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The Effect of a Combination of Biodive Fertilizers on The Growth of Sweet Corn (*Zea mays L. Saccharata Sturt*)

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Abstract
This research aims to determine the effect of a combination of biological fertilizers on the growth of sweet corn plants. This research was conducted at Subak Mambal Jl. Raya Semana, Mambal Village, Abiansemal District, Badung Regency, with an altitude of 240 meters above sea level. The experiment lasted for approximately 3 months, starting from April to July 2023. This research was conducted using a single-factor Randomized Block Design (RAK), which employed five treatments with five replications, and the dose of fertilizer was calculated based on the land area. The combinations used are P1 (NPK 100%), P2 (NPK 50% + Aspergillus costaricaensis Biological Fertilizer), P3 (NPK 50% + Liquid Biological Fertilizer), P4 (Aspergillus costaricaensis Biological Fertilizer + Organic Fertilizer), P5 (Organic Fertilizer + Liquid Biological Fertilizer). The results of statistical analysis show that the combination of biological fertilizer on plant height, number of leaves, stem diameter, cob length, weight of cobs with husks, weight of cobs without husks, number of cobs, and fresh weight of roots can equalize the results from using 100% NPK even though the differences are not significant. In terms of the weight of cobs with husks and the weight of cobs without husks, the combination of 50% NPK + liquid biofertilizer can increase the weight of husked cobs and the weight of cobs without husks, which is not significantly different from the 100% NPK treatment.

***Keywords**: Biological Fertilizer; Sweet Corn Plants; Fertilizer Combination; Aspergillus costaricaensis Biological Fertilizer.*

1. Introduction

Sweet corn is an agricultural commodity favored by farming communities because its harvest time is shorter than that of regular corn, specifically 70 days for sweet corn and 85-95 days for regular corn. Generally, sweet corn harvest time is 70-85 days after planting in the midlands and 60-70 days after planting in the lowlands. Sweet corn is generally consumed fresh, so it must be available fresh at all times and cannot be stored for a relatively long time [1]. The chemical composition of corn varies depending on age and variety. Sweet corn contains vitamins A, B, C, and E, as well as minerals and carbohydrates. Carbohydrates in sweet corn comprise reducing sugars (glucose and fructose), sucrose, polysaccharides, and starch [2]. According to [3], harvesting sweet corn beyond 75 days after planting results in seeds that are harder and wrinkled, ultimately diminishing the overall production quality.

The demand for sweet corn in 2021 is expected to reach 10.76 million tons, necessitating an increase in corn production to meet market needs. One effort to increase sweet corn production is by fertilizing. Fertilization is one way to improve soil fertility for the growth and production of sweet corn. According to [4], the nutrients needed by plants are sufficiently available when fertilization is carried out. Apart from that, fertilization has a beneficial effect on the physical and chemical properties of the soil, encouraging the development of microorganisms.

Biofertilizer is a component containing live microorganisms that are given to the soil as an inoculant to help provide specific nutrients for plants. Biofertilizers can reduce the use of chemical fertilizers by up to 75%. Biological fertilizer technology utilizes active biological products, consisting of soil-fertilizing microbes, to enhance fertilization efficiency, fertility, and soil health [5]. Biofertilizers can serve as an alternative to chemical inorganic fertilizers, which can help reduce production costs by minimizing their use and minimizing environmental damage [6]. It is essential to pay attention to the use of biological fertilizer, as excessive application can lead to competition for food among microbes, resulting in unmet nutritional needs and reduced microbial performance [7].

Organic fertilizer is a type of fertilizer that comes from plant remains and animal waste. In contrast, inorganic fertilizer is a type of fertilizer produced through chemical, physical, and biological engineering processes, typically manufactured in industrial or fertilizer manufacturing facilities. Organic fertilizer has a complete nutrient composition and a high organic material content. Decomposed organic material produces organic acids, which are highly beneficial for soil fertility [8]. One of the organic fertilizers that can be used to improve soil structure and maintain the availability of organic material in the soil is Nakula allegro fertilizer. Based on the above background, the importance of using organic fertilizers and biological fertilizers in soil nutrient management is increasingly recognized. The use of biological fertilizer is one of the safest methods to help provide the nutrients needed by plants and contributes and plays a vital role in improving plant quality and reducing the use of chemical fertilizers [9,10]

2. Materials and Methods

This research is a field study conducted in rice fields in Subak Mambal, Jl. Raya Semana, Mambal Village, Abiansemal District, Badung Regency, with an altitude of 240 meters above sea level. This research was conducted over three months, from 24 April to 2 July 2023. This research was carried out using a single-factor Randomized Block Design (RAK) using five treatments with five replications; the combination used was P1 (NPK 100%), P2 (NPK 50% + Aspergillus costaricaensis Biological Fertilizer), P3 (NPK 50% + Biological Fertilizer), P4 (Aspergillus costaricaensis Biological Fertilizer + Organic Fertilizer), P5 (Aspergillus costaricaensis Biological Fertilizer + Liquid Biological Fertilizer). Using 100% NPK utilizes the full recommended amount of fertilizer, while 50% NPK uses half the recommended amount.

