The response of first year immature oil palm to compound fertilizers of NPK

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Abstract. This research aims to analyse the morphological response of oil palm plants of the first year immature to the provision of compound fertilizer (NPK). The treatment design uses a Randomized Complete Block Design, grouping based on the slope of the land. The treatment applied consisted of 4 treatments, namely M0: 60 kg organic fertilizer, rock phosphate 500 g and dolomite 500 g plant⁻¹ as a control treatment; M1: 650 g NPK + 25 g borate + 25 g copper sulfate plant⁻¹; M2: 1300 g NPK + 25 g borate + 25 g copper sulfate plant⁻¹; M3: 2 600 g NPK + 25 g borate + 25 copper sulfate plant⁻¹. The observations of plant morphology include: plant height, stem circumference, number of leaf midribs, 9th leaf midrib length, leaf area on the 9th midrib.

The results showed that the compound fertilizer package in general had not shown a significant effect on morphological variables, except for the stem circumference of the age of 3 month after treatment (MAT) and leaf area aged 1 and 3 MAT. In general, the higher the dose of compound fertilizer (NPK), the better the growth of plants.

1. Introduction

Fertilization is a factor that plays an important role in the productivity of oil palm plants [1-4] especially in the phase of immature plants. In terms of production cost efficiency, fertilization is one aspect that must be considered, given the high cost. Fertilization costs range from 40–60% of the cost of maintaining plants or around 30% of total production costs in oil palm plantation [5-6]. Plant nutrition as a limiting factor for plant growth and production is highly dependent on location, mostly due to factors of soil properties related to nutrient availability [7].

Like other plants, oil palm also needs nutrients for its growth and development processes, both macro and micro nutrients. Macro nutrients play an important role in the compilation of cell protoplasms so that they are needed in large amounts in planting [8]. Macro nutrients include C, H, O, N, P, K Ca, Mg and S, while micronutrients are needed in very small quantity by plants. If present in excessive amounts can be toxic to plants. Micro nutrients include Fe, Mn, B, Mo, Cu, Zn, Cl and Co [9]. Moreover, oil palm plants are known as plants that require high amounts of fertilizer, given that 1 ton of TBS produced is equivalent to 6.3 kg of Urea, 2.1 kg of TSP, 7.3 kg of MOP, and 4.9 kg of Kiserit [10].

These nutrients can be obtained from inorganic fertilizers, whose absorption is known to be fast. Inorganic fertilizers are contain macronutrients and generally are in single mineral fertilizers such as nitrogen/urea, potassium chloride, super phosphate, which contains phosphate and sulfate, borate and compound fertilizers such as NPK [11]. The compound fertilizer is now commonly used in plantation such as oil palm, cocoa and rubber. Compound fertilizers can improving of fertilisation efficiency, easily in application and are slow released in soil [12]. The availability of information on the type and dosage of appropriate fertilization package will be beneficial in increasing the efficiency and effectiveness of fertilizing and supporting oil palm plantations in an area [13]. This research aims to analyse the
morphological response of oil palm plants of the first year immature to the provision of compound fertilizer (NPK).

2. Material and Methods
The experiments have been carried out in Bukit Sudan Village, Subdistrict of Peusangan Siblah Krueng, Bireuen Aceh Regency, which is located at an altitude of 120 m above sea level. This research was conducted for 10 months starting from March to December 2018. The articles submitted in this seminar were part of the overall research which showed some parameters for 4 months of observation.

2.1. Materials
The materials used were oil palm seedlings of DP-9 varieties, organic fertilizer (cow manure), NPK Phonska fertilizer, copper sulfate (CuSO₄·5H₂O), phosphate rock, and borate. The tools used are analytical scales, meters, chlorophyll meters, microscopes, ovens, and object glasses.

2.2. Methods
The treatment design uses a Randomized Complete Block Design (RCBD), grouping based on the slope of the land. The treatments tested consisted of (Table 1) [14].

| Fertilizer | Treatment               | Dose                                                                 |
|------------|-------------------------|----------------------------------------------------------------------|
| Control (M0) | 60 kg cow manure + 500 gr rock phosphate + 500 gr dolomite |
| 50% recommended dose (M1) | 650 gr NPK + 25 gr of borate + 25 gr copper sulfate (CuSO₄·5H₂O) |
| 100% recommended dose (M2) | 1300 gr NPK + 25 gr of borate + 25 gr copper sulfate (CuSO₄·5H₂O) |
| 200% recommended dose (M3) | 2600 gr NPK + 25 gr of borate + 25 gr copper sulfate (CuSO₄·5H₂O) |

Data analysis was performed by analysis of variance (ANOVA) at a level P <0.05. If there is a significant influence on the treatment, then further analysis is done with orthogonal polynomial tests at α level of 5%.

