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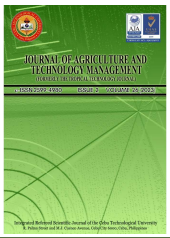

Improving the yield of hybrid corn using bioprime nanofertilizer under Echague, Isabela condition

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ABSTRACT

The study was confined to Dalibubon, Jones, Isabela from June 5 to September 20, 2022, to evaluate the effect of Bioprime nanotechnology on increasing the productivity of hybrid corn in Isabela. The different treatments used were varying levels of inorganic fertilizer and Bioprime NPK nanofertilizer (T1 – 140-20-30 kg NPK ha¬-1, T2 – 70-10-15 kg NPK ha¬-1 + 5g Bioprime seed treatment, 10g soil treatment and 5g foliar spray at 25 DAP, T3 – 70-10-15 kg NPK ha¬-1 + 5g Bioprime seed treatment, 10g soil treatment and 5g foliar spray at 25 and 35 DAP, T4 – 105-15-22.5 kg NPK ha¬-1 + 5g Bioprime seed treatment & 10g soil treatment and 5g foliar spray at 25 and 35 DAP, T5 – 140-20-30 kg NPK ha¬-1 + 5g Bioprime seed treatment, 10g soil treatment and 5g foliar spray at 25 DAP, T6 – 70-10-15 kg NPK ha¬-1 + 10g Bioprime soil treatment and 5g foliar spray at 25 DAP) laid-out in a randomized complete block design (RCBD), with three replications.

Findings suggest insignificant results in terms of height and stem of plants at 30, 60, and 90 DAP, number of roots at 30 DAP and harvest, ear length, ear diameter, ear weight per plant and 15m2 sampling area, grain weight and moisture, weight of 100 kernels, weight and length of roots. Highest shelling recovery was found in T5 with 77.51%. Overall, reduced utilization of inorganic fertilizer along with a system of application of Bioprime nanofertilizer for growing hybrid yellow corn exhibits promising potential in terms of increasing yield as well as economic returns. More specifically, a reduction of inorganic fertilizer at 25% supplemented with 25 g Bioprime nanofertilizer and a reduction of inorganic fertilizer at 50% applied with 15 g Bioprime nanofertilizer are recommended in hybrid yellow corn production.

KEYWORDS: *Bioprime Nanofertilizer, Foliar Spray, Hybrid Corn, Seed Treatment, Soil Treatment*

1 INTRODUCTION

Corn is the second most important cereal crop in the Philippines (Gerpacio, 2004). Yellow corn is the most important corn type in the Philippines and is primarily used as feed, especially for poultry and swine. In 2003, more than 844 885 ha of agricultural land in the Philippines were planted with yellow corn. Furthermore, it is the staple food for many Filipinos in the southern part of the country. It is estimated that about five million Filipinos, who depend on the commodity for their livelihood. In terms of gross value added (GVA) in agriculture, corn ranks second to rice as a staple food grown in 9.67% of the crop area (PSA, 2020). In 2021, corn registered an output of 4.23 metric tons per hectare, which increased by 0.22 metric tons over the yield per hectare in 2020 of 4.01 metric tons (PSA, 2021). Productivity slightly improved by 0.5% owing to increase use of good-quality seeds; however, there was an 85 thousand hectare drop in the area harvested. An extended dry spell during the first semester of the year and flooding or excessive rains before year-end caused most of the losses.

Isabela is the top corn-producing province in the Philippines, contributing 18.33%, or 18.33 metric tons of the country's total yellow corn production in 2020 (DA-BAR, 2022). It is located in the northeast region of the country. Corn is grown rainfed in lowland, upland, and even in riverine or flood plain areas along the Cagayan River in Isabela. Monocropping of corn is predominantly practiced in Isabela, and there are two cropping seasons per year: wet season cropping from May to August and dry season cropping from November to February. A total of 146,965 ha were planted to yellow corn in the province in 2003. The average yield of yellow corn was 3.65 tons per hectare (t ha-1), which was comparatively higher than the national yellow corn yield average of 3.03 t ha-1. Most of the corn type being produced in the province is yellow corn, which accounts for 95% of the total corn produced in the province (Lansigan et al. 2001).

