole cropping because of the complimentary effect of intercrops such studies included amaranth with cowpea, cucumber with cowpea (Vains et al., 2013), maize with cowpea (Pazhanivelan et al., 2006) and cassava with cowpea (Gomez & Gomez, 1983).

Methodology

Research Design

The study was laid out using Randomized Complete Block Design (RCBD). Random numbers generated from the calculator were used in the distribution of each treatment to each plot by ranking them from lowest to highest.

Research Environment

This study was conducted in Buug, Zamboanga Sibugay. Buug is a coastal municipality in the province of Zamboanga Sibugay.

The municipality has a land area of 134.06 square kilometers or 51.76 square miles which constitutes 3.72% of Zamboanga Sibugay's total area. Its population as determined by the 2015

Census was 36,634. This represented 5.79% of the total population of Zamboanga Sibugay province, or 1.01% of the overall population of the Zamboanga Peninsula region.

Based on the great-circle distance (the shortest distance between two points over the surface of the Earth), the cities closest to Buug are Pagadian, Tangub, Ozamiz, Dipolog, Dapitan, and Oroquieta. The nearest municipalities are Diplahan, Kumalarang, Malangas, Bayog, Imelda, and Lakewood. Its distance from the national capital is 792.84 kilometers (492.65 miles).

Materials

The equipment being used in conducting the study were the following; a land area of 540 square meters (excluding alley ways), Carabao drawn plow, harrow, bolo, sprayer, meter stick, plastic straw, treatment indicators, sign boards, shovel, weighing scale, tape measure, cellophanes, record notebook, ball pen, water pump and camera.

Factor and Treatments. There was only one factor being considered in the study; the different types of legumes intercropped to sweet corn as green manure and this was replicated five times.

The treatments were the following:

T_1 – Peanut
T_2 – Mung bean
T_3 – Soybean
T_4 – Control (Sweet corn only)

Cultural Practices

Planting. Two seeds of sweet corn were sown at a distance of 75 cm x 25 cm intercropped with different legumes as green manure. The seeds were covered with soil at a depth of 2-5 centimeters. On the same day two seeds of legumes were also planted between the rows of corn plants using quincunx method of planting with the same distance to the main crop.

Thinning. The corn plants were thinned 15 days after emergence by removing unhealthy seedlings, leaving one healthy seedling per hill.

Weeding and Cultivation. Weeding was carried on after 2 weeks of planting to ensure good and rapid growth of the corn plant. Hilling up was done after side dressing.

Irrigation and Water Management. The field was irrigated every early in the morning by using sprinkler. This was continued as needed.

Fertilizer Application. Complete fertilizer (14-14-14) was applied as basal before planting at the rate of 6.56 grams per hill and at 26 days after planting 2.81 grams per hill of Urea (45-0-0) and 0.93 grams per hill of Muriate of Potash (0-0-60) was applied as side dressing.

Green Manuring. One month after planting the legumes were pulled out and chopped into pieces and buried in the soil that would serve as green manure to the sweet corn.

Insect Pest and their Control. Corn earworms, aphids, and cut worms were observed during the conduct of the study. These were controlled by spraying Lannate Tm 40 SP at the rate of 2.5 ml per 16 liters of water using knapsack sprayer.

Diseases and Their Control. Seedling blight, downy mildew and bacterial stalk rot were observed in the corn plants. These were controlled using Tango at the rate of 2.6 ml per 16 liters of water.

Sampling Procedures. The number of samples per plot was determined by getting the 30 percent of the total plant (density) per plot. The sample plants were harvested using the systematic sampling. This was done by picking the corn ears in every fourth plant per row in every plot.

Harvesting. Macho F1 Hybrid corn ears were harvested 75 days after planting. Harvested corn ears were placed and labelled in separate sacks according to plot number and treatment to avoid mixing and misrepresentation of data.

Collection of Data. Collection of the data was done during harvesting. Forty three sample plants per plot were harvested first before the other corn plants. This was done by picking the corn ears in every fourth plant per row. These samples were segregated and labelled to avoid misrepresentation of data.

Data Gathered

1. Average length of corn ears in centimeter per plant per treatment.

The length of each corn ears was measured using a tape measure and the sum was divided by the total number of samples to get the average length.

