ISSN: 2641-6379
DOI: 10.33552/WJASS.2022.07.000672
World Journal of Agriculture and Soil Science
Iris Publishers

Research Article

Effect of Different Fertilizer Formulations on Growth of Pineapple (*Ananas comosus*) and Soil Nutrients

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Received Date: February 21, 2022

Published Date: March 14, 2022

Abstract

In Sri Lanka, there is a big gap between the total pineapple production and the total export demand of pineapple. Most of the growers tend to use new fertilizer formulations in the market in search of increasing the productivity. Multi-nutrient Compound Fertilizer Package (MCFP) with balanced nutrient supply including micronutrients is considered as a viable option to enhance the productivity. This study was conducted to evaluate the impact of MCFP, on early growth of pineapple in Red Yellow Podzolic soil with soft laterite. The early growth of Mauritius variety was tested at field level with five treatments. T1 (control), T2 (Fertilizer recommended by Department of Agriculture (DOA)), T3 (Farmer practiced fertilizer; 70% straight fertilizer recommended by DOA + 30% MCFP), T4 (MCFP), T5 (organic fertilizer). The experiment was designed in a Randomized Complete Block Design. Plant growth parameters including plant height, number of leaves and Leaf Area Index (LAI) were recorded. Soil properties were determined at the beginning and two months after application of treatments. T4 has given the highest plant height (61.13 cm) and T3 has been recorded the highest LAI (0.745) and number of leaves (33.2). There was no significant difference among treatments for soil chemical parameters. However, there was a considerable increment in Phosphorus content (1.59 ppm) and Electrical Conductivity (77.53 µS/cm) in soil compared to the initial soil status in T4 treated soil. The results revealed that the MCFP has shown an improving trend in initial plant growth performance of pineapple. It can be concluded that MCFP used in T3 and T4 can effectively be used in enhancing growth of pineapple cost effectively.

Keywords: Fertilizer; Micronutrients; Pineapple; Plant nutrients; Productivity

Introduction

Sri Lanka is a tropical island nation located between 5° 55' and 9° 51' N latitude and 79° 42' and 81° 53' E longitude, at the southern tip of the Indian sub-continent. Based on the rainfall pattern, the total land area of 6.6 million ha, is divided into three major agroclimatic zones: a wet zone, a dry zone, and an intermediate zone. Sri Lanka's wide variation in precipitation, topography and soil makes it possible to grow a wide range of crops [1].

Pineapple is considered as one of the most important tropical fruits in the world. Its pleasant flavor and exquisite taste qualities have made it as one of the choicest fruits throughout the world [2]. Pineapple in Sri Lanka are grown on 6,430 ha, producing around 35,000 MT per year as an intercrop in the coconut triangle. In Sri Lanka, there is a huge potential for growing pineapple, because of the ideal agroclimatic conditions. About 90% of the pineapple in the country is grown within the Kurunegala, Puttalam, Gampaha and Colombo districts (coconut triangle). Out of the total pineapple production, 70% is produced from the Kurunegala and Gampaha districts [3].

It is recommended that pineapple under coconut be grown when the coconut plantation is below 5 years or over 30 years of age. Well drained, gravelly or loamy soils are suitable for pineapple cultivation. There are two major pineapple varieties in Sri Lanka, namely 'kew" and 'Mauritius'.

Sri Lanka contributes less than one percent of total world production among the world's pineapple producers. The national productivity is so far below the potential. There are issues related to finding exportable quality pineapples in sufficient quantities. In case of Sri Lanka, there is a big gap between the total pineapple production and the total export volume of pineapple [2]. Fertilizers play a key role in enhancing yield which is a limiting factor for productivity and important for minimizing pest and diseases. Improving the efficiency of fertilizers is very important as conventional soluble fertilizers show higher nutrient losses, especially Nitrogen.

When it considers about Urea, the loss of Nitrogen (N) is about 60 % due to its high solubility and hygroscopic nature. Urea undergoes three major steps before taken up by plant roots. There is a greater potential for loss of N via ammonia (NH_3) volatilization and leaching in the forms of Nitrate (NO_3-), Ammonium (NH_4+) and Nitrite (NO_2-). So, there is a need of advance properties in fertilizers to remain the nutrients in the soil for a longer period without depletion.

