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Productivity of 'Saba' Banana (*Musa acuminata* x *balbisiana*) as influenced by Different Levels of NPK Fertilizer under Jasaan Soil Series

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Abstract

'Saba' (Musa acuminata x balbisiana) is the second most grown banana in the Philippines. With the banana's increasing demand and wider market both locally and abroad, growers need to advance and sustain farm efficiency. Among the various factors in production, plant nutrition is one of the key components for higher productivity. Hence, a field study was conducted in Claveria, Misamis Oriental, Philippines to evaluate the effects of NPK fertilizer on the banana's productivity under the Jasaan Soil Series – a major soil dominating Claveria. In addition to T1 (no NPK), there were four varying levels of NPK fertilizer applied as treatments, namely T2 (N_{90}-P_{30}-K_{120}), T3 (N_{135}-P_{60}-K_{180}), T4 (N_{180}-P_{120}-K_{360}) and T5 (N_{270}-P_{180}-K_{540}). The results showed that T3 produced a significant difference in base girth in the 11th month and one-third girth in the 7th month, while T5 recorded the most number of suckers in the 12th, 13th and 14th months from planting. The highest level of NPK (T5) influenced the total bunch weight with 28.87 kg and yield (10.98 t/ha), while T3 obtained a significant difference in the diameter of the finger (16.04 cm). T1 showed the highest return on investment (2.03%); however, the highest level of NPK prevailed with the highest yield among all the other treatments on the main crop. Related studies are suggested to verify the sustainability of NPK fertilizer on the succeeding ratoons.

***Keywords**:* Jasaan soil, nitrogen, phosphorus, plant nutrition, potassium, 'Saba' banana

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1. Introduction

Banana is the number one fruit grown in the Philippines in terms of volume, value and area of production; it is considered one of the most important crops in the country (Aguilar and Gabertan, 2017). Between 2010 and 2017, the Philippines produced an annual average of 7.5 million tons (Food and Agriculture Organization of the United Nations, 2019). Moreover, according to the Philippines' Bureau of Agricultural Statistics (2008), the banana supply is about 50% for human consumption, 32% for commercial purposes as processed fruit and the remaining 18% as feeds and organic fertilizer. The top three grown banana cultivars in the Philippines are Cavendish (Figure 1a) followed by 'Saba' (Figure 1c) and Lakatan (Figure 1b). 'Saba' (*Musa acuminata x balbisiana*), also known as 'Cardaba' or 'Kardaba,' is popularly known as a cooking type banana (or plantain) used to supplement staple food and make snacks such as banana cue and '*turon*' (fried banana roll). It is often not usually consumed fresh due to its high starch content. 'Saba' is a high source of carbohydrates, with a rich blend of nutrients and vitamins A, B6 and C, dietary fiber and iron. However, this specific cultivar of banana can be processed into banana chips, which gained wide acceptance, particularly in the international market. Among the processed fruit products, the banana chip is the top dollar earner (Eusebio, 2002). The Philippine government saw the potential of this cultivar; hence, it introduced "Banana Industry Development Act of 2017" (Villafuerte, 2017) to improve banana production, particularly 'Saba,' due to its high demand both for domestic and international markets.

Figure 1. Cavendish (a), 'Lakatan' (b) and 'Saba' (c) bananas

Among the various factors in production, plant nutrition plays a significant role to achieve optimum growth and yield. Several studies showed that banana responds well to chemical fertilizer treatment compared with organic fertilizer. The crop exhausts major and micronutrients from the soil in large quantities; hence, soils require a continuous replenishment of nutrients (Thangaselvabai and Suresh, 2009). According to Ratke *et al.* (2012), banana needs large amounts of nutrients compared with other fruit crops. The plant holds a high amount of water per unit area of land; thus, the potassium (K) and nitrogen (N) are the elements absorbed by the banana in the greatest amounts (Turner *et al.*, 2007).

Despite the known benefits of fertilization in bananas, very limited research works have been conducted and documented about NPK fertilizer application in both timing and doses in Claveria, Misamis Oriental, Philippines. The findings are relevant in helping Claveria banana growers adjust fertilizer inputs and improve fertilizer use efficiency while maintaining and sustaining high banana yield and quality. Furthermore, the results can help protect and preserve the native Philippine banana cultivar. Hence, this field study was generally designed to evaluate the effects of the application of different levels of NPK fertilizer on the ‘Saba’ banana’s productivity (growth performance, fruit yield and return on investment [ROI]) under the Jasaan Soil Series of Claveria, Misamis Oriental.

2. Methodology

2.1 Time and Place of the Study

The study was conducted at the University of Science and Technology of Southern Philippines – Claveria under the Center for High-Value Crops (8.6788° N, 124.9727° E) in Claveria, Misamis Oriental, Philippines. Initially, a total of 90 suckers were planted utilizing a total land area of 1,800 m^2 with a 5 x 5 m planting distance, 5 m between varieties and 5 m between replications. This was grown within six months with uniform management but without the applications of the treatments yet. The application of the fertilizer treatments was done at the 6^{th}-month stage of the crops’ growth from July 2020 until February 2022.

