



Response of sweet corn (*Zea mays* L. var. Macho F₁) as affected by rice straw mulch and levels of nitrogen fertilizer

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ABSTRACT

Nitrogen is an essential micronutrient that influences the growth and yield of sweet corn. However, it has many avenues of losses like volatilization and soil moisture thus, it must be maintained through mulching. The mulch material protects soil surface from sunlight which reduces evaporation by preserving soil water and altering soil temperature. This study was conducted to evaluate the effect of rice straw mulch and Nitrogen level, and assess the profitability of sweet corn production. The treatments designated as follows: T₁- 0-60-60 kg ha⁻¹ N, P₂O₅, K₂O, T₂- 60-60-60 kg ha⁻¹ N, P₂O₅, K₂O, T₃- 90-60-60 kg ha⁻¹ N, P₂O₅, K₂O, T₄- 120-60-60 kg ha⁻¹ N, P₂O₅, K₂O, and T₅- 150-60-60 kg ha⁻¹ N, P₂O₅, K₂O. The experimental area was laid out in a Randomized Complete Block Design (RCBD) with three replications. Results revealed that sweet corn applied with different levels of Nitrogen mulched with rice straw significantly affected the number of days from sowing to silking, stover yield, number of marketable ears plot⁻¹, weight (t ha⁻¹) of marketable ears, ear diameter, and total ear yield (t ha⁻¹). Application of 120-150 kg of N ha⁻¹ resulted in late silking comparable to sweet corn without N. Application of N regardless of rates increased the stover yield, ear diameter, and total ear yield (t ha⁻¹). Application of 150 kg of N ha⁻¹ gave the highest weight of marketable yield. Thus, sweetcorn requires higher rates of nitrogen fertilizer to obtain its optimum ear yield tha⁻¹.

KEYWORDS: *Conserve moisture, agronomic evaluation, productivity, cost and return analysis, net income*

1 INTRODUCTION

Philippines. One-third of Filipino farmers, or 1.8 million, depending on maize as their primary source of livelihood (Biniñas and Cagasan, 2018). Sweet corn is one type of maize and contains 13 to 15% sugar in immature grains and is consumed at the soft dough stage with succulent grains, emerges as an alternative dish of

urbanites, namely, vegetable, roasted ears, soups, corn syrup, and sweeteners (Bhatt, 2012). In addition, it can be harvested within 60 to 75 days after sowing, earlier by 35 to 45 days compared to regular grain corn. Due to population growth resulting from an increase in demand, the cultivation and production of sweet corn must be given importance. However, there are different factors affecting sweet corn production, such as reducing soil fertility due to soil erosion and volatilization losses because of improper fertilizer application specifically nitrogen. Mulching application can be a great help to lessen the said factors affecting sweet corn production.

Nitrogen (N) is an essential component influencing both the yield and amino acids that contributed to the size and flavor of the kernels (Anjorin, 2013). Nitrogen is one of the essential macronutrients required by sweet corn in a large amount for its growth and development. The proper amount of Nitrogen fertilizer must be appropriately observed to avoid excessive application considering its cost and could be a potential source of nitrate pollution to groundwater and surface water. According to Limon-Ortega et al. (2016), nitrogen level of 150 kg N ha⁻¹ resulted in the most excellent grain yield (2006.95 kg ha⁻¹) and grain yield reduced to 1983.95 kg ha⁻¹ by increasing Nitrogen from 150 to 200 kg ha⁻¹. In addition, N application at 120 kg N ha⁻¹ produced the highest amount of dry matter and gave the highest values for both cob yield and grain yield, while the lowest values were obtained at 0 kg ha⁻¹ (Olaniyan et al., 2014). Ahmad et al. (2018) reported that urea (180 kg N ha⁻¹) showed the best results on the production of maize crops among the nitrogen sources. The maximum number of leaves plant⁻¹, number of cobs plant, number of grains cob, taller plants, grain, and biological yield was recorded in the application of 200kg N ha⁻¹ (Bakht et al. 2006). A study by Okumura (2011) showed that ear diameter and dry matter, plant height, and ear height increased with an increase in nitrogen level, but there was no significant effect on the index leaf's ear length and dry matter. He also added that grain protein increased until the level of 160 kg ha⁻¹ of N. Oktem. et al. (2010) concluded that increasing N applications increased the fresh ear yield, plant height, ear

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length, ear diameter, single fresh ear weight, leaf area index, dry root matter, and protein content.