The climate in the agricultural region of Isabela has historically had no pronounced dry or wet seasons but relatively dry in the first half of the year and wet during the second half. Average rainfall is 1844 mm per year, the mean temperature is 29 °C, and relative humidity is 66%

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(PAGASA, 2000). The crop grows well in the province even without irrigation infrastructure, with the local climate classification bordering on types III and IV (no pronounced dry season and even rainfall distribution year-round). In general, the climate and the vast plains of Isabela are suitable for corn production. As of 2005, the top producing municipalities in Isabela were: San Agustin, Naguilian, San Guillermo, San Mariano, Tumauini, Angadanan, Jones, Echague, Cauayan City and Ilagan City.

Apart from different biotic and abiotic factors, a decrease in corn production is also attributed to technological and socioeconomic constraints encountered by farmers. It has long been established that conventional agriculture depends heavily on the use of inorganic fertilizer that provides sufficient macronutrients, with some drawbacks for the environment, and corn is no exception. In general, corn is cultivated with the intensive application of inorganic fertilizers (Brotodjojo and Arbiwati, 2018). Thus, even the ability to purchase such inputs poses a problem as it allows the excessive application that leads to undesirable consequences such as pollution of food and feed, health hazards, toxicity towards plants and animals, degradation of soil quality, and overall, environmental pollution (Rahman et al., 2008).

Among the emerging methods developed to address these concerns is to reduce the application of inorganic fertilizer and utilize some other sources of nutrients in order to balance the fertilization. Like traditional fertilizer, nanofertilizers are also nutrients consisting in whole or in part of nano-structured formulation that can be supplied to plants, enabling the active ingredients to be taken up efficiently or released slowly. The exceptional properties of nanoparticles, such as high surface area/volume size ratio and enhanced optoelectronic and physicochemical properties compared to their bulk counterparts, are now emerging as a promising strategy to promote plant growth and productivity. As a result of their unique properties, nanoparticles may influence the metabolic activities of the plant to different degrees compared to conventional materials and have the potential to mobilize native nutrients, such as phosphorous, in the rhizosphere (Kumar et al., 2021).

Bioprime nanofertilizer is a unique organic fertilizer and soil conditioner that brings the soil back to life as it rejuvenates the natural nutrients that are essential for healthy plants and healthy soil and allows the plants to reach their fullest potential. Bioprime nanofertilizer has a guaranteed analysis of 0.5% N, 0.5% P2O5 and 10% K2O. It is an NPK fertilizer that is a proprietary blend of three components: (1) billions of microorganisms; (2) sea kelp; and (3) mineral electrolytes. When mixed and activated in water, these microbes wake up and reproduce and are able to solubilize phosphate reserves, leading to increased yields, better quality harvests, increased root growth, quicker release of rock phosphate, and increased Brix (Urth Agriculture, 2021). Thus, this paper evaluates the effect of Bioprime nanotechnology on increasing the productivity of hybrid corn under Isabela condition. Specifically, it aims to: a) determine the effect of Bioprime as a seed treatment on the germination, growth, and yield of hybrid corn; b) evaluate the effect of Bioprime as a soil treatment and foliar spray on the growth and yield of hybrid corn; c) determine the best time to apply the Bioprime fertilizer as foliar spray and; d) determine which among the different treatments will give the highest return on investment.

2 MATERIALS AND METHODS

2.1 Planting Material and Location of Trial

The hybrid yellow corn seeds used were NK 6410 variety. It was conducted at Dalibubon, Jones, Isabela, Philippines.