2. Average circumference of corn ears in centimeter per plant per treatment.

The circumference of each corn ear in every plot was measured using a tape measure and the sum was divided by the total number of samples to get the average circumference.

3. Average weight of corn ears in grams per plot per treatment.

Each corn ear in every plot was weighed using a weighing scale and the sum was divided by the total number of samples to get the average weight.

4. Total number of corn ears per plot per treatment.

All corn ear from each plot were collected and counted to obtained total number of corn ears per plot per treatment.

5. Total weight of corn ears in kilogram per plot per treatment.

All corn ear from each plot were weighed using a weighing scale to obtain the total weight of corn ears per plot per treatment.

Statistical Analysis of Data. The Analysis of Variance (ANOVA) for one-way classification was used in the study to determine if there were significant difference among the yield of sweet corn intercropped with different legumes as green manure.

Presentation, Analysis and Interpretation of Data

The results are summarized in the following tables.

Table 1. Average Length of Sweet Corn Ears in Centimeter per Plot per Treatment

Different Legumes	Replication						
	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total	Mean
T_1	28.32	28.09	27.44	27.42	26.25	137.52	27.50
T_2	27.41	25.59	26.58	27.28	37.62	144.48	28.90
T_3	26.63	27.42	26.34	27.18	28.46	136.03	27.21
T_4	28.60	27.20	27.40	26.86	26.79	136.85	27.37
Total	110.96	108.30	107.76	108.74	119.12	554.88	27.74

The table above presents the average length of sweet corn ears in centimeters per plot per treatment. It shows that, T_2 obtained the longest average length of 28.89 centimeters followed by T_1 with 27.50 centimeters, T_4 obtained 27.37 centimeters and the shortest average length of sweet corn ears was obtained in T_3 with 27.21 centimeters. The result shows that sweet corn intercropped with peanut and mung bean had longer ears compared to control (Corn alone) which is comparable to sweet corn intercropped with soybeans.

Table 2. Average Circumference of Corn Ears in Centimeter per Plot per Treatment

Different Legumes	Replication						
	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total	Mean
T_1	20.32	18.86	18.37	19.11	18.90	95.56	19.11
T_2	19.90	18.25	19.00	18.41	19.27	94.83	18.97
T_3	18.31	17.95	19.41	20.00	19.48	95.15	19.03
T_4	19.55	18.83	19.40	19.70	18.84	96.32	19.26
Total	78.08	73.89	76.18	77.22	76.49	381.86	19.09

Table 2 presents the average circumference of sweet corn ears in centimeters per plot per treatment. It shows that, T_4 obtained the biggest average circumference of sweet corn ears with 19.26 centimeters followed by T_1 with 19.11 centimeters T_3 obtained 19.03 centimeters and the smallest average circumference of sweet con ears was obtained in T_2 with 18.97. The result shows that control (corn alone) and sweet corn intercropped with peanut had bigger circumference compared to sweet corn intercropped with soybean which is comparable to corn intercropped with mung bean.

Table 3. Average Weight of Corn Ears in Grams per Plot per Treatment

Different Legumes	Replication						
	Rep.1	Rep.2	Rep. 3	Rep.4	Rep.5	Total	Mean
T_1	348.00	237.55	238.20	271.17	289.83	1384.75	276.95
T_2	337.90	240.95	261.90	258.67	292.04	1391.46	278.29
T_3	257.48	338.02	318.48	293.51	314.48	1521.97	304.39
T_4	344.33	263.46	281.95	297.63	248.69	1436.06	287.21
Total	1287.71	1079.98	1100.53	1120.98	1145.04	5734.24	286.71

Table 3 presents the average weight of sweet corn ears in grams per plot per treatment. It shows that T_3 obtained the heaviest weight of sweet corn ears with the average of 304.39 grams followed by T_4 with the average weight of 287.21 grams. T_2 had the average weight of 278.29 grams and the lightest average weight of 276.95 grams was obtained from T_1. The result shows that the sweet corn intercropped with soybean and control (corn alone) had the heaviest weight of corn ears compared to sweet corn intercropped with mung bean which is comparable to corn intercropped with soybean.