2.2 Description of the Experimental Site

The experimental field is slightly rolling, with soil classified under the Jasaan Soil Series (an Oxisol), which is known to have major soil types of Jasaan clay loam and Jasaan clay. Jasaan clay is with a deep soil profile (> 1 m) and rapid drainage (Bureau of Soils, 1985). It is generally acidic with pH ranging from 3.9 to 5.2, low cation exchange capacity (CEC), low to moderate organic matter content of 1.8% and high aluminum saturation. It also contains low levels of available phosphorus and exchangeable potassium (Magbanua and Garrity, 1990). The rainfall patterns throughout the municipality differ with elevation; the upper areas usually experience a relatively greater amount of rainfall compared with the lower counterparts.

2.3 Experimental Design and Treatments

The experiment was laid out in a randomized complete block design (RCBD) with five treatments replicated three times with six sample plants per replication. Different levels of NPK fertilizer were imposed as treatments:

T1 = 0 NPK (control), T2 = N_{90}-P_{30}-K_{120}, T3 = N_{130}-P_{60}-K_{180}, T4 = N_{180}-P_{120}-K_{360}, and T5 = N_{270}-P_{180}-K_{540} in g/mat (Table 1).

Table 1. Levels of NPK application as treatments and dates of application

Treatments	Jan 26, 2021			April 26, 2021			July 26, 2021		
	N (g)	P (g)	K (g)	N (g)	P (g)	K (g)	N (g)	P (g)	K (g)
T1	0	0	0	0	0	0	0	0	0
T2	537.00	208.34	250.00	268.50	104.17	125.00	268.50	104.17	125.00
T3	803.57	416.65	375.00	401.79	208.33	187.50	401.79	208.33	187.50
T4	1,071.43	833.34	750.00	535.72	416.67	375.00	535.72	416.67	375.00
T5	1,607.00	1,250.00	1,125.00	803.50	625.00	562.50	803.50	625.00	562.50

2.4 Nutrient Management

A basal application of 1 kg vermicompost was applied to each plant during planting time. The NPK fertilizers that served as treatments were ammonium sulfate (21-0-0), superphosphate (0-18-0) and muriate of potash (0-0-60). Experimental treatments were applied to six-month-old (50%), nine-month-old (25%) and twelve-month-old (25%) banana plants as shown in Table 1. The percentages represent the part of NPK fertilizers applied from the overall amount.

2.5 Data Collection

2.5.1 Agronomic Parameters

Agronomic data were measured and collected from the six sample plants per plot per treatment in each replication at varying crop stages (7, 8, 9, 10, 11, 12, 13, 14 and 15 months after planting and at harvest). The agronomic parameters obtained were plant height per plant (cm), number of leaves per plant, base girth per plant (cm), one-third girth per plant (cm) and number of suckers.

The mean of the agronomic parameters at 7, 8, 9, 10, 11, 12, 13, 14 and 15 months after planting (MAP) at harvest were calculated using Equation 1, where *S* means sample.

$$Agronomic\ parameter = \frac{S1 + S2 + S3 + S4 + S5 + S6}{6} \tag{1}$$

2.5.2 Yield and Yield Parameters

Two sample plants per plot per treatment in each replication were selected after harvest to attain the number of hands, weight per hand (kg), number of fingers per hand, finger length and diameter (cm), total bunch weight (kg) and yield (t/ha).

2.5.3 ROI

Return on investment demonstrates the percentage of return for every peso invested when considering the cost of the fertilizer treatments applied. The ROI was computed using Equation 2.

$$ROI = \frac{Net\ revenue}{Cost\ of\ investment} \times 100 \quad (2)$$

2.6 Data Analysis

The data gathered was analyzed using analysis of variance (ANOVA) in RCBD, and treatments were compared using Tukey's honestly significant difference test (HSD) at 0.05 level of significance.

3. Results and Discussion

3.1 Agronomic Parameters

3.1.1 Plant Height per Plant

The different levels of NPK at the varying crop stages indicated a similar effect on the plant height per plant (cm) as shown in Table 2. However, in the 15^{th} month, T4 (N_{180}-P_{120}-K_{360}) measured the highest plant height (444.23 cm), while the control recorded the lowest plant height (417.74 cm). As apparent in the result, the pseudostem exhibited a steady increase in growth until the 12^{th} month. However, some of the plants maintained their growth while others declined from the 13^{th} month until harvest. One possible reason for this was at this time, the plant was already in the reproductive stage wherein the nutrients applied were deliberately drawn toward the fruit of the banana rather than to its growth. Likewise, the weight of the bunch was pulling down the pseudostem causing it to be slightly inclined. Moreover, the plant height of non-fertilized control plants was neither significantly different nor produced better vegetative growth relative to plants that imposed fertilizers. The plant height is a key measured vegetative variable that describes the growth of bananas.