Varietal Characteristic of NK6410	
Maturity	100 – 105 days after planting
Potential Yield	12 metric tons per hectare
Key Characteristics	Shorter Maturity (15 – 20 days earlier) Heavy Grains Yellow orange grains (Class A) Easy to dehusk and harvest

2.2. Field Experiment

A total land area of 5,000 square meters were used as experimental area for the study. It was initially plowed with a tractor and harrowed. The area was left idle for two weeks to allow weeds to decay and allow weed seeds to germinate before the final plowing. Final harrowing was performed using the animal–drawn plow before transplant, until the soil was thoroughly pulverized. After the final harrowing, the experimental area was divided into three blocks with an alleyway of one meter in between blocks. Each block was subdivided into six plots with an alleyway of half meter in between plots (5m x 38m). The different treatments were allocated to the plots following the procedure for randomized complete block design (RCBD). The furrows at a distance of 60 centimeters in between were established just before the application of inorganic fertilizer along the furrows of their corresponding plots. Two seeds were planted per hill at a distance of 20 centimeters using a manual jabber. Thinning of corn was done 10 days after planting, and final thinning was carried out 15 days after planting.

The different treatments used were the following: T1 – 140-20-30 kg N, P2O5, K2O ha¬-1 (recommended rate based on soil analysis), T2 – 70-10-15 kg N, P2O5, K2O ha¬-1 + 5g bioprime seed treatment & 10g soil treatment and 5g foliar spray at 25 days after planting (DAP), T3 – 70-10-15 kg N, P2O5, K2O ha¬-1 + 5g Bioprime seed

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treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP, T4 – 105-15-22.5 kg N, P2O5, K2O ha¬-1 + 5g Bioprime seed treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP, T5 – 140-20-30 kg N, P2O5, K2O ha¬-1 + 5g Bioprime as Seed & 10g Soil Treatment and 5g Foliar Spray at 25 DAP, T6 – 70-10-15 kg N, P2O5, K2O ha¬-1 + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP. The N, P2O5, K2O content of the soil was used as the basis for the recommendation of inorganic fertilizer.

The Bioprime nanofertilizer was applied as a seed treatment, soil treatment, and foliar spray. For seed treatment, the Bioprime concentrate was prepared by activating 5 grams of Bioprime nanofertilizer into 2L non-chlorinated water and incubating it in an open container for 48 hrs. This was diluted with 30 liters of non-chlorinated water. For seed soaking, 2 bags of NK6410 seeds were soaked in the Bioprime solution for 12 hours before planting. For soil treatment, 10 grams of Bioprime nanofertilizer were mixed with 4 liters of non-chlorinated water and incubated in an open container for 48 hrs. The 4 liters Bioprime concentrate was diluted to 96 liters of non-chlorinated water and sprayed into the soil prior to planting. Foliar application was applied over the top through mist application using a single-hole nozzle sprayer at 25 and 35 days after planting at a rate of 5 grams per hectare. The corn was managed following the farmer's practice for corn production. Hilling-up was done after side dressing, which was done 35 days after planting. The occurrence of pests and weeds was monitored and controlled using an insecticide and an herbicide. The following data were gathered: plant height at 30, 60, and 90 DAP, stem diameter at 30, 60, and 90 DAP; number of adventitious roots at 30 DAP and harvest; corn ear length; corn ear diameter; weight of 100 kernels; corn ear weight per plant; corn ear weight per 15m2 sampling area; and grain weight per plant.

2.3 Statistical Analysis

The data were analyzed using the statistical tool for agricultural research (STAR). The data were analyzed using the ANOVA for Randomized Complete Block Design. The treatments with significant results were compared using the Tukey's Honestly Significant Difference (HSD) Test.

2.4 Economic Analysis

The return on investment was computed using the simple economic analysis. The cost of production was based on the prevailing price of farm inputs and labor in the community. The gross income was determined based on the prevailing price of dried grains per kilo in the market. The following formula was used in this study;

Net Income = Gross Income – Cost of Production

$$\text{Return on Investment} = = \frac{\text{Net Income}}{\text{Cost of Production}} \text{ x } 100$$

3 RESULTS AND DISCUSSIONS

3.1 Plant Height at 30 Days after Planting. The plant height at 30 days after planting as affected by Bioprime nanofertilizer is presented in Table 1. It was found that the application of Bioprime nanofertilizer did not significantly influence the height of plants at 30 days after planting with means ranging from 87.63 to 100.62 centimeters.