Table 4. Total Number of Corn Ears per Plot per Treatment

Different Legumes	Replication						
	Rep.1	Rep.2	Rep. 3	Rep.4	Rep.5	Total	Mean
T_1	153.00	149.00	148.00	149.00	156.00	755.00	151.00
T_2	164.00	149.00	148.00	149.00	152.00	762.00	152.40
T_3	154.00	152.00	146.00	161.00	151.00	764.00	152.80
T_4	157.00	151.00	147.00	162.00	148.00	765.00	153.00
Total	628.00	601.00	589.00	621.00	607.00	3046.00	152.30

Table 4 presents the total number of sweet corn ears per plot per treatment. It shows that T_4 obtained the highest total number of sweet corn ears with 765 ears followed by T_3 with the total number of 764. T_2 had the total number 762 ears and the lowest total number of 755 ears was obtained from T_1. The result shows that control (corn alone) and sweet corn intercropped with soybean had more numbers of ears compared to sweet corn intercropped with mung bean which is comparable to sweet corn intercropped with peanut.

Table 5. Total Weight of Corn Ears in Kilograms per Plot per Treatment

Different Legumes	Replication						
	Rep.1	Rep.2	Rep. 3	Rep.4	Rep.5	Total	Mean
T_1	49.97	41.62	34.11	35.80	40.75	202.25	40.45
T_2	48.53	35.41	41.94	37.61	39.74	203.23	40.65
T_3	40.42	36.56	45.74	47.26	42.15	212.13	42.43
T_4	51.75	37.83	40.28	43.74	35.71	209.31	41.86
Total	190.67	151.42	162.07	164.41	158.35	826.92	41.35

Table 5 presents the total weight of ears in kilogram per plot per treatment. It shows that T_3 obtained the heaviest weight of sweet corn ears with a total of 212.13 kilograms followed by T_4 with the total of 209.31 kilograms. T_2 had the total weight of 203.23 kilograms and the lowest total weight of 202.25 kilograms was obtained from T_1. The result shows that sweet corn intercropped with soybean and control (corn alone) had the highest total weight compared to sweet corn intercropped with mung bean which is comparable to corn intercropped with peanut.

ANOVA for One-Way Classification

Table 6. ANOVA for the Average Length of Sweet Corn Ears in Centimeter per Plot per Treatment

Source of Variation	*Sum of* Square	Degrees of Freedom	Mean of Square	Computed "f"	Tabulated f 5%	Tabulated f 1%
Replication	22.21	4.00	5.55			
Treatment	9.07	3.00	3.02	0.43	3.49	5.95
Error	82.45	12.00	6.87			
Total	113.72	19.00				

Table 6 presents the Analysis of Variance for the average length of sweet corn ears in centimeters per plot per treatment. Statistical analysis shows that computed "f"(0.43) was lesser than tabulated "f" at 5% (3.49) level of significance. This led to the acceptance of null hypothesis and rejection of alternative hypothesis. The result implied that there was no significant difference on the average length of sweet corn ears per plot per treatment as influence by different legumes intercropped to sweet corn which is in contradiction with the results and findings of Matusso (2001) stated that the maize-soybean intercropping patterns had significant effect on maize stover and grain yield both on wet and dry season. It was also in contradiction with the results and findings of Fabumni (2015) stated that the response of maize to green manure from varying populations of cowpea in a derived savannah of Nigeria higher significantly higher biomass.

Table 7. ANOVA for the Average Circumference of Sweet Corn Ears in Centimeter per Plot per Treatment

Source of Variation	*Sum of Square*	Degrees of Freedom	Mean of Square	Computed "f"	Tabulated f 5%	1%
Replication	2.46	4.00	0.62			
Treatment	0.25	3.00	0.08	0.19	3.49	5.95
Error	5.08	12.00	0.42			
Total	7.79	19.00				

Table 7 presents the Analysis of Variance for the average circumference of sweet corn ears in centimeter per plot per treatment. It shows that computed "f"(0.19) was lesser than tabulated "f" at 5% (3.49) level of significance. Therefore, the null hypothesis was accepted and the alternative hypothesis was rejected. This implies that there was no significant difference on the average circumference of sweet corn ears per plot per treatment which is in contradiction with the results and findings of Matusso (2001) stated that the maize-soybean intercropping patterns had significant effect on maize stover and grain yield both on wet and dry season. It was also in contradiction with the results and findings of Fabumni (2015) stated that the response of maize to green manure from varying populations of cowpea in a derived savannah of Nigeria higher significantly higher biomass.

