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The Effect Of NPK Fertilizer Doses And Biofertilizers On The Growth Of Sugar Cane Chips Bud (*Saccharum Officinarum L.*) Seedlings

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***Abstract*— The need of sugar cane for sugar production continues to increase yearly as human population increasing. Based on Central Bureau of Statistics, sugar cane production in Indonesia grew by 3.54% per year. However, this growth is not sufficient to meet the sugar demand of 2.70 million tons. The cause of Indonesia's low sugar production can be seen from the on-farm side, namely seed preparation. Preparing seeds using conventional methods (mules) affects the seeding time because it takes 6 months for one planting period. The experimental design was carried out using the basic pattern of a Completely Randomized Factorial Design consisting of two factors with three replications. Factor I, namely the dose of NPK inorganic fertilizer (16:16:16) and Factor II, namely the dose of Sinarbio biological fertilizer. The results of the research were (1) The interaction between the treatment of NPK fertilizer doses and biofertilizer doses on the growth of sugarcane bud chip seedlings had a significant effect on shoot length and an insignificant effect on the variables number of leaves, stem diameter, number of tillers, root volume, root wet weight and root dry weight. (2) The effect of NPK fertilizer dosage on the growth of sugarcane bud chip seedlings had no significant effect on all observed variables except root wet weight and number of tillers. (3) The effect of biofertilizer dosage on the growth of sugarcane bud chip seedlings had no significant effect on all observed variables except root volume.**

***Keywords*— biofertlizer, fertilizer, NPK, sugarcane.**

I. Introduction

Indonesia is one of the countries with potential for producing sugar cane and sugar [1] . Sugar cane is a plant that produces sugar as part of the basic ingredients (basic necessities) needed by the community [2]. In 2020, sugar production was 2.12 million tons, decreasing by 103.65 thousand tons (4.65%) compared to 2019. Then in 2021, it increased again by 224.93 thousand tons [3]. The need for sugar cane as a sugar producer from year to year continues to increase with the increasing population. Based on BPS agriculture, sugar cane production in Indonesia grew by 3.54% per year. However, this growth has not been sufficient to meet the sugar needs of 2.70 million tons [4]. The cause of Indonesia's low sugar production can be seen from the on-farm side, namely the preparation of seeds [5]. Preparing seeds using conventional methods (mules) affects the length of the nursery period because six months are needed for one planting period [6]. Based on these problems, a short seed preparation technology is needed, not slowing down the nursery and quality seeds. Increasing sugarcane production through intensification can be done by managing land typology (rice fields or dry fields), managing and planting, using production facilities and improving cultivation techniques [7].

Fertilization is an effort to increase soil fertility [8], [9], in certain amounts and combinations it can increase sugar cane growth and production [10]. Fertilization of sugar cane plants depends on the variety, climate, pests and diseases and productivity levels [11]. Based on this, recommendations for the provision of types and kinds of fertilizers are based on the optimum needs and availability of nutrients in the soil. The combination of types and doses of fertilizers used is closely related to the level of productivity of sugarcane plants. Fertilization needs to be done to improve soil productivity and increase fertilization efficiency [12], [13]. Soil fertility can be increased by providing organic matter and soil microbes that are beneficial to plants [14][15].