3.1.2 Number of Leaves per Plant

Table 3 shows the influence of the different levels of NPK on the number of leaves per plant at varying crop stages. All NPK levels demonstrated a similar effect on the number of leaves per plant. However, the highest recorded number of functional leaves produced was in the 8th month with 9.94 leaves from both T2 (N_{90}-P_{30}-K_{120}) and T3 (N_{135}-P_{60}-K_{180}) compared with other treatments. Moreover, the decrease in the number of leaves was also observed from the 9th month (April 2021) until harvest, with T3 recorded as the least number of leaves (2.67). The 9th month also recorded the lowest rainfall. However, the rain resumed in the succeeding months. The leaf is where chlorophyll is produced; thus, the site of biomass production. More leaves contribute to the increased yield of bananas.

3.1.3 Base Girth per Plant

The base girth per plant (cm) in response to the varying levels of NPK fertilizer treatment is presented in Figure 2. Only the 11th month showed a significant effect while the rest of the months showed no significant results. The highest base girth measurement was from T3 (108.94 cm) followed by T4 (108.17 cm). In contrast, T5 (N_{270}-P_{180}-K_{540}) recorded the lowest base girth (98 cm). Furthermore, the results showed that the two of the highest base girth were obtained by T3(a) and T4(a); however, these results were comparable with the base girth obtained by T1(ab) and T2(ab). Moreover, even if T5(b) got the lowest base girth, still, it was comparable with both T1(ab) and T2(ab). This implied that T1 and T2 had the tendency to be on par with the highest base girth growth or to stoop down their performance in this particular parameter.

Due to the plant's large plant base, there was no incident of toppled plants throughout the conduct of the study; hence, propping the plants was not even needed to support heavy bunch load during its reproduction stage until maturity. A bigger pseudostem can minimize the risk of toppling higher plants (Borges *et al*., 2011). In Brazil, this positive influence of N and K fertilization on the pseudostem girth was also observed by Nomura *et al.* (2016). However, the findings of Al-Harthi and Al-Yahyai (2009) showed no significant effect of fertilization on the stem circumference of bananas grown in the arid country of Oman. Similarly, Rahman *et al.* (2017) showed an insignificant variation in the base girth in the split application of N and K.

Table 2. Plant height per plant (cm) of ‘Saba’ banana at varying crop stages as influenced by different levels of NPK fertilizer under Jasaan Soil Series

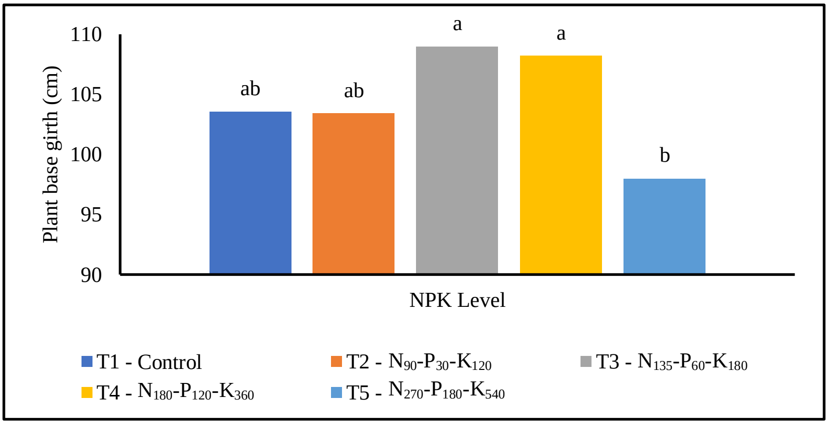
Treatments	7 MAP	8 MAP	9 MAP	10 MAP	11 MAP	12 MAP	13 MAP	14 MAP	15 MAP	Harvest
T1: Control (0 NPK)	189.06	240.28	308.11	324.33	354.94	392.39	427.17	421.39	417.74	419.90
T2: N_{90}-P_{30}-K_{120}	235.34	252.11	309.00	329.06	363.89	402.33	427.83	421.83	425.19	425.53
T3: N_{135}-P_{60}-K_{180}	226.22	269.56	341.61	351.00	381.94	420.17	439.78	442.61	439.42	437.73
T4: N_{180}-P_{120}-K_{360}	181.61	265.39	327.45	343.00	380.78	414.28	442.67	438.11	444.23	441.84
T5: N_{270}-P_{180}-K_{540}	192.78	217.39	285.67	306.44	349.83	385.11	423.89	416.39	424.66	425.16
F-test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	25.81	14.19	8.29	8.02	5.32	4.66	2.38	3.10	2.81	3.12