Likewise, no significant differences were noted on the height of plants at 60 days after planting with means ranging from 232.28 to 242.68 centimeters. Also, the plant height at 90 days after planting showed insignificant results with means ranging from 230.75 to 243.17 centimeters.

Stem Diameter at 30 Days after Planting. The influence of Bioprime nanofertilizer on the stem diameter at 30, 60, and 90 days after planting is shown in Table 2. Insignificant variations were obtained in the stem diameter after 30, 60, and 90 days after planting with means ranging from 2.02 to 2.16 centimeters, 1.98 to 2.09

Number of Adventitious Roots at 30 Days after Planting and Harvesting. The effect of Bioprime nanofertilizer on the number of adventitious roots at 30 days after planting and harvesting is obtained in Table 3. It was observed that the number of adventitious roots at 30 days after planting and harvesting showed no significant differences as affected by Bioprime nanofertilizer with means ranging from 12.67 to 15.33 and 14.00 to 18.33 counts, respectively.

Visual Root Condition at 30 Days after Planting. The root condition at 30 days after planting was visually assessed following the scale indicated in Figure 1. It was observed that T6 got the highest rating of 9.0 which manifested thick roots with lateral roots and many root hairs. It was followed by T3, T4 and T5 having a rate of 7.0 which indicates that the roots are thick with lateral roots and minimal root hairs. Lowest rating was obtained from T1 and T2 with 5.0 which exhibited thick roots with lateral roots and very few root hairs. The increase on the number of root hair is attributed to the soil application of Bioprime wherein, the microorganisms granulated the soil, which aerated it to facilitate the infusion of water and air, resulting in stronger and deeper plant root systems.

The presence of root hair is found to significantly increase the interaction between the plant and the soil, especially on the nutrient- and water-absorbing root surface area (Holz et al., 2018). In addition to increasing the surface area, root hairs access finer pores than the main root axis, so the volume of soil influenced by roots can increase significantly (Ruiz et al., 2020). The maize primary roots with root hairs could penetrate soil that is five times stronger than that penetrated by root hairless maize mutants. Together, root hairs are involved in a number of processes that enhance crop tolerance to abiotic stresses (Bengough et al., 2016).

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Table 1. Plant Height at 30 Days after Planting as Affected by Bioprime

TREATMENT	Plant Height (cm)		
	30 DAP	60 DAP	90 DAP
T_1 – 140-20-30 kg NPK ha^{-1}	88.75	232.77	233.22
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	87.63	232.58	230.75
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	89.88	232.28	237.73
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	100.62	242.68	243.17
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime as Seed & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	96.53	234.80	235.12
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	95.35	239.93	238.32
F-RESULTS	ns	ns	ns
C.V (%)	7.95	2.98	2.19

Table 2. Stem Diameter at 30 Days after Planting as Affected by Bioprime Nanofertilizer

TREATMENT	Stem Diameter (cm)		
	30 DAP	60 DAP	90 DAP
T_1 – 140-20-30 kg NPK ha^{-1}	2.02	2.09	1.95
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	2.08	1.98	1.91
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	2.04	1.91	1.99
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	2.16	2.09	1.70
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime as Seed & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	2.07	1.98	1.94
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	2.12	2.02	1.69
F-RESULTS	ns	ns	ns
C.V (%)	4.34	4.66	12.84

Table 3. Number of Adventitious Roots at 30 Days after Planting as Affected by Bioprime Nanofertilizer

TREATMENT	Number of Adventitious Roots	
	30 DAP	Harvest (105 DAP)
T_1 – 140-20-30 kg NPK ha^{-1}	12.67	16.33
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	14.00	16.17
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	13.67	16.50
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	13.00	14.00
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	14.00	18.33
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	15.33	16.00
F-RESULTS	ns	ns
C.V (%)	13.10	16.58

Ear Length. The length of ears as influenced by Bioprime nanofertilizer is presented in Table 4. No significant variations were obtained in the length of the ears with means ranging from 16.92 to 18.43 centimeters.