On the other hand, nitrogen also is an element that is highly mobile and has many avenues of losses when applied in soil, such as leaching, volatilization, immobilization, and denitrification. Climate change is being experienced wherein there's an increase in surface temperatures due to greenhouse gases like carbon dioxide, methane, nitrous oxide, and fluorinated gases. According to Canatoy (2018), an increase in temperature will also increase the losses of Nitrogen-containing fertilizer through volatilization. To mitigate this kind of problem, the proper amount of soil moisture must be maintained and supplied, facilitating nutrient absorption by sweet corn. Soil moisture could be maintained by applying mulching materials covering and protecting the soil from sunlight's direct heat, which causes evaporation (Ndukwe et al., 2014). Iqbal et al (2020) reported that mulching can conserve soil moisture, enhance nutrients in the soil, control soil erosion, suppress weed growth, and remove the residual effects of pesticides, fertilizers, and heavy metals. Moreover, Amin et al (2021) found out that mulched treatments had lower N volatilization rate as compared to un-mulched soils due to the mulch barrier between the soil and the atmosphere.

In field conditions, organic mulch is mostly used as it can increase the overall performance of crop plants and also improves soil conditions. Rice straw could be a potential source of mulching materials due to high availability and profitability. In addition, rice straw conserve soil moisture and prevent soil erosion and release nutrients to the soil upon decomposition. Akhtar et al. (2019) concluded that the implementation of straw returning with nitrogen fertilization considerably increased soil moisture and decreased the temperature of the soil.

Integrated use of rice straw mulch with nitrogen fertilizer can increase crop yield and improved soil health. Hence, this study was conducted to verify the effects of different levels of N application mulched with rice straw on sweetcorn, particularly on the Macho F₁ variety.

2 MATERIALS AND METHODS

Table 1. Actual amount of fertilizer in grams per plot (11.25m²) used in the study

Treatments	Nitrogen	Solophos	Muriate of Potash
T ₁ = 0-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	0	337	112
T ₂ = 60-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	150	337	112
T ₃ =90-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	225	337	112
T ₄ = 120-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	300	337	112
T ₅ = 150-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	375	337	112

The study was conducted at the experimental area of the Department of Agronomy, Visayas State University, Baybay City Leyte, last July to September 2019. An Umingan clay loam soil of 325.25 m² was plowed and harrowed twice using a tractor at weekly intervals. This was done to pulverize the soil, incorporate the weeds into the soil, and provide a good soil condition for seed germination and seedling establishment. After the last harrowing, furrows were made at a distance of 0.75 m apart. The experimental area was laid out in Randomized Completely Block Design (RCBD) with three replications. Each plot measured 3 m x 3.75 m (11.25 m²). Alleyways of 1 m between replication and 0.5 m between treatment plots were provided to facilitate farm operations and data gathering. The treatments designated as follows: T₁- 0-60-60 kg ha⁻¹ N, P₂O₅, K₂O, T₂- 60-60-60 kg ha⁻¹ N, P₂O₅, K₂O, T₃- 90-60-60 kg ha⁻¹ N, P₂O₅, K₂O, T₄- 120-60-60 kg ha⁻¹ N, P₂O₅, K₂O, and T₅- 150-60-60 kg ha⁻¹ N, P₂O₅, K₂O.

Sweet corn seed (Macho F₁) was soaked overnight before planting to have a higher germination percentage. Seeds were sown in furrows at a distance of 75 cm between rows and 25 cm between hills at one seed per hill. Seeds were covered with a thin layer of soil to protect them from ants and birds. Rice straw was used as mulch 15 t ha⁻¹ equivalent to 16.89 kg per 11.25m² plot. These were applied in one plot 15 days after planting. All plots were applied with mulch. This can help to conserve moisture in the soil and control weed growth. Complete (14-14-14) fertilizer was applied for T₂ to T₅. At the same time, Solophos and Muriate of Potash for T₁ were applied ten days after planting. The second application for T₂ to T₅ was done 21 days after planting as a side dress. Nitrogen fertilizer applied was based on the specified treatments and was computed on a per plot basis. Spot weeding was done to control the growth of weeds in all treatment plots 14 days after planting. Very low infestation of corn borer was observed. Hence, no spraying was done throughout the growing stages of the sweetcorn. Harvesting was done 70 days after planting when the crop attained maturity, as exhibited by well-formed ears and yellowing and drying of mature leaves. Corn plants in the two inner rows, excluding the border

plants in each row, were harvested and used as experimental samples.