MAP – months after planting; ns – not significant ($p >= .05$)

Table 3. The number of leaves per plant of ‘Saba’ banana at varying crop stages as influenced by different levels of NPK fertilizer under Jasaan Soil Series

Treatments	7 MAP	8 MAP	9 MAP	10 MAP	11 MAP	12 MAP	13 MAP	14 MAP	15 MAP	Harvest
T1: Control (0 NPK)	9.83	9.55	8.05	7.78	6.72	6.22	5.95	5.05	5.11	3.39
T2: N_{90}-P_{30}-K_{120}	8.67	9.94	7.78	7.28	6.44	6.72	5.89	5.44	4.34	3.81
T3: N_{135}-P_{60}-K_{180}	9.33	9.94	8.22	8.06	6.50	5.89	5.94	4.56	4.22	2.67
T4: N_{180}-P_{120}-K_{360}	9.33	9.06	7.89	7.78	6.44	6.28	5.67	4.78	4.50	3.53
T5: N_{270}-P_{180}-K_{540}	8.39	8.89	7.83	7.95	7.28	6.55	6.22	5.67	5.00	3.25
F-test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	7.02	6.18	6.98	6.41	10.70	8.54	7.36	11.87	20.20	44.11

MAP – months after planting; ns – not significant ($p >= .05$)

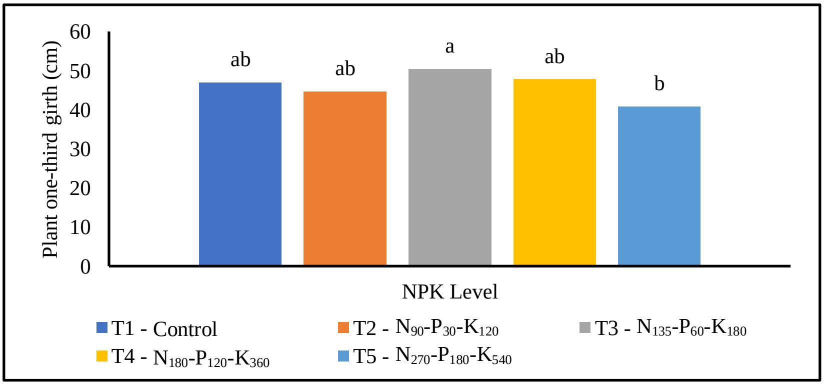


Means with different letters within varying treatments of NPK fertilizers are significantly different at 5% level by HSD.

Figure 2. Base girth per plant (cm) of 'Saba' banana at 11th month as influenced by different levels of NPK fertilizer under Jasaan Soil Series

3.1.4 One-Third Girth per Plant

The different NPK levels influenced the one-third girth per plant (cm) of 'Saba' with T3 obtaining the largest one-third girth measurement (50.44 cm) in the 7th month compared with other months (Figure 3).



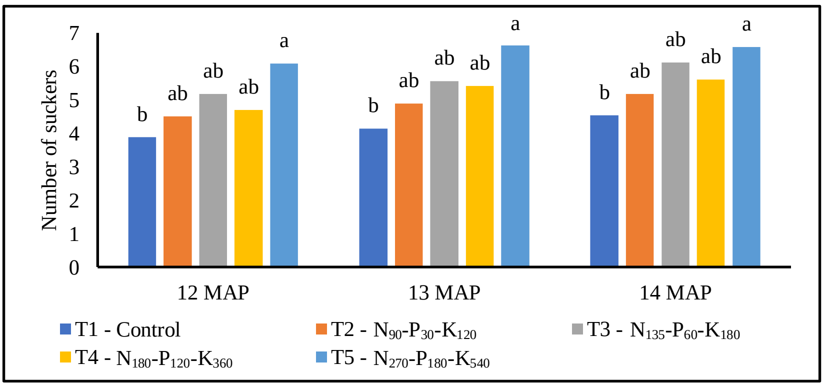
Means with different letters within varying treatments of NPK fertilizers are significantly different at 5% level by HSD.

Figure 3. One-third girth per plant (cm) of 'Saba' banana at 7th month as influenced by different levels of NPK fertilizer under Jasaan Soil Series

On the other hand, T5 recorded the lowest one-third girth (40.38 cm), and the rest of the treatment showed a similar effect. Bigger one-third girth meant stronger banana plants, and as a result, there was no bent plant even during the increase in bunch size, heavy rainfalls and windy days. The strength of the banana to resist weather changes such as strong winds and heavy rains can be seen on the stem (Guy, 2011). The findings are consistent with Tomar *et al.* (2021) wherein the inorganic fertilizers showed a significant favorable influence on banana girth. Mahato *et al.* (2014) also showed a similar trend wherein the varying combination of N and P along with K significantly influenced most of the vegetative growth parameters including the pseudostem girth. In contrast, neither the soil amendments, ways of applying fertilizer nor fertilizer composition showed a significant effect on the pseudostem girth of bananas in Oman (Al-Busaidi, 2013).