Ear Diameter. The effect of bioprime nanofertilizer on the ear diameter is shown in Table 5. There were no

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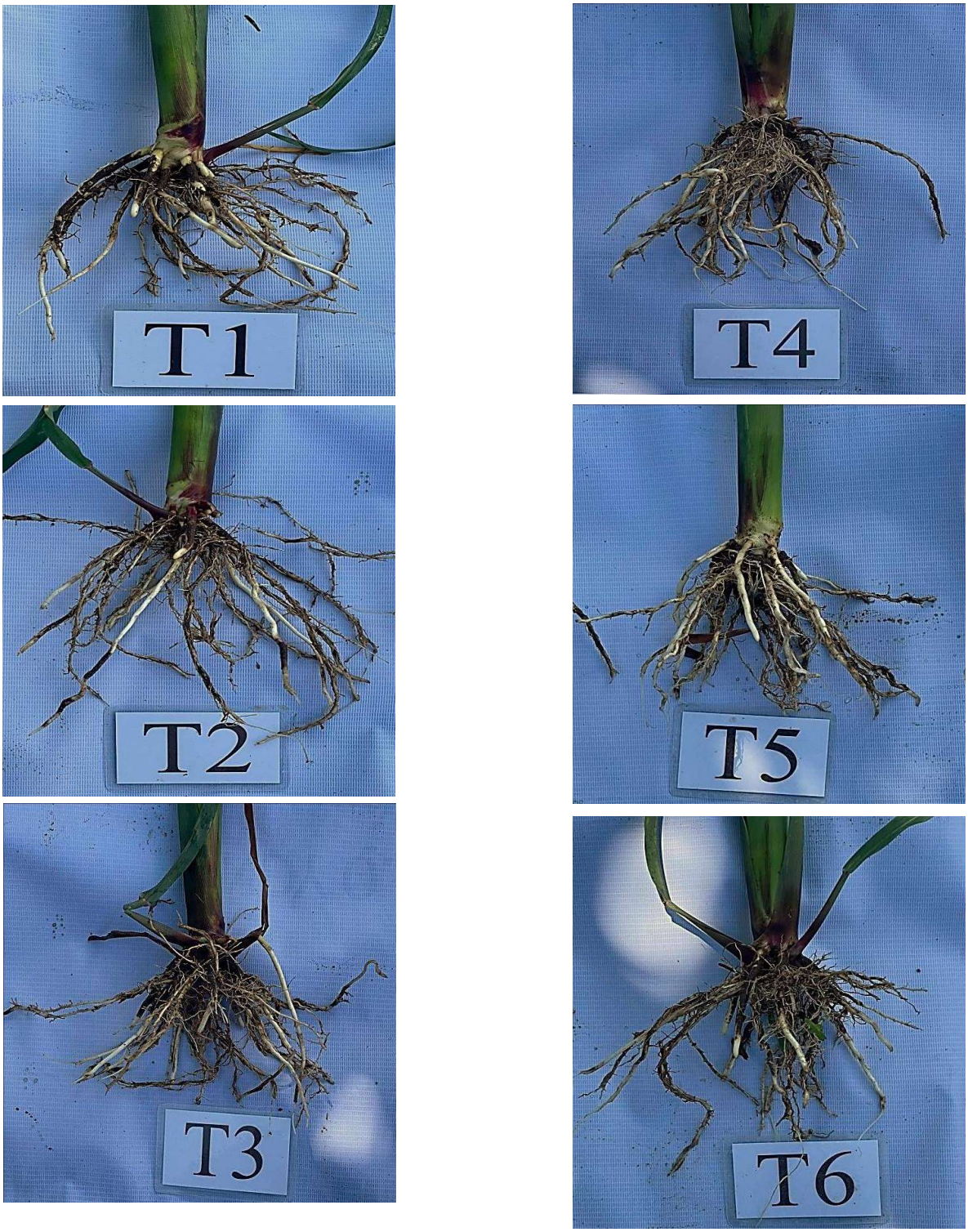

Figure 1. Representative examples of visual scoring scale for root condition. Visual scoring scale for root condition where 9 = thick roots with lateral roots and many root hairs, 7 = thick roots with lateral roots with minimal root hairs, 5 = thick roots with lateral roots and very few root hairs, 3 = thin roots with lateral roots, 1 = thin roots without lateral roots.