Data Gathered

The agronomic characteristics evaluated were the following; number of days to tasseling, number of days to maturity, plant height (cm), and Leaf Area Index (LAI). Leaf Area Index (LAI) and stover weight (tha^{-1}) were determined using these two formulae (Ahmad, et al. 2018):

$$\text{LAI} = \frac{\text{Length} \times \text{width} \times 0.75 \times 9.93}{\text{Ground area allotted per plant}}$$

$$\text{Stover Weight (t ha}^{-1}\text{)} = \frac{\text{Plot Yield(kg)}}{\text{Harvestable Area (5.625 m}^2\text{)}} \times \frac{10,000\text{m}^2\text{ha}^{-1}}{1,000 \text{ kg t}^{-1}}$$

Likewise, yield and yield components such as; ear length (cm), ear diameter (cm), number of marketable ears plot-1, number of non-marketable ears plot-1, the weight of marketable ears (t ha^{-1}). The weight was converted to tons per hectare basis using the formula:

$$\text{Wt. of marketable (t ha}^{-1}\text{)} = \frac{\text{Plot yield (kg)}}{\text{Harvestable area(5.625 m}^2\text{)}} \times \frac{10,000\text{m}^2\text{ha}^{-1}}{1,000 \text{ t}^{-1}}$$

Weight of non-marketable ears (t ha^{-1}), total ear yield (t ha^{-1}). The weight plot-1 was converted into tons per hectare basis using the formula as follows:

$$\text{Total Ear Yield (t ha}^{-1}\text{)} = \frac{\text{Plot yield(kg)}}{\text{Harvestable area (5.625 m}^2\text{)}} \times \frac{10,000\text{m}^2\text{ha}^{-1}}{1,000 \text{ kg t}^{-1}}$$

Harvest Index (HI) this parameter was obtained using the formula:

$$\text{Harvest Index (HI)} = \frac{\text{Economic Yield}}{\text{Economic Yield} + \text{Biological Yield}}$$

Other parameters gathered; profitability and meteorological data such as; total monthly rainfall (mm), average daily minimum and maximum temperatures ($^{\circ}\text{C}$), and relative humidity (%) throughout the conduct of the study were obtained from the records of Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA) Station, Visayas State University, Visca, Baybay City, Leyte. All the data was statistically analyzed using Statistical Analysis Software (SAS version 6.12). Comparison of means was done using the Honestly Significant Difference (HSD) test at 5% level of significance.

3 RESULTS AND DISCUSSIONS

Agronomic Characteristics

The agronomic response of sweet corn mulched with rice straw applied with different levels of Nitrogen is shown in Table 2. Results revealed that the different Nitrogen levels did not significantly affect all the agronomic characteristics except on the number of days from sowing to maturity and stover yield (t ha^{-1}). No significant response to days from sowing to tasseling, plant height, and Leaf Area Index (LAI). This results can be attributed to the varietal characteristics of macho hybrid corn variety can absorbed more moisture than the ordinary inbred corn variety. Moreover, application of rice straw mulch can conserve soil moisture needed by the plants. Likewise, it improves the properties of the soil in all treatment plots. On the other hand, sweet corn matures late when applied at 120- 150 kg N ha^{-1} (T_4 and T_5) 77.00-77.67 days, respectively. This implies that as nitrogen application increases the number of days from sowing to maturity. This might be due to high amount of nitrogen that will result to delay in vegetative growth (Shrestha, 2013) and in return, it will delay the reproductive stage of sweet corn. Relative to the stover weight (tha^{-1}), plants applied with Nitrogen (T_2 - T_5) had a comparable higher result with each other compared to the plants not applied with N. This indicated that fresh herbage weight (FHW) had similar comparable weights when applied with nitrogen level from 60-150 kg N ha^{-1} . The effects of different nitrogen levels were significant in forage and dry matter yield. It was determined that 300 kg N ha^{-1} was suitable for high forage and dry matter yield. The forage yields of cultivar were obtained between 81,457 and 92,913 kg ha^{-1} (Abdullah, et al., 2009).

Yield and Yield Components

Table 3 shows the yield and yield components of sweet corn mulched with rice straw applied with Nitrogen levels. Results revealed that the number of marketable ears per hectare, weight of marketable ear (t ha^{-1}), ear diameter, and total ear yield (t ha^{-1}) were significantly affected by the treatments.

The highest level of N application at 150 kg ha^{-1} (T_5) obtained more numbers of marketable ears but is comparable to the level of application of N at 60 and 90 kg ha^{-1} . On the other hand, application of N at the highest level (150 kg ha^{-1}) significantly had the heaviest weight of marketable ears (tha^{-1}), while the lightest had significantly observed on zero N application (T_1). Without N application, this may cause nutrient deficiency that can result to small and deformed ears, thus decrease marketable ears (Oktem and Oktem (2005). In terms of ear diameter, application of N at any rate (T_2 - T_5) had a

Table 2. Agronomic characteristics of sweet corn mulched with rice straw applied with different levels of Nitrogen