Mule seeds (sugarcane cuttings with 2 to 3 buds) which are developed in Indonesia vegetatively, namely bud chips (one bud) [16]. Bud chips are an efficient nursery technique because the handling of seedlings is very easy, can produce high-quality seedlings and does not require a large area of land. The use of bud chips seedlings must be balanced with NPK fertilization and biological fertilizers to accelerate the growth of sugarcane seedlings [17]. The application of NPK fertilizer and biological fertilizer to the growth of sugarcane seedlings is one of the efforts to increase sugarcane seed production by improving the physical, chemical and biological properties of the soil as well as soil fertility [18]. The use of planting media in bud chip nurseries is very necessary to increase the growth of sugarcane plants by using planting media that optimally meet the needs of plant nutrients. The nutrients N, P and K are the main nutrients needed in large quantities for sugarcane cultivation. At each sugarcane harvest, there is a very large reduction in nutrients in agricultural soil. NPK fertilization to increase the availability of soil nutrients, especially the levels that are still low in problematic soil or nutrient deficiencies [19]. In sugarcane plants, the elements N, P and K are needed in large quantities [20]. The application of biofertilizers is needed to increase the efficiency of fertilization. Soil fertility and health will be reflected in various changes in soil properties, both physical, chemical and biological. Biofertilizers are environmentally friendly fertilizers that provide nutrients for plants and play a dual role by producing hormones that are beneficial for plants [21]. Biofertilizer contains bacteria that are useful for stimulating the growth of sugarcane seedlings, so that the production of sugarcane plants remains high and sustainable. Biofertilizer contains microorganisms that are useful for sugarcane seedlings, namely N fixers and P solvents, so it is necessary to conduct research related to the application of a combination of inorganic fertilizers and biological fertilizers as additional nutrients for sugarcane plants.

II. Methodology

A. Tools and Materials

The tools used in this research include: (1) digital scales, (2) planting shovels, (3) meters, (4) vernier calipers, (5) hoes, (6) writing instruments, (7) cell phone cameras, (8) rulers, (9) counting tools (hand counters), (10) and other research support tools, and the materials used in this research include: (1) bud chips sugarcane seeds, Bululawang variety, (2) biological fertilizer, (3) NPK Mutiara fertilizer, (4) soil, (5) sand (6) label paper, (7) observation forms/observation sheets, (8) polybags (9) insulation, (10) distilled water and other research support materials.

B. Research Stages

Preparation of bud chip planting material, Preparation of planting media before application of treatment, Planting, Application of NPK inorganic fertilizer and biological fertilizer treatment, and maintenance which includes weeding, replanting, watering, fertilizing, Control of Plant Pest Organisms (OPT) and diseases, and observation.

C. Experimental Design

The experiment was conducted using a basic pattern of Completely Randomized Factorial Design consisting of 2 factors with 3 replications. The treatment of each factor is as follows:

Factor I is the dose of inorganic fertilizer NPK (16:16:16) consisting of 3 levels, namely:

a. P_0 : 0 gram/plant (Control)

b. P_1 : 0.8 gram/plant

c. P_2 : 1.6 gram/plant

Factor II is the dose of sinarbio biological fertilizer which consists of 3 levels, namely:

a. S0 : 0 gram/plant (Control)

b. S_1 : 0.8 gram/plant

c. S_2 : 1.6 gram/plant

D. Method of Analysis

The data obtained were analyzed using analysis of variance and if there were significant differences between treatments, further tests were carried out using Duncan's multiple range test at the 5% level.

III. Result And Discussion

The results of the analysis of the variation of the effect of NPK fertilizer and biological fertilizer doses on the growth of sugarcane bud chips (Saccharum officinarum L.) seedlings on all observation variables are presented in Table 1.

TABLE I. Summary Of Results Of Analysis Of Variance (F-Count) On All Observation Variables

Variable	Value of F-Count		
	NPK inorganic fertilizer (P)	**Biofertilizer Sinarbio (S)**	**Combination (P x S)**
Length of Shoots	2.86^{ns}	0.71^{ns}	3.94^{*}
Number of leaves	0.39^{ns}	2.97^{ns}	0.82^{ns}
Stem diameter	0.30^{ns}	0.99^{ns}	0.27^{ns}
Number of offspring	3.88	0.50^{ns}	0.12^{ns}
Root volume	0.37^{ns}	3.70*	1.61^{ns}
Root wet weight	8.25^{**}	0.37^{ns}	1.56^{ns}
Root dry weight	0.55^{ns}	0.26^{ns}	0.18^{ns}

Description: Very significant effect**, Significant effect*, Not significant effect^{ns}