2.3. Implementation of Research

2.3.1. Fertilization
All oil palm plants have been fertilized with 60 kg of organic manure plant, 500 grams of Rock phosphate plant, and 500 gr of dolomite plant (basic fertilizer). Application of treatment or administration of fertilizer is carried out three times, ie every four months with a minimum rainfall of 60 mm/month (first fertilization on April). The dosage of fertilization is one-third of the total dose of treatment.

The application of NPK compound fertilizer is carried out in the morning by sprinkling fertilizer on oil palm trays and platters, except for the application of Borate fertilizer which is stocked on the leaf midrib armpits [5].

2.3.2. Observation
Observation of plant morphology is done by observing:

1. Plant height. Plant height is measured from the base of the marked stem to the youngest leaf that opens perfectly which is enforced using a modified fabric meter
2. Number of leaf midribs. The calculated number of leaf midribs is leaf midribs that have opened
3. Stem circumference. The stem circle is a collection of leaf midribs that are still wrapped in fibers. Measurements are made using a cloth meter and measured 5 cm from the ground.

4. The 9th leaf midrib length. Measurements are made with a cloth meter, starting from the base of the midrib to the end of the midrib.

5. Leaf area. Measurements of leaf area were carried out on the 9th midrib leaf, measuring several strands of length and width of leaflets and calculated by the formula [15]:

$$\text{LeafArea} = \frac{\sum p xl}{6} x 2n x k$$

3. Result and Discussion

The results of the study showed that the administration of NPK compound fertilizer added with boric fertilizer (B) and copper sulfate (CuSO$_4$.5H$_2$O) had a significant effect on the stem circumference and the 9th midrib leaf area but did not affect plant height, stem circumference, 9th midrib length (Table 2). The data presented for this progress report are morphological variables at 0, 1, and 3 Months after Treatment (MAT).

The results showed that the treatment of compound fertilizer had no significant effect on plant height at age 1 and 3 MAT (Table 2). However, plant height increased with increasing NPK compound fertilizer dosages to M2 doses, i.e., treatment of 1300 grams + 25 grams of borate + 25 grams copper sulfate (CuSO$_4$.5H$_2$O) plants$^{-1}$ (M2). Treatment of M2 produced the highest plant height (14.01%) compared to controls (M0), M, 1 and M3, respectively at 10%, 12.55%, and 12.55% at 1MAT. The same results were also obtained at the growth rate of plant height 3 MAT, where the highest increase in plant height was found in the treatment of M2, followed by M3, M1 and M0, namely: 28%, 26.66%, 25.11% and 21.13%.

Furthermore, the results of the analysis of NPK compound fertilizer treatment showed no significant effect on stem circumference in oil palm plants on 1 MAT but significantly affected the stem circumference of 3 MAT (Table 1). The average stem circumference of oil palm plants increases with the provision of NPK compound fertilizer. The stem circumference in M3, M2, and M1 treatments averaged 19% greater than the control (16%) at 1 MAT and respectively 43% and 40%, compared to 39% at 3 MAT.

The application of compound NPK fertilizer did not significantly affect the number of leaf midribs of oil palm plants, namely in 1 and 3 MAT (Table 2). The application of compound fertilizer (NPK) had effects on increasing the number of leaf midribs to the highest dosage of compound fertilizer, namely M3 fertilizer treatment. The increase in the number of leaf midribs to the highest dose (M3) reached 70% in 3 MATs, compared to 43% in the control treatment (M0) in 3 MAT.

The treatment of NPK compound fertilizer significantly increased the area of 9th palm fronds, namely in 1 and 3 MAT (Table 2). The 9th midrib leaf width variable continued to increase with increasing doses until the highest compound fertilizer dose (M3). The increase in the 9th midrib leaf area to the highest fertilizer dose at 1 MAT reached 46% wider than the control (M0).