Slow Releasing Fertilizers (SRF) and Control Release Fertilizers (CRF) are a promising strategy to improve the utilization of nutrients. Multi-nutrient Compound Fertilizer Package (MCFP) is a fertilizer, combination of both SRF and CRF which is now available and specially formulated for pineapple. The granules of MCFP are physically coated with organic polymers and resins around the fertilizer prill and inside all the nutrients are in one prill. The N: P: K ratio of MCFP is 12:11:18 where Nitrogen in the form of NH_4^+-N (7.17 %) and NO NO_3^--N (5.43 %). It contains Phosphorus in the form of P_2O_5 - citrate soluble (11.89 %), P_2O_5 – water soluble (8.06 %) and Potassium in the form of K_2O which is water soluble (18.41 %). Apart from that it contains secondary nutrients like MgO (2.80 %), S (8.37 %) and micronutrients such as B (0.020%), Fe (0.198 %), Mn (0.020%) and Zn (0.027 %) which are favorable for growth of pineapple. The fertilizer prills and granules of MCFP has even size distribution for accurate spreading in the field.

This study aims to evaluate the effect of MCFP over other fertilizer formulations on the growth of pineapple and to evaluate the behavior of soil nutrients before and after application of different fertilizers.

Methodology

Experimental site

This field experiment was carried out in coconut-pineapple integrated land in Dummalapitiya Estate in Pannala, Kurunegala district, situated in low country intermediate zone at elevation of 30m from mean sea level. The average annual rainfall of the area is 2,095 mm. The soil type is Red Yellow Podzolic with soft laterite. According to the USDA soil taxonomy, it is classified as Plinthudults, fine loamy, non-calcarious isohyperthemic.

Experimental design

The experiment was conducted in Randomized Complete Block Design (RCBD) with five treatments and three replicates. The total area of the experimental site was 580.5 m^2 and area of a treatment plot was 36.8 m2. The spacing between double rows were 1.05 m, spacing within a double row were 0.6 m and spacing between consecutive plants along the row were 0.45 m. Double row system was used for planting. The treatments are given in the Table 1.

Table 1: Application rates of basal dressing in different Treatments.

Treatment	Time of Application	Fertilizer	Rate of Application
T1	-	No fertilizers	-
T2	1 MAP	Urea, TSP, MOP (10:7:15)	32 g/plant
T3	At the time of planting	YB (3)	255 kg/ ac
T4	At the time of planting	YB (4)	100 kg/ac
T5	At the time of Planting	Poultry Litter	20 tons/ha

**MAP- Months after Planting, YB – "Yara" Basal Dressing, TSP- Triple Super Phosphate, MOP- Muriate of Potash*

T1: Control, T2: Fertilizer recommended by Department of Agriculture (DOA), T3: Farmer Practiced fertilizer (70 % DOA + 30 % Multi-nutrient Compound fertilizer package), T4: Multi-nutrient Compound Fertilizer Package, T5: Poultry litter.

Crop establishment and maintenance

Mauritius variety was used for the experiment and double row system was used for planting. Stem suckers and axil suckers were used for planting. First, suckers were treated with insecticides and kept for one day. Then, they were treated with fungicides and kept 2-3 days under a partial shade before planting was done. Planting was done according to the spacing given and treatments were applied according to the recommendations. Manual irrigation, weeding, pest and disease control practices were done according to the recommendations providing similar conditions for all treatments.

Soil collection and sample analysis

Soil samples were collected from the experimental site to determine soil chemical properties. Soil samples from three points per block were taken before planting, assuming that there was no considerable variation within a block. Then soil samples from every treatment plot were taken two months after planting.

Sample preparation

After soil sampling, the soil samples brought to the soil science laboratory were emptied from bags and spread out to dry on flat trays. After that air-dried soil samples were sieved through a 2 mm sieve and each sieved sample was placed in separate bags, labelled properly and kept under dry conditions until analysis was performed.

Vegetative parameters

Plant height, Leaf Area Index (LAI) and number of leaves were taken from individual sampling plants at two weeks intervals from one week after planting. Plant height was measured from ground level to the leaf-base of the highest fully expanded leaf using a meter ruler. Leaf area was calculated using length and width method and LAI was calculated. Number of leaves were taken by counting.

