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Application of Mycorrhizal Biofertilizer and NPK Fertilizer to the Growth and Yield of Edamame Soybean Plants

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Abstract
This study aims to evaluate the effect of doses of arbuscular mycorrhizal biofertilizer and NPK fertilizer and their interaction in increasing the growth and yield of edamame soybean plants. This research was carried out in Kutuh Village, South Kuta District, Badung Regency, Bali in March-June 2023. This study used a Factorial Group Randomized Design (2 factors) which was repeated 3 times. The first factor is the application of mycorrhizal biofertilizer (M) which consists of 4 levels (0; 7.5; 15; dan 22.5 g plant-1). The second factor is the application of NPK chemical fertilizer which consists of 4 levels (0; 1.25; 2.5; dan 3.75 g plant-1). Arbuscular mycorrhizal biofertilizer treatment of 22.5 g plant-1 (M3) gave the highest yield of fresh seed weight of 22.92 g plant-1 with an increase of 34.19% compared to without mycorrhizal fertilizer treatment (M0) which was 17.08 g plant-1. The treatment dose of NPK fertilizer 3.75 g plant-1 (N3) resulted in the highest fresh weight of seeds of 25.75 g plant-1 or an increase of 101.96% compared to treatment without NPK fertilizer which was 12.75 g plant-1. The interaction between mycorrhizal biofertilizer 15 g plant-1 and NPK fertilizer 3.75 g plant-1 resulted in the highest average number of leaves of 18.57 strands. Meanwhile, the interaction without biofertilizer treatment with NPK fertilizer 3.75 g plant-1 resulted in the highest average number of branches, namely 5.73 pieces.

Keyword: *Edamame soybeans, arbuscular mycorrhizal biofertilizer, NPK fertilizer*.

1. Introduction

Japanese soybean edamame (mao dou in Chinese) was recorded as a plant cultivated in China in 200 BC, as a medicinal plant even today it is still popular as a medicinal plant [1]. Edamame (*Glycine max L. Merrill*) is one of the sub-tropical crop commodities successfully developed in Indonesia [2]. The productivity of ordinary soybeans are only able to produce 1.1-1.5 tons ha^{-1}, while edamame soybeans can produce higher productivity reaching 3.5 tons ha^{-1}. Soybean plants are suitable for planting in open land at temperatures of 24-300 °C [3]. The optimum temperature in the soybean germination process is around 30°C, while for flowering it is 24-25°C [4]. Soybeans are short-day crops so they will not flower if the length of the day exceeds the critical limit of 15 hours per day. Soybean crops are strongly influenced by rainfall, solar radiation, and temperature [5]. In Indonesia, soybean plants can grow well in lowland areas to areas with an altitude of 1200 m above sea level. However, generally, the growth of soybean plants will be good at an altitude of no more than 500 meters above sea level. Soybeans can grow well on alluvial, regosol, grumosol, latosol, and andosol soils [6]. In addition, soybeans want fertile, loose, and organic matter-rich soil, with suitable soil similarity (pH) ranging from 5.8 to 7.0. The obstacle faced in the cultivation of edamame soybeans is the insufficiency of nutrient content in the soil due to excessive use of inorganic fertilizers [7].

Nutrients are one of the factors that support plant growth and development. The use of inorganic fertilizers in the relatively long term is generally not good for the soil. The soil becomes less able to store water, quickly hardens, and quickly becomes acidic which will eventually

decrease plant productivity [8]. Efforts to increase the production yield of edamame soybeans can be made with technology packages through the implementation of farming businesses including the use of superior seeds, tillage, fertilization, irrigation, and proper pest and disease control [9]. Biofertilizers are microbes that are applied into the soil to increase nutrient uptake by plants from the soil or air. Biofertilizer is a substance containing live microorganisms that colonize the rhizosphere or the inside of plants and promote growth by increasing the supply of primary nutrient availability and/or growth stimulus of target plants, when used on seeds, plant surfaces, or soil [10]. NPK fertilizer is an inorganic fertilizer or artificial fertilizer produced from the factory. NPK fertilizer contains macronutrients needed by plants for the process of plant growth and development during the plant growth period [11].