In general, the giving of NPK compound fertilizer with 3 recommended dosage ranges (M1, M2 and M3) can improve oil palm plant growth better than the control treatment (M0). The highest increase in growth occurred in the 9th midrib leaf area variable, which was 46% wider than the control. Correlation values showed that the area of 9th midrib leaves was significantly positively correlated with plant height (0.88) and the number of leaf midribs was (0.62), so that when the 9th midrib leaf area became wider the photosynthesis process increased and photosynthate produced increased for vegetative growth of plants such as plant height and number of leaf midribs. These results are in line with the research of [16-17] who concluded that the administration of NPK compound fertilizer can increase the height, the number of leaves and leaf area of 4th of oil palm seedlings in the main nursery. Compound fertilizer is a fertilizer that contains more than one nutrient in one type of fertilizer. NPK compound fertilizer is slow release which releases nutrients N, P and K slowly and well [18].
Table 2. Effect of compound fertilizer (NPK) on plant height variable, stem circumference, number of leaf midribs, 9<sup>th</sup> leaf midrib length, 9<sup>th</sup> leaf midrib area

| Treatment | Plant height (cm) | Stem circumference (cm) | Number of Leaf Fronds (Strands) | The 9<sup>th</sup> Length of the Leaf midribs (cm) | The 9<sup>th</sup> broad of leaf midrib area (m<sup>2</sup>) |
|-----------|------------------|-------------------------|---------------------------------|-----------------------------------------------|-----------------------------------------------|
|           | 0 MAT            | 1 MAT                   | 3 MAT                           |                                               |                                               |
| M0        | 114.97           | 126.52                  | 139.27                          |                                               |                                               |
| M1        | 111.77           | 126.01                  | 142.01                          |                                               |                                               |
| M2        | 113.91           | 129.87                  | 145.83                          |                                               |                                               |
| M3        | 113.10           | 127.30                  | 141.50                          |                                               |                                               |
| Response  | ns               | ns                      | ns                              |                                               |                                               |
| M0        | 19.74            | 22.84                   | 32.14                           |                                               |                                               |
| M1        | 20.17            | 23.49                   | 33.45                           |                                               |                                               |
| M2        | 19.77            | 23.57                   | 34.97                           |                                               |                                               |
| M3        | 19.94            | 23.75                   | 35.18                           |                                               |                                               |
| Response  | ns               | ns                      | ns                              |                                               |                                               |
| M0        | 13.73            | 15.68                   | 19.58                           |                                               |                                               |
| M1        | 13.63            | 15.73                   | 19.93                           |                                               |                                               |
| M2        | 13.47            | 15.69                   | 22.09                           |                                               |                                               |
| M3        | 13.67            | 16.02                   | 23.17                           |                                               |                                               |
| Response  | ns               | ns                      | ns                              |                                               |                                               |
| M0        | 92.80            | 96.40                   | 105.70                          |                                               |                                               |
| M1        | 92.55            | 97.29                   | 106.77                          |                                               |                                               |
| M2        | 90.42            | 96.62                   | 109.02                          |                                               |                                               |
| M3        | 90.95            | 97.35                   | 110.15                          |                                               |                                               |
| Response  | ns               | ns                      | ns                              |                                               |                                               |
| M0        | 0.46             | 0.49                    | 0.54                            |                                               |                                               |
| M1        | 0.52             | 0.60                    | 0.75                            |                                               |                                               |
| M2        | 0.49             | 0.59                    | 0.79                            |                                               |                                               |
| M3        | 0.56             | 0.74                    | 0.91                            |                                               |                                               |
| Response  | Map <sup>c</sup> | L                       | L                               |                                               |                                               |

Description: <sup>c</sup>: Orthogonal polynomial test; L: Linear, ns: not significant, *: Significantly different at the level 5%, Month after treatment (MAT).

The increase in oil palm plant growth is due to the nutrient requirements of both N, P and K that have been fulfilled through NPK compound fertilization, so that oil palm plants can grow optimally. The nutrients N, P and K are primary nutrients because they are the elements most often limiting plant growth [19]. Nitrogen in plants is a very important element for the formation of proteins, leaves and other organic compounds [20]. Phosphorus is important as a constituent of ADP and ATP which is a high-energy phosphate compound that controls many reactions in plants such as photosynthesis, respiration, protein and amino acid synthesis and nutrient transport through plant cells [21]. While potassium plays a role in plant metabolism processes such as activating enzymes, starch formation, opening and closing
of stomata, influencing the absorption of other nutrients, transporting photosynthetic products, regulating turgor pressure, increasing plant resistance to drought and plant diseases.

4. Conclusion
Based on the results obtained, it can be concluded that the treatment of compound fertilizer in general has not shown a significant effect on morphological variables, except for the stem circumference at the age of 3 MAT and leaf area at age 1 and 3 MAT. In general, the higher the fertilizing dose of compound fertilizer (NPK), the better the growth of plants.

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