From the results of the analysis of variance in Table 1, it shows that the interaction of the treatment of NPK fertilizer and biological fertilizers showed a significant effect on the variable of shoot length and no significant effect on the variable of number of leaves, stem diameter, number of shoots, root volume, root wet weight and root dry weight. This is because the simple effect of the dose of biological fertilizer at the same NPK dose level as well as the simple effect of the dose of NPK fertilizer at the same dose level of biological fertilizer are not the same in the observation variable of shoot length so that they have a significant effect on the observation variable of shoot length while the interaction of the treatment of NPK fertilizer dose and biological fertilizer dose has no significant effect on the observation variables, namely the number of leaves, stem diameter, number of shoots, root volume, root wet weight and root dry weight. The simple effect of the dose of biological fertilizer at the same dose level of NPK fertilizer as well as the simple effect of the dose of NPK fertilizer at the same dose level of biological fertilizer are almost the same in the observation variables of the number of leaves, stem diameter, number of shoots, root volume, root wet weight, and root dry weight. The difference between the two averages of each treatment has a difference that is not too large in the simple effect of NPK fertilizer doses on the level of biological fertilizer doses so that it has no real effect on the observation variables of the number of leaves, stem diameter, number of shoots, root volume, root wet weight and root dry weight.

A. The Effect of Interaction of NPK Fertilizer Doses and Biological Fertilizers on the Growth of Sugarcane Bud Chips Seedlings

Based on Table 2, the highest shoot length was found in the combination of NPK fertilizer dose treatment of 0 grams/polybag and biological fertilizer dose of 1.6 grams/polybag (P_0S_2) which showed an average value of 32.83 cm. The combination of NPK fertilizer dose treatment of 0 grams/polybag and biological fertilizer dose of 0 grams/polybag (P_0S_0) also showed a high average value of 28.33 cm. Both treatment combinations produced the highest average compared to other treatment combinations and had the same notation (not significantly different) for each simple effect so that the recommendation given to obtain the highest shoot length is the combination of NPK fertilizer dose treatment of 0 grams/polybag and biological fertilizer dose of 0 grams/polybag (P_0S_0).

TABLE II. THE RESULTS OF DUNCAN'S MULTIPLE RANGE TEST WITH A 5% LEVEL OF INTERACTION BETWEEN NPK FERTILIZER AND SINARBIO FERTILIZER ON THE VARIABLE OF SHOOT LENGTH (CM)

NPK Fertilizer	Sinarbio Biofertilizer		
	S_0 (Control)	**S_1 (0.8 gram)**	**S_2 (1.6 gram)**
P_0 (Control)	28.33 (b) A	25.50 (b) A	32.83 (a) A
P_1 (0.8 gram)	26.83 (a) A	27.33 (a) A	25.83 (a) B
P_2 (1.6 gram)	25.50 (a) A	28.17 (a) A	25.67 (a) B

- Numbers followed by the same lowercase letter (horizontal) indicate no significant difference in the simple effect of sinarbio biofertilizer dose at the same NPK fertilizer level.
- Numbers followed by the same capital letter (vertical) indicate no significant difference in the simple effect of NPK fertilizer dose at the same cyanrbio biofertilizer level.

The interaction between the provision of NPK fertilizer and biological fertilizer in influencing the length of shoots on the growth of sugarcane bud chip seedlings is due to the formation of shoot length and the availability of nutrients absorbed by plants. This is in accordance with research [22] that the treatment of NPK fertilizer doses and biological fertilizer doses is able to improve the chemical and biological properties of the soil which is able to increase the growth of sugar cane plants. This is in accordance with the statement [20] that in plant tissue, nitrogen elements contain essential compounds that are very important for the growth of sugarcane plants such as amino acids, enzymes, and nitrogen also contains chlorophyll.