Soil chemical analysis

Soil chemical properties were analyzed before planting and two months after application of treatments. Soil Nitrogen content was analyzed by Micro Kjeldahl method [4]. Soil Available Phosphorus was measured using Olsen method [5]. Soil Exchangeable Potassium was measured using Hanway method [6]. Soil pH and Electrical conductivity (EC) were determined electrometrically using a 1:5 soil water suspensions using a conductivity cell [7].

Statistical analysis

Analysis of variance was used to analyze the data using SAS Statistical software (version 9.4).

Results and Discussion

Initial soil properties

Table 2: The chemical parameters of the soil used for the experiment.

Parameter	Mean ± SD
Soil pH (Soil :H_2O - 1:5)	6.32 ± 0.40
Electrical Conductivity (µs/ cm)	41.73 ± 11.59
Total N (%)	0.37 ± 0.08
Available N (%)	0.059 ± 0
Available P (ppm)	0.500 ± 0.288
Exchangeable K (ppm)	9.275 ± 2.722

The initial soil chemical properties of the experimental site were analyzed, and the results are given in the Table 2.

The pH of initial soil was 6.32 which were between the optimum soil pH ranges of 5.5- 7.5 for pineapple. EC of soils depending on the amount of soluble salts present and its ability to transmit an electrical current. The EC of initial soil was 41.73 µS/ cm. The total Nitrogen content of the initial soil 0.37 %, which was optimum under field conditions. Available Phosphorus level of initial soil was very low, and it was 0.50 ppm. However, Potassium content of the initial soil was 9.275 ppm, which was in the range of high.

Vegetative parameters

Leaf Area Index (LAI): LAI is a good indicator of plant canopy density and production of biomass. The mean values for LAI recorded during week 1, 3 and 15 are given in the Table 3. There was a significant difference among treatments in week 15. T3 showed highest mean value and T1 (control) showed least mean value for LAI. This increasing trend in T3 indicates that, MCFP has considerable effect on plants canopy growth compared to other treatments due to the provision of Nitrogen, which is readily available to plants, which enhance vegetative growth.

Table 3: Mean values for LAI of different treatments.

Treatment	1 WAP	3 WAP	15 WAP
T1	0.302^{a}	0.347^{a}	0.685^{b}
T2	0.314^{a}	0.365^{a}	0.702^{ab}
T3	0.320^{a}	0.369^{a}	0.745^{a}
T4	0.276^{a}	0.350^{a}	0.717^{ab}
T5	0.284^{a}	0.336^{a}	0.688^{ab}
P<0.05	0.381	0.537	0.02

Means with different letters within the same column represent significant differences at p<0.05 level.

Table 4: Plant growth parameters of different treatments.

Treatment	Plant Height (cm)	Number of Leaves
1	55.73^{a}	24.93^{ab}
2	56.13^{a}	24.75^{ab}

3	60.73[a]	25.70[a]
4	61.13[a]	24.54[ab]
5	60.83[a]	23.45[b]
P<0.05	0.036	0.083

Means with different letters within the same column represent significant differences at p<0.05 level.

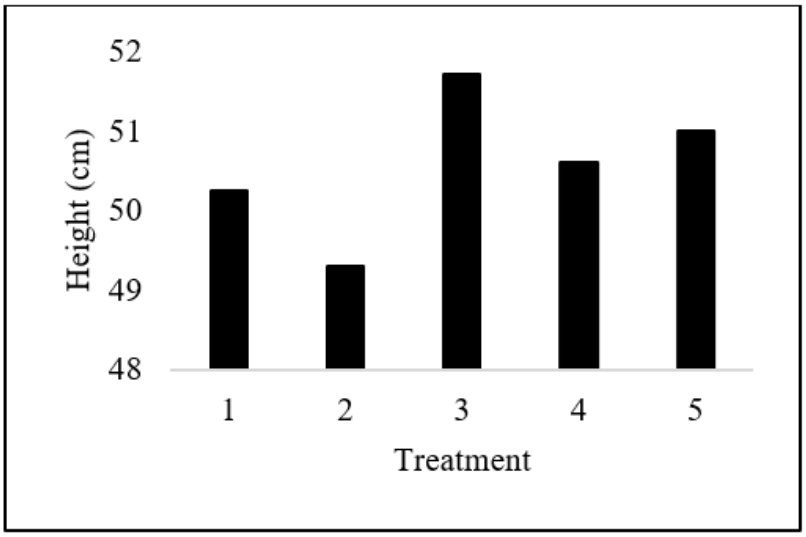

Figure 1: Average Plant height of different treatments within the experimental period (cm).