The first fertilization is carried out when the plants are 21 DAP, and the second fertilization is carried out when the plants are 35 DAP. The dose of NPK fertilizer and organic fertilizer is divided into two for the first and second fertilization. The variables observed in this study were plant height (cm), number of leaves (strands), stem diameter (cm), cob length (cm), weight of cobs with husks (kg), weight of cobs without husks (kg), number of cobs (fruit).), fresh weight of roots (g), number of productive tillers (stem), number of panicles per plant (stem), weight of dry harvested grain (g), weight of dry grain in the sun (g), and dry weight of 500 grains. The research data were analyzed using a statistical analysis of variance, as outlined in the research design. A single treatment that has a significant to very significant effect is then continued with the LSD test at the 5% level.

3. Results and Discussion

Based on the results of statistical analysis, the effect of the combination of biological fertilizers on the variables observed during the research is evident in Attachments 1-8. The significance of the influence of the combination of biological fertilizers on the observed variables is presented in Table 1.

Table 1. Significance of the influence of the combination of biological fertilizers on the observed variables

No.	Treatment	Variables
1	Maximum Plant Height	ns
2	Number of Leaves	ns
3	Rod Diameter	**
4	Cob Length	ns

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5	Weight of Bloated Cobs per plant	ns
6	Weight of Cobs Without Husks per plant	ns
7	Number of Cobs per plant	ns
8	Fresh Root Weight per plant	ns

Note: *= significant effect (P<0,05), **= very significant effect (P<0,01), ns= not significant (P≥0,05)

Based on Table 1, the results of the statistical analysis show that the treatment has no significant effect (P > 0.05), but the effect is significant (P < 0.01). Higher plant height was obtained in treatment P4 (Aspergillus costaricaensis Biological Fertilizer + Organic Fertilizer), at 176.40 cm, which was not significantly different from treatments P1 (100% NPK), P2 (50% NPK + Aspergillus costaricaensis Biological Fertilizer), and P3 (NPK 50% + Liquid Biological Fertilizer). A higher number of leaves was obtained in treatment P3 (NPK 50% + Liquid Biological Fertilizer) of 10.80, which was not significantly different from treatments P1 (NPK 100%), P2 (NPK 50% + Aspergillus costaricaensis Biological Fertilizer), and P4 (Aspergillus costaricaensis Biological Fertilizer + Organic Fertilizer). A higher stem diameter was obtained in treatment P1 (NPK 100%) at 7.18 cm, which was not significantly different from treatment P3 (NPK 50% + Liquid Biological Fertilizer) and P5 (Liquid Biological Fertilizer + Organic Fertilizer) with stem diameters each of 6.69 cm and 6.51 cm. A higher cob length was obtained in treatment P3 (NPK 50% + Liquid Biofertilizer) at 19.57 cm, which was not significantly different from treatments P1 (NPK 100%), P2 (NPK 50% + Biofertilizer Aspergillus costaricaensis), and P5 (Fertilizer Liquid Biological + Organic Fertilizer). The highest husk cob weight was obtained in treatment P3 (NPK 50% + Liquid Biological Fertilizer) at 0.57 kg, which was not significantly different from treatments P1 (NPK 100%), P4 (Biological Fertilizer Aspergillus costaricaensis + Organic Fertilizer), and P5 (Liquid Biological Fertilizer + Organic Fertilizer). The higher cob weight without husks was obtained in treatment P3 (NPK 50% + Liquid Biological Fertilizer) at 0.44 kg, which was not significantly different from treatments P1 (NPK 100%), P5 (Liquid Biological Fertilizer + Organic Fertilizer), and P4 (*Aspergillus costaricaensis* Biological Fertilizer + Organic Fertilizer). The highest number of cobs was obtained in treatment P1 (NPK 100%) at 5.00, which was not significantly different from treatment P4 (Aspergillus costaricaensis Biological Fertilizer + Organic Fertilizer), P5 (Liquid Biological Fertilizer + Organic Fertilizer). Higher fresh root weight was obtained in treatments P1 (NPK 100%) and P4 (Biological Fertilizer Aspergillus costaricaensis + Organic Fertilizer) of 0.72 kg, which was not significantly different from treatment P2 (NPK 50% + Biological Fertilizer Aspergillus costaricaensis).