If the availability of essential nutrients does not meet the required amount, plant metabolism will be inhibited and the growth of plant organs in the form of roots, stems and leaves of plants will be limited. The growth of plant stems is not only influenced by nitrogen but is influenced by the plant environment such as water availability. The provision of NPK fertilizer and biological fertilizer does not interact with all variables except shoot length. Therefore, the provision of NPK fertilizer and biological fertilizer cannot be directly absorbed by plants because the content in the fertilizer must be dissolved, so that the fertilizer that is applied will evaporate and it takes time for the decomposition process [23]. Excessive nitrogen nutrient content can reduce the photosynthesis capacity of plants [24]. The availability of sufficient nutrients in the planting medium affects the vegetative growth of plants such as plant height and number of leaves [25], this is due to the formation of new cells in plants that require sufficient availability of macro and micro nutrients for the planting medium. Determination of fertilizer doses will affect plant growth [26]. Fertilizer doses that do not match plant needs will cause plants to die or wilt, especially in vegetative phase plants. From these results, the addition of the right application of NPK fertilizer and biological fertilizer will increase the length of sugarcane seedling shoots. The nutritional needs of plants through the application of NPK fertilizer and biological fertilizer can maximize the formation of sugarcane shoots. The addition of elements of biological fertilizer materials also plays an active role in improving soil aggregation so that sugarcane plant growth can grow optimally.

Based on the discussion above, the recommendation given to obtain the highest shoot length is to provide a combination of fertilizer dose treatment of 0 grams/polybag NPK fertilizer dose and biological fertilizer dose of 0 grams/polybag (P_0S_0).

B. Equations

The results of the analysis of variance Table 1 show that the effect of NPK fertilizer gives a very significant effect on the wet weight of the roots and a significant effect on the number of tillers. This is because the difference in the application of NPK fertilizer given to sugarcane bud chips seedlings produces different results on the observation variables of wet weight of the roots and the number of tillers so that it gives a very significant effect, while the observation variables of shoot length, number of leaves, stem diameter, root volume, and dry weight of the roots give results that are not significant because the difference in the application of the use of NPK fertilizer doses given to sugarcane bud chips seedlings produces almost the same results.

From the results of Duncan's multiple distance test at 5% level of treatment in Figure 1, namely P_2 (NPK fertilizer) provided the highest increase in root wet weight of 10.90 grams. Good nutrient absorption can support better plant growth and further produce higher sugarcane seedling root wet weight [27]. From the analysis results of Table 1, it shows that the effect of NPK fertilizer on sugarcane bud chips seedlings has no significant effect on the observation variables of shoot length, number of leaves, stem diameter, root volume, and root dry weight. This is due to environmental factors where at the location of the study, around the greenhouse there are several plants that can disrupt the growth of sugarcane seedlings, especially in the leaves which cause the leaves to have holes eaten by grasshoppers and are mostly influenced by uncertain weather factors which cause some plants to not grow uniformly and the plants are unhealthy or wilt. The growth of sugarcane seedlings is unhealthy due to sunlight because in the morning some of the sunlight that shines on the sugarcane plants is blocked by other plants at the research location.

From the results of Duncan's multiple distance test at 5% level in Figure 2, it shows that the P_2 treatment (1.6 grams) gave the highest average number of tillers of 2.22 tillers which was significantly different from the P_0 (Control) and P_1 (0.8 grams) treatments. So the recommendation given to get the highest number of tillers, it is better to use the NPK fertilizer dose with the P_2 treatment (1.6 grams). This is in line with previous research that according to [27] N nutrients play a role in the assimilation of carbohydrates to form sugarcane plant protein in green leaves and increase the number of tillers. In the observation variables of the number of tillers and the wet weight of the roots, it can be said that the results of this study are in accordance with research using NPK fertilizer with a dose of 1.6 grams/polybag or 600 kg/Ha [28] the application of NPK fertilizer to plants with a dose of 600 kg/Ha can have a significant effect on the number of tillers and has a very significant effect on the wet weight of the roots.

The application of NPK fertilizer doses on the growth of sugarcane bud chips seedlings had no significant effect on all observation variables except the number of tillers and the wet weight of the roots, which can be caused by a lack of N which will cause the plants to become stunted with a small number of tillers and low production. Excessive N fertilization and given too late will extend the vegetative period, increase water content, reduce sugar content and the quality of sap, in addition the plants become more sensitive to disease attacks. The growth of sugarcane seedlings is determined by the availability of nutrients, the higher the dose of fertilizer applied will affect the observation variables above, the growth of sugarcane plants is influenced by vegetative growth such as the increase in shoot height at the beginning of growth, so that indirectly the sugarcane seedlings obtained will affect the observation variables. Each plant has a difference in nutrient absorption capacity [29].