3.1.5 Number of Suckers Per Plant

There were significant effects among treatments in the three consecutive months (12th, 13th and 14th) in terms of the number of suckers per plant (Figure 4). The other months showed relatively similar responses for all the treatments imposed.



Means with different letters within varying treatments of NPK fertilizers are significantly different at 5% level by HSD.

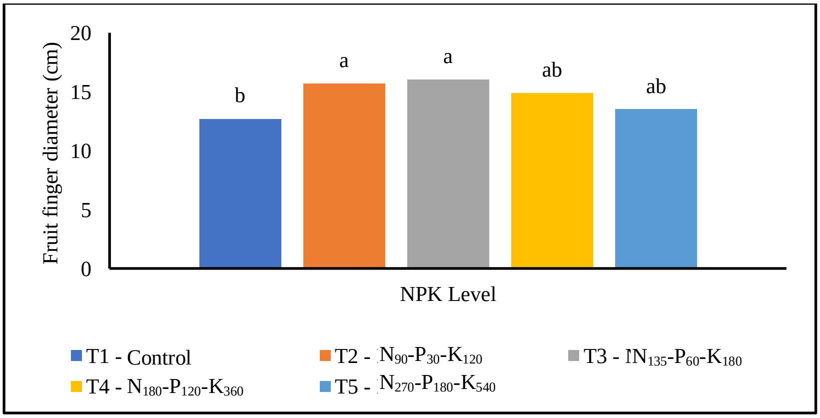
Figure 4. The number of suckers per plant of 'Saba' banana at 12th, 13th and 14th months as influenced by different levels of NPK fertilizer under Jasaan Soil Series

The highest level of NPK fertilizer, T5, consistently obtained the highest number of suckers with 6.08 (12th month), 6.63 (13th month) and 6.58 (14th month). In contrast, T1 (no fertilizer application) consistently got the lowest number of suckers with 3.88 (12th month), 4.14 (13th month) and 4.53 (14th month). A similar study showed that the highest level of NPK fertilizer applied produced more suckers in bananas compared with no fertilizer input (Tomar *et al.*, 2021). Correspondingly, Mahato *et al.* (2014) found that the number of suckers per plant was prominent in the highest level of NPK over control of plantain cv. Nendran in India.

3.2 Yield and Yield Parameters

3.2.1 Diameter of Finger

Figure 5 shows the significant response of the different NPK levels on the diameter of the finger (cm). The highest finger girth was attained by T3 (16.04 cm) followed by T2 (15.70 cm), while the smallest measurement was observed in T1 (control) (12.72 cm).



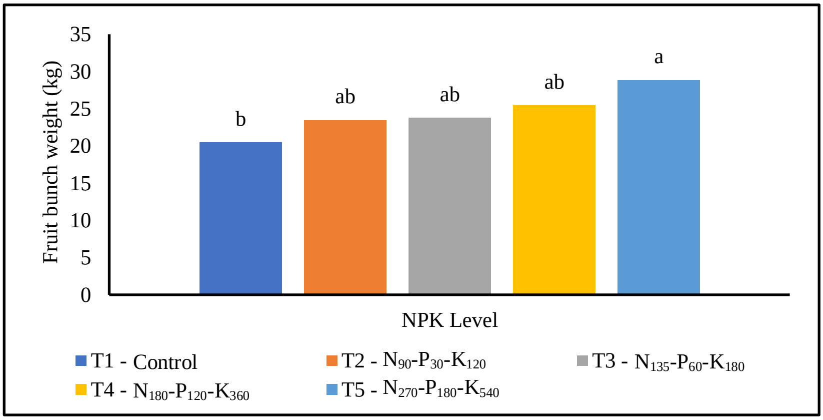
Means with different letters within varying treatments of NPK fertilizers are significantly different at 5% level by HSD.

Figure 5. Diameter of finger (cm) of 'Saba' banana as influenced by different levels of NPK fertilizer under Jasaan Soil Series

This result was also observed by Rahman *et al.* (2017) where the three-split application of N and K showed a significant effect on the diameter of the finger in Bangladesh. Similarly, the conclusion of Srikul and Turner (1995) indicated that there was a direct relationship between fruit fresh weight and the amount of nitrogen applied. Nitrogen promoted early pulp growth during fruit maturity, and this determined its influence on the final fruit fresh weight. This result could be expressed in terms of fruit length and girth as a result of accelerated early pulp growth and cell expansion (Al-Harthi and Al-Yahyai, 2009). A larger finger circumference may result in a larger hand; hence, may also increase the total bunch weight. Moreover, in this study, T3 exhibited significant performance among the treatments, which was similarly observed in the agronomic parameters such as base girth and one-third girth.