Table 2. Average results of observation variables for combinations of biological fertilizers

No	Variable	Treatment				
		P1	P2	P3	P4	P5
1.	Maximum plant height (cm)	167.13a	168.87a	172.90a	176.40a	165.97a
2.	Number of leaves (Strands)	10.47a	10.07a	10.80a	10.33	9.93a
3.	Rod diameter (cm)	7.18a	5.95bc	6.69a	5.49c	6.51ab
4.	Cob length (cm)	19.43a	18.83a	19.57a	18.27a	19.10a
5.	Weight of bloated cobs (kg)	0.56a	0.49a	0.57a	0.53a	0.56a
6.	Weight of cobs without husks (kg)	0.42a	0.39a	0.41a	0.41	0.44a
7.	Number of cobs (buah)	5.00a	3.60a	3.60a	4.20a	0.60a
8.	Fresh root weight (g)	0.33a	0.31a	0.27a	0.35a	0.27

3.1. Discussion

The average plant height in the P4 treatment (Aspergillus costaricensis Biological Fertilizer + Organic Fertilizer) with the LSD test level of 5% got the highest yield. Still, it was not significantly different from the other treatments. This means that the combination of P4 (Aspergillus costaricensis biological fertilizer and organic fertilizer) can balance the treatment of P1 (100% NPK fertilizer). This is influenced by the Aspergillus biofertilizer, which contains

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organic C, the fixation of N from the air, and the dissolution of phosphate from the inorganic phosphate content. This bacterium enhances the availability of macronutrients for sweet corn plants, as indicated by an increase in plant height, while the organic fertilizer encourages productivity. Microorganisms in the soil and stimulate root growth for nutrient absorption. According to [11, 12], organic fertilizer can improve the physical condition of the soil by serving as a source of nutrition for bacteria, fungi, and other organisms and by dissolving insoluble soil minerals and making them available to plants. The results of this research are research conducted by [13] that the provision of biological and organic fertilizers has a significant effect on the vegetative growth of corn plants, such as plant height; this is because the content of biological fertilizers can help the decomposition process so that the corn plants can absorb the nutrients in the soil.

The highest average number of leaves was obtained in the P3 treatment (NPK 50% + Liquid Biological Fertilizer) with an LSD test level of 5%, which received the highest yield but was not significantly different from other treatments. This means that the combination of P3 fertilizer (NPK 50% + liquid biological fertilizer) can balance the treatment of P1 fertilizer (NPK 100%). According to Widawati and Suliasih (2006), the bacteria Pseudomonas sp., Bacillus megatherium, Bacillus sp., and Chromobacterium sp. are solubilizing bacteria which has the most remarkable ability as a biofertilizer, namely by dissolving the phosphate element which is bound to other components such as the elements Fe, Al, Ca and Mg, so that the phosphorus element becomes available to plants. The correct composition of nutrients from NPK fertilizer, combined with additional nutrients from liquid biological fertilizer, provides a synergistic effect that supports plant growth and development, including an increase in leaf number. From the results obtained, the combination of P3 fertilizer (NPK 50% + liquid biological fertilizer) provides optimal conditions for plants to produce the highest number of leaves.

The highest average stem diameter was obtained in treatment P1 (NPK 100%) with the LSD test at 5% level, which was not significantly different from other treatments. This is because the P1 (NPK 100%) treatment provides complete nutrition, specifically nitrogen (N), phosphorus (P), and potassium (K), in the correct proportions according to plant needs. This nutrient is crucial for the stem diameter of sweet corn plants, and providing sufficient amounts (such as 100% NPK) can ensure optimal nutritional intake for growth.

The average cob length in the treatment using P3 (NPK 50% + liquid biological fertilizer) yielded the highest cob length results compared to other treatments. This means that the combination of P3 (50% NPK fertilizer + liquid biofertilizer) can balance the P1 treatment (100% NPK fertilizer). This is because the provision of nitrogen can encourage plant vegetative growth and better cob formation. This is also influenced by the use of liquid biological fertilizer, which contains the fungus Pseudomonas sp., which can dissolve phosphate in the soil in the form of NPK. According to [14], only 10-30% of the phosphorus nutrients added to the soil through inorganic fertilization can be utilized by plants, which means that around 70-90% of the phosphorus fertilizer remains in the soil and cannot be used by plants. This microorganism can stimulate plant growth, fix nitrogen, dissolve phosphate, and inhibit the growth of plant diseases [15]. Plant-stimulating compounds, such as auxin and gibberellins, are produced by many microorganisms, including Azotobacter sp., Azospirillum sp., and Bacillus sp. [15].