Arbuscular Mycorrhizal Fungi (CMA) is a soil fungus that can live symbiotically in the soil with plant roots. Arbuscular mycorrhizal fungi can produce phosphatase enzymes that can release P nutrients bound to Al and Fe nutrients in acidic soils, and Ca in calcareous soils so that nutrients can be available more adequately to plants [12]. Inorganic fertilizers are fertilizers resulting from chemical, physical, and or biological engineering processes and are the results of industrial or fertilizer manufacturing plants [13]. Inorganic fertilizers can be divided into single inorganic fertilizers and compound inorganic fertilizers. Single inorganic fertilizers have only one kind of nutrient, while compound inorganic fertilizers have more than one kind of nutrition. Inorganic fertilizers that are often used include Urea and ZA for nutrient N; TSP, DSP, and SP-36 fertilizers for P nutrients, and KCL for K nutrients [14]. While compound fertilizers are usually made by mixing single fertilizers [15].

2. Materials and Methods

The research activity was carried out for 3 months, from March to June 2023. The research was conducted in Kutuh Village, South Kuta District, Badung Regency which is located at an altitude of 180 meters above sea level. This study was carried out in a greenhouse using polybags, the research design used was a Group Random Design with 2 treatment factors. The first factor is arbuscular mycorrhizal biofertilizer (M) which consists of 4 levels, namely: M0 = 0 g plant^{-1} (control), M1 = 7.5 g plant^{-1}, M2 = 15 g plant^{-1}, M3 = 22.5 g plant^{-1}. The second factor is NPK 16-16-16 chemical fertilizer which consists of 4 levels, namely: N0 = 0 g plant^{-1} (control), N1 = 1.25 g plant^{-1}, N2 = 2.5 g plant^{-1}, N3 = 3.75 g plant^{-1}. Thus, 16 treatment combinations can be obtained, each of which is repeated 3 times so that 48 polybags of edamame plants are obtained. Variables observed in this study include planting height, number of leaves, number of branches, flowering age number of fresh pods per plant, weight of fresh pods per plant, fresh weight of seeds per plant, dry weight of seed oven per plant, wet weight of stash per plant, and dry weight of stash oven per plant.

The collected data were analyzed statistically by fingerprint analysis by the research design. If a single treatment has a real to very real effect, then proceed with a 5% LSD test. If the interaction has a real effect, it is continued with the Duncan test at a level of 5%. Meanwhile, to find out the closeness of the relationship between variables is done using correlation analysis.

3. Results and Discussion

Based on the results of statistical analysis, the significance of the effect of mycorrhizal biofertilizer dose treatment (M) and compound NPK fertilizer dose (N) and its interaction (MXN) on the observed variables presented in Table 1 were obtained. The significance of the effect of mycorrhizal fertilizer and NPK fertilizer doses on all observed variables.

The interaction between mycorrhiza and NPK (MXN) had no real effect ($P \geq 0.05$) on all observed variables, except for the variable number of leaves had a very real effect ($P<0.01$). The dose treatment of mycorrhizal fertilizer (M) had no real effect on all variables observed except on the variable fresh weight of seeds had a real effect ($P<0.05$). The treatment dose of NPK fertilizer (N) had a very real effect ($P<0.01$) on all observation variables, except for the observation variable of plant height had a real effect ($P<0.05$).