Table 8. ANOVA for the Average Weight of Sweet Corn Ears in Grams per Plot per Treatment

Source of Variation	Sum of Square	Degrees of Freedom	Mean of Square	Computed "f"	Tabulated f 5%	1%
Replication	6782.80	4.00	1695.70			
Treatment	2395.48	3.00	798.49	0.58	3.49	5.95
Error	16505.82	12.00	1375.48			
Total	25684.10	19.00				

Table 8 presents the Analysis of Variance for the average weight of sweet corn ears in grams per plot per treatment. It shows that computed "f"(0.58) was lesser than tabulated "f" at 5% (3.49) level of significance. Therefore, the null hypothesis was accepted and the alternative hypothesis was rejected. This implies that there was no significant difference on the average weight of sweet corn ears per plot per treatment which is in the contradiction with the results and findings of Fabunmi (2015) stated that the response of maize to green manure from varying populations of cowpea in a derived savannah of Nigeria gave significantly higher biomass. It was also in contradiction with the results and findings of Matusso (2001) stated that the maize-soybean intercropping patterns had significant effect on maize stover and grain yield both on wet and dry season.

Table 9. ANOVA for the Total Number of Corn Ears per Plot per Treatment

Source of Variation	*Sum of Square*	Degrees of Freedom	Mean of Square	Computed "f"	Tabulated f 5%	1%
Replication	243.20	4.00	60.80			
Treatment	12.20	3.00	4.07	0.19	3.49	5.95
Error	260.80	12.00	21.73			
Total	516.20	19.00				

Table 9 presents the Analysis of Variance for the total number of sweet corn ears per plot per treatment. It shows that computed “f“(0.19) was lesser than tabulated “f” at 5% (3.49) levels of significance. Therefore, the null hypothesis was accepted and the alternative hypothesis was rejected. This implies that there was no significant difference on the total number of sweet corn ears per plot per treatment which is in contradiction with the results and findings of Matusso (2001) stated that the maize-soybean intercropping patterns had significant effect on maize stover and grain yield both on wet and dry season. It was also in contradiction with the results and findings of Fabunmi (2015) stated that the response of maize to green manure from varying populations of cowpea in a derived savannah of Nigeria was significantly higher biomass.

Table 10. ANOVA for the Total Weight of Corn Ears in Kilograms per Plot per Treatment

Source of Variation	*Sum of* Square	Degrees of Freedom	Mean of Square	Computed “f”	Tabulated f 5%	1%
Replication Treatment Error	223.95 13.63 262.01	4.00 3.00 12.00	55.99 4.54 21.83	0.21	3.49	5.95
Total	499.59	19.00				

Table 10 presents the Analysis of Variance for the total weight of sweet corn ears in kilograms per plot per treatment. It shows that computed “f“(0.21) was lesser than tabulated “f” at 5% (3.49) levels of significance. Therefore, the null hypothesis was accepted and the alternative hypothesis is rejected. This implies that there was no significant difference on the total weight of sweet corn ears per plot per treatment which is in the contradiction with the result and findings of Fabunmi (2015) stated that the response of maize to green manure from varying populations of cowpea in a derived savannah of Nigeria was significantly higher in biomass. It was also in contradiction with the findings of Matusso (2001) stated that the maize-soybean intercropping patterns had significant effect on maize stover and grain yield both on wet and dry season.

Conclusions

Based on the result of the study, the following conclusions were drawn:

1. There was no significant difference among the average length of sweet corn ears in centimeters per plot per treatment.
2. There was no significant difference among the average circumference of sweet corn ear in centimeter per plot per treatment.
3. There was no significant difference among the average weight of sweet corn ears in gram per plot per treatment.
4. There was no significant difference among the total weight of sweet corn ears in kilogram per plot per treatment.
5. There was no significant difference among the total number of sweet corn ears per plot per treatment.

Recommendations

Based on the foregoing findings and conclusions, the researchers came up with the following recommendations:

1. The adoption of any of the four treatments to obtain longer length of sweet corn ears in centimeters.
2. The adoption of any of the four treatments to obtain bigger circumference of corn ear in centimeters.

3. The adoption of any of the four treatments to obtain heavier sweet corn ear in gram per plot per treatment.
4. The adoption of any of the four treatments to obtain higher yield of sweet corn ears per plot per treatment.
5. The adoption of any of the four treatments to obtain more number of sweet corn per plot per treatment.

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