- Root Wet Weight

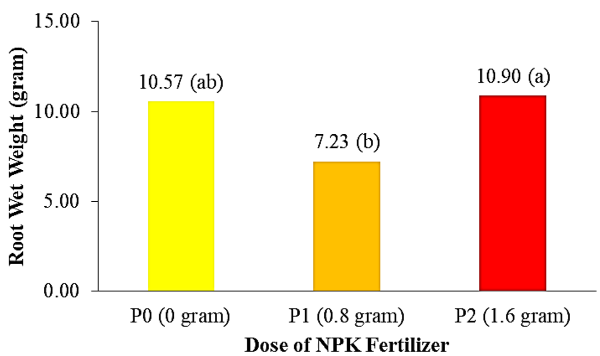

Fig. 1. Results of Duncan's multiple range test at 5% level of influence of NPK fertilizer dose on the observation variable of root wet weight (grams)

Based on the average above, it shows that the P_2 treatment (1.6 grams) gave the highest average root wet weight of 10.90 grams, which was not significantly different from the P_0 treatment (Control) but significantly different from the P_1 treatment (0.8 grams) so that the recommendation given to get the heaviest root wet weight, it is better to use a dose of NPK fertilizer with the P_2 treatment (1.6 grams). Inorganic fertilization can increase the K element which affects the absorption of the N element so that in plant metabolism it can increase the results of sugarcane seedlings [30].

- Number of offspring

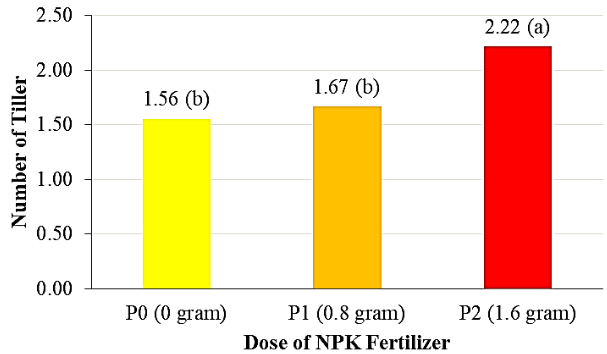

Fig. 2. Results of Duncan's multiple range test at 5% level of the main effect of NPK fertilizer dose on the observation variable of the number of tillers.

Based on the average above, it shows that the P_2 treatment (1.6 grams) gave the highest average number of tillers, which was 2.22 tillers, which was significantly different from the P_0 (Control) and P_1 (0.8 grams) treatments. So the recommendation given to get the largest number of tillers is to use a dose of NPK fertilizer with the P_2 treatment (1.6 grams). According to [31] stated that the nutrient N is needed in nurseries for the formation of protein and green leaves. The N element plays a role in carbohydrate assimilation, a lack of N will cause plants to become stunted with a small number of tillers and low production. So high NPK fertilization can increase the growth of sugarcane nursery tillers.

C. Equations

The results of the analysis of variance in Table 1 show that the application of the dose of biofertilizer gave no significant effect on all observation variables ranging from shoot length, number of leaves, stem diameter, number of shoots, root wet weight and root dry weight except for the root volume variable which had a significant effect. This is because the difference in the application of the dose of biofertilizer on sugarcane bud chips seedlings produced almost the same results.

From the results of Duncan's multiple distance test at 5% level showed that the S_1 treatment (biofertilizer) provides the highest root volume increase of 11.62 ml. Good root growth will affect the growth of other plant organs. Biofertilizer is able to increase soil nutrients that play a role in the development of root cells. Soil nutrients play a role in accelerating the growth of the plant root system. The better the root growth, the roots can reach the plant's nutrient supply and the plant's needs are met so that more roots grow on the plant causing an increase in root volume [32].