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Table 1. Significance of the effect of mycorrhizal fertilizer and NPK fertilizer doses on all observed variables

No	Variable	Treatment		
		Mycorrhizal (M)	NPK (N)	Interaction (M×N)
1.	Plant height (cm)	ns	*	ns
2.	Number of leaves (pieces)	ns	**	**
3.	Number of branches (fruit)	ns	**	*
4.	Flowers appear (DAP)	ns	**	ns
5.	Fresh weight of stover (g)	ns	**	ns
6.	Dry weight of stover (g)	ns	**	ns
7.	Number of pods (fruit)	ns	**	ns
8	Pod weight (g)	ns	**	ns
9	Fresh weight of seeds (g)	*	**	ns
10	Seed dry weight (g)	ns	**	ns

Note:
Ns = not significant (P≥0,05)
** = very significant (P<0.01)
* = significant (P<0.05)

3.1. Maximum Plant Height (cm)

Based on Table 2 shows that increasing the dose of mycorrhizal fertilizer from M0 to M3 increases the average height of edamame plants, where the highest is obtained at M1 which is 46.05 cm increased by 8.91%, which is not real with M0, M2, and M3. However, the NPK fertilizer treatment from N0 to N3 increased the average height of edamame plants by 19.46%, where the highest in N2 was 46.83 cm and was not significantly different from N1, and N3, but significantly different from N0.

Table 2. The average height of edamame plants aged 37 days after planting (DAP) at mycorrhizal fertilizer dose treatment and NPK fertilizer dose.

Treatment	Plant height 37 DAP (cm)
Mycorrhizal dosage	
M0 (0 g plant^{-1})	42.58 a
M1 (7.5 g plant^{-1})	46.05 a
M2 (15 g plant^{-1})	45.27 a
M3 (22.5 g plant^{-1})	42.28 a
LSD 5%	3.56
NPK dosage	
N0 (0 g plant^{-1})	39.20 b
N1 (1.25 g plant^{-1})	44.95 a
N2 (2.5 g plant^{-1})	46.83 a
N3 (3.75 g plant^{-1})	45.20 a
LSD 5%	3.56

Note: The mean value followed by the same letter in the same treatment and the same column means no real difference on the 5% LSD test

3.2. Number of leaves (strands)

The interaction in mycorrhizal fertilizer dose treatment of 15 g plant^{-1} with NPK fertilizer 3.75 g plant^{-1} (M2N3) resulted in the highest average number of leaves of 23.67 strands, which was significantly different from the interaction of mycorrhizal biofertilizer dose of 7.5 g plant^{-1} and NPK fertilizer dose of 3.75 g plant^{-1} (M1N3) and in the dose treatment of biofertilizer 22.5 g plant^{-1} and NPK fertilizer 2.5 g plant^{-1} (M3N2) and was not significantly different from other interaction treatments (Table 3).

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Table 3. The average number of edamame leaves aged 44 DAP in the treatment of the interaction between mycorrhizal fertilizer dose and NPK fertilizer dose.

Treatment	N0	Notation	N1	Notation	N2	Notation	N3	Notation
M0	16.00	ef	14.00	f	14.00	f	20.00	bcd
M1	14.00	f	14.67	f	16.00	cdef	20.33	ab
M2	14.00	f	15.00	f	19.33	bcde	23.67	a
M3	13.00	f	15.00	f	21.33	abc	15.33	def

Note: The mean value followed by the same letter in the same treatment and the same column means no real difference on the 5% Duncan test.

3.3. Number of Branches (fruit)

Increasing the dose of mycorrhizal fertilizer from M0 to M3 increased the number of edamame plant branches, where the highest was found in M2 which was 4.50 pieces increased by 14.79%, which is not noticeable from M0, M2, and M3. However, the NPK fertilizer treatment from N0 to N3 increased the average height of edamame plants by 91.09%, where the highest in N3 was 5.58 pieces and was significantly different from N0, N1, and N2 (Table 4).

Table 4. The average number of edamame branches in the interaction treatment between mycorrhizal fertilizer dose and NPK fertilizer dose.