3.2.2 Total Bunch Weight

The total bunch weight (kg) of 'Saba' in response to the different level of NPK is presented in Figure 6. The highest bunch weight was obtained by the highest fertilizer treatment, T5, with 28.87 kg compared with all other treatments followed by T4, T3 and T2 with weights of 25.48, 23.77 and 23.51 kg, respectively.



Means with different letters within varying treatments of NPK fertilizers are significantly different at 5% level by HSD.

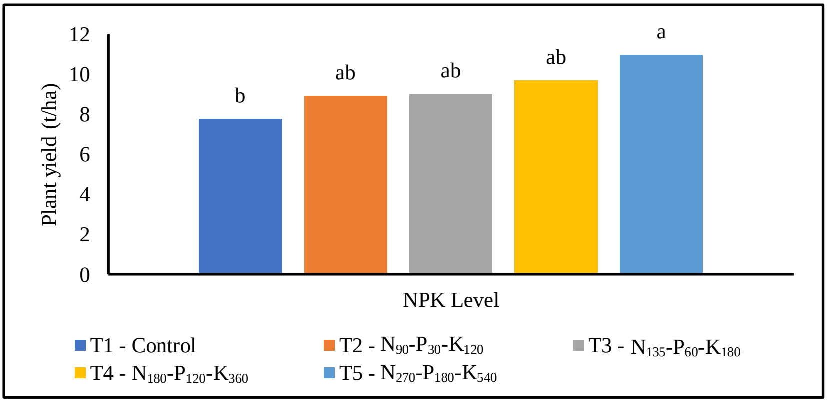
Figure 6. Total bunch weight (kg) of 'Saba' banana as influenced by different levels of NPK fertilizer under Jasaan Soil Series

In contrast, T1 (control) recorded the lowest weight (20.48 kg). Results showed that the bunch weight paralleled the level of N, P and K fertilizer application. As the level of treatment increased, the bunch weight likewise increased and vice versa. Al-Harthi and Al-Yahyai (2009) noticed the same trend wherein fertilized plants produced much better total bunch weight in comparison with the non-fertilized control plants, and the weight of the bunch declined when the level of N, P and K was decreased or when there was no application thereof. This can also be attributed to the high level of K in the treatment. Bananas' fruit and plant tissue are rich in potassium, which also controls the movement and buildup of sugars within the plant to enable fruit filling (Ganeshamurthy *et al*., 2011). A low potassium supply produces 'thin' fruit and fragile bunches – a phenomenon frequently observed in the field as well as in controlled experiments (Mahato *et al*., 2014). This was also observed by Memon *et al*. (2010) in Pakistan: when the level of K fertilizer was increased, the banana yields likewise increased. Similarly, the study of

Rahman *et al*. (2017) disclosed that an increase in fertilizer application resulted in increased bunch weight in bananas.

3.2.3 Yield

The yield (t/ha) of 'Saba' as influenced by varying levels of NPK under the Jasaan Soil Series is shown in Figure 7. The result showed a significant difference between treatments T1 (control) and T5 (maximum fertilizer). The highest yield was produced by T5 with 10.98 t/ha, while the lowest yield was produced by T1 with 7.78 t/ha.



Means with different letters within varying treatments of NPK fertilizers are significantly different at 5% level by HSD.

Figure 7. Yield (t/ha) of 'Saba' banana as influenced by different levels of NPK fertilizer under Jasaan Soil series

The result was in agreement with those obtained by Albadawy and Maha (2019) wherein the highest yield was attained by the highest dose of chemical fertilizer applied in banana cv. Grande Naine in Egypt. Moreover, in Varela and Gonzales's (2016) on-site evaluation in the Philippines, the difference was highly significant between the farmers' practice of no fertilization compared with the integrated crop management technology intervention that included fertilizer application in the yield of 'Cardaba.' However, this result contradicted the findings of Sun *et al*. (2020) wherein there was no significant effect on banana yield with the N treatments in China. Identically, the result of Fratoni *et al*. (2017) showed the banana yield was not influenced by the N and K_2O rates when they planted bananas in humid tropical Arizona.

3.3 Return on Investments

Table 4 shows the ROI of 'Saba' production under varying levels of NPK fertilizer. The three treatments that attained the highest ROI were T1 (2.03%), T2 (1.49%) and T3 (1.24%). In contrast, T5 got the lowest ROI (0.84%) although it got the most yield of 10.98 t/ha. This can be attributed to the current prevailing market prices at the conduct of the study based on Claveria's conditions. The ROI values indicated the return per peso invested; thus, a very relevant parameter in measuring economic efficiency.