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Table 4. Ear Length (cm) as Affected by Bioprime Nanofertilizer

TREATMENTS	Ear Length (cm)
T_1 – 140-20-30 kg NPK ha^{-1}	17.46
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	17.60
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	17.30
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	18.43
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	16.92
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	17.26
ANOVA RESULT	ns

Table 5. Ear Diameter (cm) of corn as affected by BioPrime Nanofertilizer

TREATMENTS	Ear Diameter (cm)
T_1 – 140-20-30 kg NPK ha^{-1}	4.57
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	4.51
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	4.46
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	4.66
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	4.50
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	4.61
ANOVA RESULT	ns

Table 6. Ear (g) Weight without Husk per Plant as Affected by BioPrime Nanofertilizer

TREATMENTS	Ear Weight without Husk per plant
T_1 – 140-20-30 kg NPK ha^{-1}	212.13
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	203.33
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	197.17
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	236.50
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	202.00
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	177.00
ANOVA RESULT	ns

significant differences obtained in the ear diameter with means ranging from 4.50 to 4.66 centimeters.

occurs during vegetative stages). This should explain the results as shown in Table 14 and also agree to the cause being excessive amount of water, in this case, rain which is critical during the vegetative stage. Additionally, because there is less oxygen in the soil due to standing water, nitrate in the soil may be transformed into forms that plants cannot absorb and may be lost to the environment. Even with sidedress N treatment, maize flooded for 6 days or more yields less than corn flooded for 4 days or less by 9 to 33%. During the trial, persistent rainfall which took place for more than a month during the vegetative and reproductive stages of the hybrid corn further justifies the results obtained in this study.

Ear Weight without Husk per Plant. Ear weight without husk per plant as affected by Bioprime nanofertilizer is revealed in Table 6. It was observed that bioprime nanofertilizer exhibited insignificant results on

Table 7. Ear Weight (kg) per 15m^2 Sampling Area as Affected by Bioprime Nanofertilizer

TREATMENTS	Ear Weight (kg) per Sampling Area
T_1 – 140-20-30 kg NPK ha^{-1}	25.09
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	21.87
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	23.94
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	26.15
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	25.20
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	23.46
ANOVA RESULT	ns

Table 8. Grain Weight (kg) per Plant as Affected by BioPrime Nanofertilizer

TREATMENTS	Grain Weight (g)
T_1 – 140-20-30 kg NPK ha^{-1}	1718.33
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	1650.00
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	1710.00
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	1740.00
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	1718.33
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	1686.67
ANOVA RESULT	ns

Table 9. Grain Moisture (%) of Corn as Affected by BioPrime Nanofertilizer

TREATMENTS	Grain Moisture (%)
T_1 – 140-20-30 kg NPK ha^{-1}	28.20
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	26.73
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	27.77
T_4 – 105-15-22.5 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	26.83
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	26.40
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	27.47
ANOVA RESULT	ns

the ear weight without husk per plant with means ranging from 177.00 to 236.50 grams.

Ear Weight per 15m2 Sampling Area. The weight of ear per 15m2 sampling area as influenced by Bioprime nanofertilizer is shown in Table 7. Similarly, there were no significant differences obtained on the weight of ear per sampling area having means ranging from 21.87 to 26.15 kilograms.

Grain Weight. The grain weight as influenced by Bioprime nanofertilizer is shown in Table 8. Insignificant results was denoted on the weight of grain per sampling area with means ranging from 1650.00 to 1718.33 grams.