Treatment	Number of days from sowing to		Plant Height (cm)	Leaf Area Index	Stover Weight (t ha ⁻¹)
	Tasseling	Maturity			
T ₁ = 0-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	57.33	73.67 c	176.90	2.80	10.77 b
T ₂ = 60-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	56.67	74.33 c	189.37	2.87	13.62 a
T ₃ = 90-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	57.33	76.00 b	188.70	2.68	14.37 a
T ₄ = 120-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	57.67	77.00 ab	189.30	3.01	13.23 a
T ₅ = 150-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	58.67	77.67 a0	189.77	2.79	14.76 a
CV (%)	02.55	1.090	4.74	8.04	7.510

Table 3. Yield and yield components of sweet corn mulched with rice straw applied with different levels of Nitrogen

Treatment	Ear Number (ha ⁻¹)		Ear Weight (t ha ⁻¹)		Ear Diameter (cm)	Ear Length (cm)	Harvest Index	Total Ear Yield (t ha ⁻¹)
	Marketable	Non-marketable	Marketable	Non-marketable				
T ₁ = 0-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	21,352 b	8878	3.01 c	0.61	4.59 b	13.28	0.25	3.61 c
T ₂ = 60-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	29,056ab	7117	5.54 b	0.60	4.91 a	15.32	0.31	6.15 b
T ₃ = 90-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	28,469ab	8878	5.78 b	0.80	5.01 a	15.67	0.31	6.58 b
T ₄ = 120-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	26,103 b	8878	5.54 b	1.00	5.07 a	16.91	0.33	6.54 b
T ₅ = 150-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	35,587 a	7117	7.44 a	0.71	5.20 a	16.18	0.35	8.15 a
CV (%)	15.59	23.03	15.30	20.06	3.31	8.71	11.51	14.12

The same and without letters in a column are not significantly different at the 5% level, HSD test

Table 4. Profitability analysis of sweet corn production mulched with rice straw applied with different levels of Nitrogen

Treatment	Weight of Marketable Ears (t ha ⁻¹)	Gross Income (PhP)	Total Variable Cost (PhP)	Gross Margin (PhP)
T ₁ = 0-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	3.01 c	60,200.00	31,534.00	28,666.00
T ₂ = 60-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	5.54 b	110,000.00	34,210.00	75,790.00
T ₃ = 90-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	5.78 b	115,600.00	38,898.00	76,702.00
T ₄ = 120-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	5.54 b	110,800.00	40,155.00	70,645.00
T ₅ = 150-60-60 kg N, P ₂ O ₅ , K ₂ O ha ⁻¹	7.44 a	148,800.00	48,176.00	100,624.00

Gross income was based on the prevailing market price of Php 20.00 per kg of sweet corn during harvest.
 comparable result, while the shortest ear diameter was significantly observed on zero N application (T1).

Increased ear diameter was observed by Khan et al. (2008) who states that more photosynthetic activities occur on plants in response to adequate supply of N. On the other hand, the highest total ear yield (t ha⁻¹) was obtained by T5 with the highest N application (150 kg ha⁻¹) but is comparable to T4 and T3. T1 obtained the lowest ear yield with zero N application. This result can be attributed to the effect of nitrogen fertilizer to enhance the growth and yield of the crop, particularly on sweet corn plants.

Profitability Analysis

Profitability analysis of sweet corn (Macho F1) mulched with rice straw applied with different Nitrogen levels is presented in Table 4.

Sweet corn applied with the highest N levels at 150 kg ha⁻¹ N, P205 and K20 obtained the highest gross margin of PhP100,624.00 ha⁻¹ due to a higher marketable yield at 7.44 tha⁻¹ plants applied with 90 kg N, P205, K20 ha⁻¹ at PhP76,702. Lowest gross margin of PhP28,666.00 ha⁻¹ obtained by the plants not applied with N fertilizer. According to Cagasan and Agarcio (2004), the most critical factor to consider in increasing net income is efficiency in managing the resources to reduce production costs.

4 CONCLUSION

Application of 120-150 kg of N ha⁻¹ resulted in a late maturity than plants did not receive Nitrogen fertilizer. Likewise, application of N regardless of rates increased the stover yield (tha⁻¹) and ear diameter. However, the application of 150 kg of N ha⁻¹ increased the marketable yield (t ha⁻¹) and total ear yield (t ha⁻¹). Thus, this treatment (T5) obtained the highest net income of PhP100,624.00. This implies that hybrid sweetcorn (Macho F1 variety) requires higher rates of N fertilizer at 150 kg of N ha⁻¹ to obtain its maximum potential yield per hectare. It is recommended that sweetcorn variety Macho F1 be applied with 150 kg of N ha⁻¹ to obtain the maximum potential yield.

RECOMMENDATION

Moreover, it is recommended to include the weed data to monitor the positive effects of mulching materials in controlling the weeds.

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