Treatment	Number of branches (fruit)
Mycorrhizal dosage	
M0 (0 g plant^{-1})	3.92 a
M1 (7.5 g plant^{-1})	4.33 a
M2 (15 g plant^{-1})	4.50 a
M3 (22.5 g plant^{-1})	4.08 a
LSD 5%	0.81
NPK dosage	
N0 (0 g plant^{-1})	2.92 c
N1 (1.25 g plant^{-1})	3.83 b
N2 (2.5 g plant^{-1})	4.50 b
N3 (3.75 g plant^{-1})	5.58 a
LSD 5%	0.81

Note: The mean value followed by the same letter in the same treatment and the same column means no real difference on the 5% LSD test

3.4. Flowering age (DAP)

On average, the first interest increased by 0.69% and the fastest interest appeared on M1, which was 24.33 DAP, but it was not noticeable from M0, M2, and M3. The N2 treatment resulted in the fastest average first flower appearance and increased by 3.82% with an average of 24.08 DAP which differed unmarkedly with N0, N1, and N2 (Table 5).

3.5. Fresh Weight of Safe (g)

Increasing the dose of mycorrhizal fertilizer from M0 to M3 increased the average fresh weight of stash in edamame plants, where the highest average fresh weight of stash was obtained in M1 which was 137.75 g which increased by 2.16%, but was not significantly different from M0, M2, and M3. The treatment of NPK fertilizer doses from N0 to N3 gave an increase in the variable fresh weight of edamame plant stamps, where the highest average was obtained at N3 which was 176.83 g which increased by 96.84%, the treatment had significantly different results from N1, N2, and N3 (Table 5).

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3.6. Dry Weight of Safe (g)

Increasing the dose of mycorrhizal fertilizer from M0 to M3 increased the average dry weight of stash in edamame plants, where the highest average was found in M3 which was 30.75 g which increased by 10.25%, but was not significantly different from M0, M1, and M2. The treatment of NPK fertilizer doses from N0 to N3 gave an increase in the variable dry weight of stash in edamame plants, where the highest average was obtained at N3 which was 41.00 g which increased by 106.75% and was significantly different from N0, N1, and N2, but the N1 treatment was not significantly different from N2 (Table 5).

Table 5. Average flowering age, fresh weight of stamps, and dry weight of edamame plant strollers on mycorrhizal fertilizer dose treatment and NPK fertilizer dose

Treatment	Flowering age (DAP)	Fresh weight of stash (g)	Dry weight of stamp (g)
Mycorrhizal dosage			
M0 (0 g plant^{-1})	24.42 a	136.58 a	28.78 a
M1 (7.5 g plant^{-1})	24.33 a	137.75 a	30.51 a
M2 (15 g plant^{-1})	24.42 a	134.83 a	32.02 a
M3 (22.5 g plant^{-1})	24.50 a	135.25 a	30.74 a
LSD 5%	0.38	20.12	6.04
NPK Dosage			
N0 (0 g plant^{-1})	25.00 a	89.83 d	19.83 c
N1 (1.25 g plant^{-1})	24.42 a	128.17 c	27.80 b
N2 (2.5 g plant^{-1})	24.08 a	149.58 b	33.41 b
N3 (3.75 g plant^{-1})	24.17 a	176.83 a	41.00 a
LSD 5%	0.38	20.12	6.04

Note: The mean value followed by the same letter in the same treatment and the same column means no real difference on the 5% LSD test.

3.7. Number of Fresh Pods per Plant (Fruit)

The results of the statistical analysis in Table 6 show that increasing the dose of mycorrhizal fertilizer from M0 to M3 increases the average number of pods in edamame plants, where the highest average is found in M3 which is 37.17 pieces, the average number of the highest pods in M treatment increases by 9.32%, but is not significantly different from M0, M1, and M2. The treatment of NPK fertilizer doses from N0 to N3 gave an increase in the number of pods in edamame plants, where the highest average was obtained at N3 which was 42.92 pieces which increased by 59.43% and was significantly different from N0, N1, and N2 (Table 6).