The success of plant growth can be influenced by two main factors, namely genetic factors related to the inheritance of traits from the parent plant, and environmental factors related to the conditions where the plant grows [33]. The results of the analysis of Table 1 show that there is no significant effect on all observation variables except for a significant effect on the root volume variable. This is suspected due to the influence of environmental factors and the application of fertilizers to plants, environmental factors can be caused by weather factors where the research location was conducted, the weather often changes and pests that attack sugarcane seedlings because at the research location there are various plants that can cause these pests to land on sugarcane plants and the application of fertilizer is more recommended to be dissolved first because granular fertilizer cannot spread or absorb to the bottom of the plant.

In addition, biofertilizers have similar functions to ZPT. According to [34], ZPT is a synthetic hormone added from outside the plant body. ZPT functions to stimulate growth, for example in root growth, shoot growth, germination process, and so on. [18] stated that in the budding phase, the natural resources needed are water, sunlight, N and P nutrients and root growth. Conditions of insufficient sunlight and soil that are too dense can cause sugarcane growth to be ineffective. If the research environmental conditions support with appropriate nutrients and mineral elements, the plants will experience upward growth and become taller [32]. Shoot formation is determined by internal and external factors. Internal factors are genetic traits carried from plants as special characteristics of each variety. While external factors are sunlight and humidity. Lack of sunlight and dense soil will interfere with the growth of young shoots [35]. Nitrogen plays an important role in supporting sugarcane production because it functions in the formation of chlorophyll, leaves, stems, shoots and roots as well as various enzymes. The role of providing biological fertilizers containing P-solubilizing bacteria, where bacteria will release P bonds from the soil and provide them for plants. Bacteria that are highly capable of dissolving P are generally highly capable of dissolving K [36].

- Volume of Root (ml)

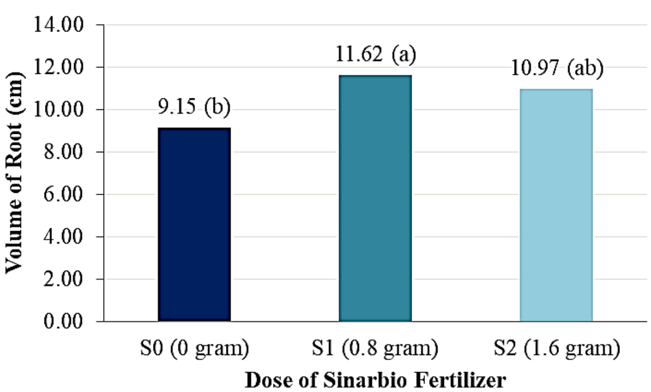

Fig. 3. Results of Duncan's multiple range test at 5% level of the main effect of the dose of sinarbio fertilizer on the observation variable of root volume (ml)

Based on the average above, it shows that the S_1 treatment (0.8 grams) gave the highest average number of tillers, which was 11.62 ml, which was not significantly different from the S0 treatment (Control) but significantly different from the S_2 treatment (1.6 grams). So the recommendation given to get the highest number of tillers is to use the Sinarbio fertilizer dose with the P_1 treatment (0.8 grams). In the vegetative phase, sugarcane seedlings require nutrients for the metabolic process and the elements absorbed by the roots can encourage the growth of sugarcane plants such as stems and roots. Thus, the better the root growth, the roots can reach plant nutrients and their growth will be optimal [37] .

IV. Conclusion

Based on the results of the research that has been conducted, several conclusions can be drawn, namely:

1. The interaction of NPK fertilizer dose treatment and biological fertilizer dose on the growth of sugarcane bud chips seedlings has a significant effect on shoot length and has no significant effect on the variables of number of leaves, stem diameter, number of tillers, root volume, root wet weight and root dry weight.

2. The effect of NPK fertilizer dose on the growth of sugarcane bud chips seedlings has no significant effect on all observation variables except root wet weight and number of tillers.

3. The effect of biological fertilizer dose on the growth of sugarcane bud chips seedlings has no significant effect on all observation variables except root volume. The effect of biological fertilizer dose shows that root growth can reach the supply of plant nutrients and plant needs are met, resulting in an increase in root volume.

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