Table 4. ROI of 'Saba' banana as influenced by different levels of NPK fertilizer under Jasaan Soil Series

Treatments	Total cost* (Php)	Total return (Php)	Net return (Php)	ROI (%)
T_1 – Control	65,178.95	132,260.00	67,081.05	2.03
T_2 – N_{90}-P_{30}-K_{120}	101,987.27	151,810.00	49,822.73	1.49
T_3 – N_{135}-P_{60}-K_{180}	124,295.75	153,510.00	29,214.25	1.24
T_4 – N_{180}-P_{120}-K_{360}	159,579.59	164.730.00	5,150.41	1.03
T_5 – N_{270}-P_{180}-K_{540}	221,132.87	186,660.00	(34,472.87)	0.84

*Computation of agricultural inputs, labor costs and other expenses were all based on the current prevailing costs and on a per ha basis, respectively.

Consequently, fertilizer cost greatly influenced the final ROI although a significant difference was observed in the yield between the control and other treatments. The cost of fertilization at a higher rate far exceeded the income return as compared with the treatment without fertilization. Furthermore, the selling price of bananas was really low in these times and even if the productivity was doubled, it still did not compensate for the fertilizer's cost. Thus, further review of long-term successive production with this fertilizer application is highly recommended. The conducted study by Albadawy and Maha (2019) in Egypt showed an increase in the second season in yield of the banana Grande Naine cultivar when applied with 100% recommended dose of fertilizer.

The cost of fertilizer constitutes the highest cost of agricultural input. However, according to Al-Harthi and Al-Yahyai (2009), fertilizer application is generally needed to satisfy plant requirements for obtaining profitable production. Nomura *et al.*'s (2016) study in Brazil showed that the total production cycle of each banana season increased when larger amounts of fertilizer were applied, and the occurrence of nutrient deficiency at the lowest fertilizer doses was noticeable. A shorter crop cycle will result in more production, which, from an economic standpoint, will boost the yield and the farmers' profitability.

4. Conclusion and Recommendation

A field experiment was conducted to assess the productivity of 'Saba' banana as influenced by varying levels of NPK fertilizer under the Jasaan Soil Series. The NPK fertilizer that ranged from control (no NPK applied) to NPK of 270:180:540, respectively, influenced several agronomic parameters, namely one-third girth, base girth and the number of suckers. However, the study showed similar effects on plant height and the number of leaves. Moreover, the application of NPK fertilizer influenced the reproductive traits of the banana, namely the diameter of the finger, total bunch weight and yield. As a result, the recommended rate of application for NPK fertilizer is 270:180:540, respectively, which produced numerically the highest yield. However, despite higher yield, the highest level of NPK gained the lowest ROI compared with the other treatments, which can be attributed to the higher fertilizer inputs. In contrast, no fertilizer input obtained the highest ROI but produced the lowest yield. However, the ROI results should be reviewed as it was shown that the banana with no fertilizer application tend to decline in productivity as stated and supported by citations above. Results of this study initially showed that the 'Saba' banana can be grown successfully and profitably in Claveria, Misamis Oriental conditions. Future studies are suggested that will determine further and evaluate the long-term sustainability of NPK fertilizer on its succeeding ratoons together with some of its cultural practices.

5. References

Aguilar, E.A., & Gabertan, H.A., (2017). Promoting good agricultural practices (GAP) to enhance competitiveness, resilience and sustainability of smallhold Saba/Cardaba Banana growers. Journal of the International Society for Southeast Asian Agricultural Sciences, 1262, 227-235.

Albadawy, H.E., & Maha, M.E. (2019). Effect of some fertilization treatments on growth, yield, fruit quality and nutritional status of banana Grande Naine cultivar.

Annals of Agricultural Science, Moshtohor, 57(1), 89-98. https://doi.org/10.21608/ASSJM.2019.42213

Al-Busaidi, K.T.S. (2013). Effects of organic and inorganic fertilizers addition on growth and yield of banana (*Musa* AAA cv. Malindi) on a saline and non-saline soil in Oman. Journal of Horticulture and Forestry, 5(9), 146-155. https://doi.org/10.5897/JHF2013.0315

Al-Harthi, K., & Al-Yahyai, R. (2009). Effect of NPK fertilizer on growth and yield of banana in Northern Oman. Journal of Horticulture and Forestry, 1(8), 160-167.

Borges, R.D.S., Silva, S.D.O., Oliveira, F.T.D., & Roberto, S.R. (2011). Evaluation of banana genotypes in the north of the state of Parana. Revista Brasileira de Fruticultura, 33, 291-296. https://doi.org/10.1590/S0100-29452011005000034

Bureau of Agricultural Statistics. (2008). 2007 Commodity fact sheets. Retrieved from https://psa.gov.ph/sites/default/files/commodityfactsheet2007.pdf

Bureau of Soils. (1985) Detailed reconnaissance soil survey suitability classification: Claveria complementation project, Claveria, Misamis Oriental. Manila, Philippines: Bureau of Soils.