Table 6. Average number of fresh pods and weight of fresh pods per edamame plant aged 70 DAP on mycorrhizal fertilizer dose treatment and NPK fertilizer dose

Treatment	Number of fresh pods (fruit)	Fresh pod weight (g)
Mycorrhizal dose		
M0 (0 g plant^{-1})	36.42 a	61.50 a
M1 (7.5 g plant^{-1})	35.42 a	64.50 a
M2 (15 g plant^{-1})	34.00 a	63.33 a
M3 (22.5 g plant^{-1})	37.17 a	71.33 a
LSD 5%	6.04	9.88
NPK Dosage		
N0 (0 g plant^{-1})	26.92 c	46.25 d
N1 (1.25 g plant^{-1})	34.83 b	61.00 c
N2 (2.5 g plant^{-1})	38.33 a	71.58 b
N3 (3.75 g plant^{-1})	42.92 a	81.83 a
LSD 5%	6.04	9.88

Note: The mean value followed by the same letter in the same treatment and the same column means no real difference on the 5% LSD test.

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3.8. Weight of Fresh Pods per Plant (g)

The results of statistical analysis in Table 6 show that increasing the dose of mycorrhizal fertilizer from M0 to M3 increases the average weight of pods in edamame plants, where the highest average is found in M3 which is 71.33 g and increases by 15.98%, but is not significantly different from M0, M1, and M2. The treatment of NPK fertilizer doses from N0 to N3 gave an increase in variable pod weight in edamame plants, where the highest average was obtained at N3 increased by 76.92% at 81.83 g, and was significantly different from N0, N1, and N2, but the N1 treatment was not significantly different from N2.

3.9. Weight of Fresh Seeds Per Plant (g)

Increasing the dose of mycorrhizal fertilizer from M0 to M3 increased the average fresh weight of seeds in edamame plants, where the highest average fresh weight of seeds increased by 34.19% obtained in M3 which was 22.92 g and was significantly different from M0, M1, and M2. The treatment dose of NPK fertilizer from N0 to N3 increased the average fresh weight of edamame plant seeds by 101.96%, where the highest was obtained at N3 which was 25.75 g, but was not significantly different from N2 and significantly different from N1 and N0 treatment (Table 7).

Table 7. Average fresh weight of seeds and dry weight of edamame seeds on dose treatment of mycorrhizal fertilizer and NPK fertilizer

Treatment	Fresh weight of seeds (g)	Dry weight of seeds (g)
Mycorrhizal dosage		
M0 (0 g plant^{-1})	17.08 b	3.43 a
M1 (7.5 g plant^{-1})	18.00 b	3.48 a
M2 (15 g plant^{-1})	18.42 b	3.61 a
M3 (22.5 g plant^{-1})	22.92 a	4.86 a
LSD 5%	4.27	1.20
NPK Dosage		
N0 (0 g plant^{-1})	12.75 b	2.48 b
N1 (1.25 g plant^{-1})	16.25 b	3.15 b
N2 (2.5 g plant^{-1})	21.67 a	4.34 a
N3 (3.75 g plant^{-1})	25.75 a	5.40 a
LSD 5%	4.27	1.20

Note: The mean value followed by the same letter in the same treatment and the same column means no real difference on the 5% BNT test.

3.10. Dry Weight of Seeds per Plant (g)

Based on Table 7 shows that increasing the dose of mycorrhizal fertilizer from M0 to M3 increases the average dry weight of seeds in edamame plants, where the highest average dry weight of seeds has increased by 41.96% obtained in M3 which is 4.86 g, but differs not significantly from M0, M1, and M2. The treatment dose of NPK fertilizer from N0 to N3 increased the dry weight of edamame plant seeds by 117.74%, where the highest was obtained at N3 which was 5.40 g, but not significantly different from N2 and significantly different from N0 and N1 treatment.