The differences of plant height were significant. T4 has given highest mean value for plant height, while T1 (control) has given lowest mean value for plant height. Figure 1 shows that, there was a considerable increment in plant height in T3 and T4 compared to control, even the control showed maximum average height at initial stage than other treatments and T4 showed the lowest average height at initial stage than others.

Number of leaves: Mean values for number of leaves per treatment are given in the Table 4. There was no significant difference between treatments. However, T3 treatment gave highest mean value for number of leaves compared to all other treatments. This may be due to the well-balanced nutrients supply by MCFP to the plants.

Analysis of soil chemical properties after application of treatments

Soil properties did not show significant difference among treatments. Soil pH is one of the most crucial parameters which strongly impact nutrient availability to the plants. Soil pH was ranged from 5.54 to 6.13 among treatments and the highest pH value was recorded by T4 while the lowest was recorded by T5. The pH values of all treatments have decreased with compared to the initial status.

Electrical Conductivity (EC) indicates the ionic concentration in soil including nutrients. Soil EC was varied between 24.75 (µS/cm) to 77.53 (µS/cm) and the maximum EC was recorded by T4 while minimum was given by T3 indicating its slow releasing nature. However, T4 shows a considerable increment in soil EC with compared to the initial status.

The available Nitrogen content was ranged from 0.005 % to 0.009 %. T4 and & T3 showed the highest available N content than others.

Soil available Phosphorous was varied from 0.37 ppm to 1.59 ppm. The T4 showed the highest P content than other treatments. T4 shows an increment in soil P content with compared to initial status.

Soil exchangeable Potassium was varied from 7.61 ppm to 8.81 ppm. The highest K content was recorded by T2 and T4 than other treatments.

Conclusion

Results indicate that application of Multi-nutrient Compound Fertilizer Package (MCFP) has shown a trend on enhancing the growth performance of pineapple. According to the results, CC. There is no significant difference among treatments with relevant to soil chemical properties. This may be due to extremely high rainfall (above 300 mm per month) received within the experimental period (October- November) and the shorter time period of the experiment. However, T4 has shown increment in soil EC and Phosphorus content compared to initial status of soil than other treatments indicating nutrient reserves for growth enhancement. Therefore, it can be concluded that MCFP used in T3 and T4 can effectively be used in enhancing growth of pineapple (Table 5).

Table 5: Chemical parameters of soils of different treatments in two months after establishment.

Treatment	pH	EC (µs/ cm)	Available N%	P (ppm)	K (ppm)
1	5.98[a]	28.42[a]	0.005[a]	0.55[a]	7.61[a]
2	6.11[a]	25.77[a]	0.005[a]	0.69[a]	8.81[a]
3	5.54[a]	24.75[a]	0.007[a]	0.37[a]	5.65[a]
4	6.13[a]	77.53[a]	0.009[a]	1.59[a]	8.75[a]
5	5.85[a]	39.83[a]	0.005[a]	0.76[a]	7.90[a]
P<0.05	0.187	0.545	0.376	0.497	0.714

Means with different letters within the same column represent significant differences at p=0.05 level.

Acknowledgement

Authors wish to express their sincere gratitude to Ms. B.M.G.M. Balasooriya, technical officer and other staff of the Soil Health Laboratory, Department of Plantation Management, Wayamba University of Sri Lanka. Authors wish to acknowledge the financial assistance from Development oriented Grant (GoR) of Accelerating Higher Education Expansion and Development (AHEAD), Faculty of Agriculture and Plantation Management, in Wayamba University of Sri Lanka.

Conflict of Interest

None.

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