Eusebio, J.E. (2002). The Philippine banana industry: Status and prospects. In: A.B. Molina, J.E. Eusebio, V.N. Roa, I. Van den Bergh & M.A.G Maghuyop (Eds.), Proceedings of the 1st BAPNET Steering Committee, Laguna, Philippines, 107.

Food and Agriculture Organization of the United Nations (FAO). (2019). Banana facts and figures. Retrieved from https://www.fao.org/economic/est/estcommodities/oilcrops/bananas/bananafacts/en/#.Yn8GgehBzIU

Fratoni, M.M.J., Moreira, A., Moraes, L.A.C., Almeida, L.H.C., & Pereira, J.C.R. (2017). Effect of nitrogen and potassium fertilization on banana plants cultivated in the humid tropical Amazon. Communications in Soil Science and Plant Analysis, 48(13), 1511-1519. https://doi.org/10.1080/00103624.2017.1373791

Ganeshamurthy, A.N., Satisha, G.C., & Patil, P. (2011). Potassium nutrition on yield and quality of fruit crops with special emphasis on banana and grapes. Karnataka Journal of Agricultural Sciences, 24(1), 29-38.

Guy, A.T. (2011). Efficacy evaluation of HYFER PLUS (green) as foliar 'fertilizer' for banana. Retrieved from https://agrotiger.com/wp-content/uploads/2019/10/HyferBananaResearch.pdf

Magbanua, R.D., & Garrity, D.P. (1990). Agroecosystems analysis of a key upland farming systems research site. Proceedings of the 1988 Acid Upland Design Workshop, Laguna, Philippines.

Mahato, S.K., Suresh, C.P., & Kuna, R.K. (2014). Effects of inorganic fertilization on growth, yield and fruit quality of plantain cv. Nendran. Plant Archives, 14(2), 939-944.

Nomura, E.S., Cuquel, F.L., Damatto Junior, E.R., Fuzitani, E.J., Borges, A.L., & Saes, L.A. (2016). Nitrogen and potassium fertilization on 'Caipira'and 'BRS Princesa' bananas in the Ribeira Valley. Revista Brasileira de Engenharia Agrícola e Ambiental, 20, 702-708. https://doi.org/10.1590/1807-1929/agriambi.v20n8p702-708

Memon, N., Memon, K.S., Anwar, R., Ahmad, S., & Nafees, M. (2010). Status and response to improved NPK fertilization practices in banana. Pakistan Journal of Botany, 42(4), 2369-2381.

Rahman, H., Akter, A., & Rahman, J. (2017). Effect of split application of N and K fertilizer and bagging on the growth, yield and post-harvest quality of banana. Research and Reviews: Journal of Crop Science and Technology, 6(1), 12-22.

Ratke, R.F., Santos, S.C., Pereira, H.S., Souza, E.D.D., & Carneiro, M.A.C. (2012). Growth and yield of banana trees cultivar Thap Maeo and Prata-Anã with different levels of nitrogen and potassium fertilization. Revista Brasileira de Fruticultura, 34, 277-288. https://doi.org/10.1590/S0100-29452012000100037

Srikul, S., & Turner, D.W. (1995). High N supply and soil water deficits change the rate of fruit growth of bananas (cv. "Williams") and promote tendency to ripen. Scientia Horticulturae, 62(3), 165-174. https://doi.org/10.1016/0304-4238(95)00765-L

Sun, J., Li, W., Li, C., Chang, W., Zhang, S., Zeng, Y., & Peng, M. (2020). Effect of different rates of nitrogen fertilization on crop yield, soil properties and leaf physiological attributes in banana under subtropical regions of China. Frontiers in Plant Science, 11, 2083. https://doi.org/10.3389/fpls.2020.613760

Thangaselvabai, T., & Suresh, S. (2009). Banana nutrition – A review. Agricultural Reviews, 30(1), 24-31.

Tomar, A.K., Prasad, V.M., Bahadur, V., & Topno, S.E. (2021). Effect of organic manures and inorganic fertilizers on vegetative growth of banana (*Musa* spp.) cv. Poovan (AAB Group). The Pharma Innovation Journal, 10(9), 2047-2055.

Turner, D.W., Fortescue, J.A., & Thomas, D.S. (2007). Environmental physiology of the bananas (*Musa* spp.). Brazilian Journal of Plant Physiology, 19(4), 463-484. https://doi.org/10.1590/S1677-04202007000400013

Varela, R.P., & Gonzales, N.P. (2016). Sustainable production of banana, *Musa acuminata* × *balbisiana* Colla (ABB Group) cv 'Cardaba' through integrated crop management. International Journal of Agronomy and Agricultural Research, 9(2), 171-179.

Villafuerte, R.F., Jr. (2017). Banana Industry Development Act of 2017. Retrieved from https://hrep-website.s3.ap-southeast-1.amazonaws.com/legisdocs/basic_18/HB01264.pdf