3.2 Discussions

In the variable fresh weight of seeds, it shows that the use of mycorrhizal biofertilizer (M) and NPK fertilizer (N) has a real effect ($P<0.05$) to very real ($P<0.01$) but no interaction occurs. Increasing the dose of mycorrhizal biofertilizer (M) from M0 to M3 increases the fresh weight of seeds, where the highest fresh weight of seeds is obtained at M3 (22.92 g) or increased by 34.19% and is significantly different from M0 (17.08 g), M1 (18.00 g), and M2 (18.42 g). While in the NPK fertilizer treatment from N0 to N3, the highest fresh weight of seeds was obtained at N3 (25.75 g) which increased by 101.96% and was not significantly different from N2 (21.67 g) but significantly different from N0 (16.25 g) and N1 (12.75 g) treatments.

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Based on Table 8, the high fresh weight of seeds in mycorrhizal biofertilizer treatment of 22.5 g. plant^{-1} (M3) correlated very markedly and positively supported by increased pod weight per plant (r=0.982**), and dry weight of seeds per plant (r= 0.992**). Based on Table 9 the high fresh weight of seeds in NPK fertilizer treatment 3.75 g plant^{-1} (N3) correlated significantly to very real and positive supported by increased plant height (r = 0.747*), number of leaves (r = 0.982**), number of branches (r = 0.989**), first flower appearance (r = 0.880**), fresh weight of stash (r = 0.981**), dry weight of stash (r = 0.990**), number of pods per plant (r = 0.969**), pod weight per plant (r=0.988**), and dry weight of seeds per plant (r= 998**).

Higher yields reflected in the fresh weight of seeds per plant are supported by increased variable yield components such as first flower emergence per plant, number of pods, and pod weight per plant. There is an interaction influence on the application of mycorrhizal biofertilizer and NPK fertilizer in edamame plants. The results of the interaction of the average number of the highest leaves from the application of mycorrhizal biofertilizer 22.5 g plant^{-1} and the dose of NPK fertilizer 2.5 g plant^{-1} (M2N3) gave the highest value of 18.57 strands. This is under research from [16], which states that high absorption of N and P nutrients is found in plants given mycorrhiza because mycorrhiza will encourage the development of hyphae in plant roots which will further help nutrient absorption. Roots infected with arbuscular mycorrhizal fungi will have a wider range due to the presence of external hyphae that develop outside the roots so that plant nutrient uptake increases. Application of mycorrhizal biofertilizer showed no effect on all variables observed except on the fresh weight of seeds per plant. This is thought to be because the nutrients contained in the soil used at the time of research are quite fulfilled so that in the vegetative phase mycorrhiza does not play too much role in plant growth.

Table 8. Correlation coefficient value between variables (r) due to the influence of mycorrhizal fertilizer dose (M)

	1	2	3	4	5	6	7	8	9
2	0.498ns								
3	0.852**	0.820**							
4	0.807**	-0.078ns	0.383ns						
5	0.338ns	-0.611ns	-0.194ns	0.828**					
6	0.525ns	0.816**	0.883**	-0.046ns	-0.555ns				
7	-0.807**	-0.870**	-0.873**	-0.402ns	0.145ns	-0.634*			
8	-0.373ns	-0.231ns	-0.106ns	-0.463ns	-0.337ns	0.291ns	0.551ns		
9	-0.461ns	-0.136ns	-0.119ns	-0.613ns	-0.498ns	0.321ns	0.525ns	0.982**	
10	-0.569ns	-0.203ns	-0.235ns	-0.679*	-0.504ns	0.219ns	0.605ns	0.964**	0.992**
		r(0.05;10;1) = 0.632				r(0.01;10;1) = 0.765			

Table 9. Correlation coefficient value between variables (r) due to the influence of NPK fertilizer dose (N)