The weight of husked cobs using P3 (NPK 50% + liquid biological fertilizer) gave the highest weight of husked cobs, which was not significantly different from other treatments with the LSD test at 5% level. This means that the combination of P3 (50% NPK fertilizer + liquid biofertilizer) can balance the P1 treatment (100% NPK fertilizer). Providing P3 fertilizer (NPK 50% + Liquid Biological Fertilizer) to corn plants can increase the weight of husk cobs because they contain nutrients that are beneficial for plant growth. This is by research by [16], nitrogen plays a vital role as a component of amino acids, protein, and chlorophyll during the photosynthesis process, thereby influencing the quality and quantity of sweet corn yields, showing that NPK fertilizer and biological fertilizer treatments have the highest influence on the weight of husk cobs, which is significantly different from other treatments. This is based on [17]'s statement that applying biological fertilizer and NPK fertilizer at 50% of the recommended dose can increase corn production.

The average weight of cobs without husks in the P3 treatment (NPK50%+liquid biofertilizer) gave the highest weight of cobs without husks, which was not significantly different from other treatments with the LSD test at the 5% level. The content of the microbe Rhizobium sp causes this. 1.3 x 107, Azotobacter sp. 8.9 x 108, Pseudomonas sp. 2.2 x 108, Lactobacillus sp. 1.9 x 108, Penicillium sp. 2.0 × 10^6, pH 7.9 can simultaneously optimize the absorption of nutrients needed by plants, thereby maximizing plant yields. Providing biological fertilizer can improve soil granulation, making soil aeration better for root growth, which in turn facilitates the absorption of nutrients for plant needs. According to [18], plant growth components influence plant yield components, meaning that if growth is hampered, then the yield will be reduced. The lower the photosynthate allocated to the cobs, the lower the accumulation of food reserves that are translocated to the seeds, thereby reducing the seed weight.

The highest number of cobs was obtained in treatment P1 (NPK 100%) with an LSD test level of 5%, which was not significantly different from other treatments. According to [19], the P element is needed by corn plants in the generative phase of cob formation. Additionally, the optimal application of fertilizer will significantly increase the contribution of nutrients to the soil. According to [20], phosphorus plays a significant role in the growth process and yield formation, as it functions in energy transfer and the photosynthesis process. [21] that corn yields increase with the use of NPK fertilizer. The nutrients obtained by plants from the soil in their growing environment are crucial for the process of cob number. The results of this research are based on a study conducted by [22], who reported that applying 300 kg NPK fertilizer/ha resulted in greater numbers of cobs, longer cobs, and heavier cobs.

The highest fresh root weight was obtained in treatments P1 (NPK 100%) and P4 (Aspergillus biofertilizer Aspergillus costaricaensis + organic fertilizer), as determined by the LSD test at the 5% level, yielding the highest results, which were not significantly different from those of the other treatments. This means that P4 (Aspergillus Aspergillus costaricaensis biological fertilizer + organic fertilizer) can balance P1 (100% NPK fertilizer). Aspergillus biofertilizer contains active ingredients that can help increase the growth and production of sweet corn plants, such as Aspergillus niger, Pseudomonas mendocina, Bacillus subtilis, and Bacillus flexus. The fungus Aspergillus niger van Tieghem, 1867 is a type of soil microbe capable of producing indole acetic acid (IAA) and gibberellin (GA3) [23]. Apart from providing nutrients, the most essential part of organic fertilizer is its ability to support the activities of microorganisms in the soil, thereby maximizing plant yields. This is similar to the statement in [24], which states that the activities of microorganisms present in fertilizer help form soil aggregates, thereby increasing the ability to hold water and improving soil structure.

4. Conclusion

Based on the research results, the variable weight of cobs with husks and the weight of cobs without husks, combined with the NPK 50% + liquid biofertilizer, yielded results that were not significantly different from those of other treatments. The combination of 50% NPK + liquid biological fertilizer gave a yield of 0.57 kg for the weight of husk-cobs and 0.44 kg for the weight of husk-free cobs compared to the 100% NPK treatment of 0.56 kilograms of the weight of husk-free cobs and 0.42 kg. on the weight of the cob without husks. In the variable number of cobs, the combination of Liquid Biological Fertilizer and Organic Fertilizer at 5.00 can yield results comparable to those obtained by using 100% NPK. However, the difference is not statistically significant.

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