Grain Moisture. Grains moisture from the different treatments is presented in Table 9. The grain moisture showed insignificant differences among treatments with

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Table 10. Weight (g) of 100 Kernels as Affected by Bioprime Nanofertilizer

TREATMENTS	Ear Weight (kg) per Sampling Area
T1 – 140-20-0 kg NPK ha¬-1	36.67
T2 – 70-10-0 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	35.00
T3 – 70-10-0 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	35.00
T4 – 105-15-0 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	36.67
T5 – 140-20-0 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	36.67
T6 – 70-10-0 kg NPK ha¬-1 + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	36.67
ANOVA RESULT	ns

NOTE: Means with the same letter are not significantly different from each other using the Honest Significant Difference.

Table 11. Shelling Percentage (%) of Corn as Affected by BioPrime Nanofertilizer

TREATMENTS	Ear Weight (kg) per Sampling Area
T1 – 140-20-0 kg NPK ha¬-1	77.06ab
T2 – 70-10-0 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	76.12c
T3 – 70-10-0 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	76.57bc
T4 – 105-15-0 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	76.93abc
T5 – 140-20-0 kg NPK ha¬-1 + 5g Bioprime as Seed & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	77.51a
T6 – 70-10-0 kg NPK ha¬-1 + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	76.83abc
ANOVA RESULT	**

NOTE: Means with the same letter are not significantly different from each other using the Honest Significant Difference.

Table 12. Weight and Length of Roots as Affected by Bioprime Nanofertilizer

TREATMENTS	Weight of Roots	Length of Roots
T1 – 140-20-30 kg NPK ha¬-1	136.67	97.75
T2 – 70-10-15 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	190.00	97.25
T3 – 70-10-15 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	115.83	111.50
T4 – 105-15-22.5 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	162.50	99.75
T5 – 140-20-30 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	104.17	91.75
T6 – 70-10-15 kg NPK ha¬-1 + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	132.50	107.50
ANOVA RESULT	ns	ns

means ranging from 26.73 to 28.20 percent.

Weight of 100 Kernels. The weight of 100 kernels manifested no significant differences, with means ranging from 35.00 to 36.67 grams, as presented in Table 10.

Shelling Recovery. The shelling percentage as influenced by Bioprime nanofertilizer is obtained in Table 11. A significant result was obtained in the shelling

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Table 13. Weight and Length of Roots as Affected by Bioprime Nanofertilizer

TREATMENTS	Computed Yield (kg, tons)	
	kilograms	tons
T1 – 140-20-30 kg NPK ha¬-1	12879.53	12.88
T2 – 70-10-15 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	11080.85	11.08
T3 – 70-10-15 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	12289.26	12.29
T4 – 105-15-22.50 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	13423.73	13.42
T5 – 140-20-30 kg NPK ha¬-1 + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	13104.07	13.10
T6 – 70-10-15 kg NPK ha¬-1 + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	12042.86	12.04

Table 14. Cost and Return Analysis per Hectare of Hybrid Yellow Corn as Affected by Bioprime Nanofertilizer

TREATMENT	COST OF PRODUCTION	GROSS INCOME	NET INCOME	ROI (%)
T_1 – 140-20-30 kg NPK ha^{-1}	65,362.00	180,313.42	114,951.42	175.87
T_2 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	60,626.00	155,131.90	94,505.90	155.88
T_3 – 70-10-15 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	62,826.00	172,049.64	109,223.64	173.85
T_4 – 105-15-22.50 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 and 35 DAP	69,069.00	187,932.22	118,863.22	172.09
T_5 – 140-20-30 kg NPK ha^{-1} + 5g Bioprime Seed Treatment & 10g Soil Treatment and 5g Foliar Spray at 25 DAP	73,112.00	183,456.98	110,344.98	150.93
T_6 – 70-10-15 kg NPK ha^{-1} + 10g Bioprime Soil Treatment and 5g Foliar Spray at 25 DAP	58,776.00	168,600.04	109,824.04	186.85

Price of Corn: Php14/kg

percentage of corn, whereby highest shelling recovery was found in T5 with 77.51%. However, the latter was comparable to plants treated with T1, T4 and T6 which had means of 77.06, 76.93 and 76.83%, respectively. Moreover, T4 and T6 were similar to T3 with 76.57%. The lowest shelling recovery was obtained in T2 with 76.12%.

Spraying of nano-amino acids as supplementary feeding improved the efficiency of application of ground-based fertilizer (Alzreejawi and Al-Juthery, 2021). This is in agreement with the ability of elements or nanoparticles to bind to protein carriers that penetrate the cell walls and encourage an increase in the uptake of the material into the plant (Shakir et al., 2019). These results were consistent with those of Abidah et al. (2020) on yellow corn.

Weight and Length of Roots. The weight and length of roots after harvest are presented in Table 12. Insignificant variations were obtained in the weight of roots, with means ranging from 115.83 to 190.00 grams. However, length of roots was not significantly affected by the application of Bioprime nanofertilizer, which garnered means ranging from 91.75 to 111.50 centimeters.

Computed Grain Yield per Hectare. The grain yield per hectare of yellow corn as influenced by Bioprime nanofertilizer is presented in Table 13. The highest grain yield was obtained in T4 with 13423.73 kilograms (13.42 tons), T5 with 13104.07 kilograms

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(13.10 tons), T1 with 12879.53 kilograms (12.88 tons), T3 with 12289.26 kilograms (12.29 tons), T6 with 12042.86 kilograms (12.04 tons) and T2 with 11080.85 kilograms (11.08 tons).

The application of 75% inorganic fertilizer supplemented with 25 g of Bioprime revealed a 4.23% yield increase compared to the sole application of inorganic fertilizer.

Cost and Return Analysis. The cost and return analysis of yellow corn applied with Bioprime nanofertilizer is shown in Table 14. The highest return on investment was obtained in plants applied with 50% inorganic fertilizer supplemented with 15 grams Bioprime nanofertilizer (T6) with 186.85%. The application of 15 grams Bioprime nanofertilizer gave 10.98% increase in profit as compared to the sole application of inorganic fertilizer (T1).

Overall, the data collectively implies no significant difference in the agronomic characteristics and attributes of hybrid corn applied with Bioprime nanofertilizer. This is heavily attributed to the weather condition to which the hybrid corn plant was subjected to during the trial, which is at its vegetative and reproductive stages. According to Dill (2022), waterlogging can affect yield in two main ways: 1) damage to the plant physiologically and 2) N loss through denitrification or leaching.

Standing water in a field can reduce corn output by limiting ear development and impeding growth (which occurs during vegetative stages). This should explain the results as shown in Table 14 and also agree to the cause being excessive amount of water, in this case, rain which is critical during the vegetative stage. Additionally, because there is less oxygen in the soil due to standing water, nitrate in the soil may be transformed into forms that plants cannot absorb and may be lost to the environment. Even with sidedress N treatment, maize flooded for 6 days or more yields less than corn flooded for 4 days or less by 9 to 33%. During the trial, persistent rainfall which took place for more than a month during the vegetative and reproductive stages of the hybrid corn further justifies the results obtained in this study.

4 CONCLUSION

The smallholder pig producers said that the hog-growing business is a potentially profitable endeavor and socially sustainable. In addition to this, based on the experiences of the subsistence pig producers that hog growing or piggery operation is a promising business. It has high demand in the domestic market. Both smallholder pig producers and subsistence hog producers continue operating hog production since the demand is high. It is a profitable business, helps sustain the food supply for the southwestern part of Cebu Island, and is a sustainable industry.

RECOMMENDATION

Reduction of inorganic fertilizer at 25% supplemented with 25g Bioprime nanofertilizer and reduction at 50% of inorganic fertilizer applied with 15g Bioprime nanofertilizer are recommended in hybrid yellow corn production. In addition, since hybrid seeds are readily treated upon procurement, seed soaking should be omitted as this process may lead to the removal of chemical treatments. As the rate of inorganic fertilizer use is decreased, the rate of Bioprime nanofertilizer application should have an equivalent increase to compensate for the amount of nutrients needed for sufficient crop growth. Therefore, upon 50% reduction of inorganic fertilizer, the crop should be supplemented with 20 g Bioprime nanofertilizer during the soil treatment as well as 25 and 35 DAP foliar sprays.

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