	1	2	3	4	5	6	7	8	9
2	0.620ns								
3	0.740*	0.959**							
4	0.970**	0.789**	0.860**						
5	0.821**	0.930**	0.991**	0.915**					
6	0.777**	0.952**	0.998**	0.888**	0.997**				
7	0.849**	0.907**	0.982**	0.930**	0.998**	0.991**			
8	0.821**	0.941**	0.991**	0.921**	0.999**	0.997**	0.996**		
9	0.747*	0.982**	0.989**	0.880**	0.981**	0.990**	0.969**	0.988**	
10	0.708*	0.989**	0.989**	0.851**	0.974**	0.987**	0.959**	0.980**	0.998**
		r(0.05;10;1) = 0.632				r(0.01;10;1) = 0.765			

Information:

1. Plant height (cm)
2. Number of leaves (strands)
3. Number of branches (fruit)
4. Flowering age (DAP)
5. Fresh weight of stash (g)
6. Dry weight of the stash (g)
7. Number of pods per plant (g)
8. Pod weight per plant (g)
9. Weight of fresh seeds per plant (g)
10. Dry weight of seeds per plant (DAP)

ns = not significant effect (P≥0.05)
** = significant effect (P<0.01)
* = significant effect (P<0.05)

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The results showed that dosing NPK fertilizer can increase the availability of macro and micronutrients in edamame soybean plants. This is thought to be because the content in NPK compound fertilizer contains macro elements such as nitrogen (N), phosphate (P), and potassium (K) which are needed by plants in balanced and sufficient quantities so that they can play a role in maintaining nutrient balance in the soil. The dose of mycorrhizal fertilizer and the dose of NPK fertilizer on edamame plants exert an interaction influence on the average number of branches. The average number of branches in the interaction of mycorrhizal fertilizer dose 0 g plant^{-1} and NPK fertilizer dose 3.75 g plant^{-1} (M0N3) gave the highest value of 5.73 pieces. According to [11], in contrast to the single treatment on the variable fresh weight of seeds without treatment which produces an average of 17.08 g, because the nutrient content in the soil has been fulfilled, so mycorrhiza does not appear its role. The application of NPK fertilizer and biological fertilizer showed no real difference compared to the control [17]. The addition of NPK elements makes plant growth better and is quite effective in supporting the process of bud formation, branching, and further development until the generative phase can productively form flowers and pods.

The application of mycorrhizal biofertilizer and NPK fertilizer to edamame plants affected the variables of the first flower appearing but there was no interaction between the two, on average the fastest first flower appeared obtained at the dose treatment of mycorrhizal fertilizer 7.5 g plant^{-1} (M1) which was 24.33 DAP and at the dose of NPK fertilizer 3.75 g plant^{-1} (N3) which was 24.17 DAP. This is because the provision of NPK doses can provide nutrient needs for plants so that they can spur flower growth. According to [11], potassium nutrients in NPK 16-16-16 fertilizer can contribute to plant metabolism. Increasing assimilation causes the source of food reserves to increase, thus accelerating the appearance of flowers on soybean plants. According to [18], the nutrients needed by plants in the generative phase are P elements, which play a role in the formation of flowers and fruits. If P nutrients are fulfilled optimally, then flowering and fruiting will be faster.

The availability of sufficient nutrients causes the photosynthesis process to run optimally to produce sufficient food reserves for plant growth and development, causing more fruits to form [19]. The highest average number of pods was obtained at the dose treatment of mycorrhizal fertilizer 22.5 g plant^{-1} (M3) which was 30.75 pieces and the dose treatment of NPK fertilizer 3.75 g (N3) which was 42.92 pieces. In this study, the higher the dose of fertilizer given, the higher the number of pods produced. The more P elements available to plants, the more P elements can be absorbed by plants, thus increasing the photosynthetic process and ultimately increasing the weight of fresh pods per plant [20]. The highest average pod weight was obtained at a dose of mycorrhizal biofertilizer 22.5 g plant^{-1} (M3) which was 71.33 g, and a dose of NPK 3.75 g plant^{-1} (N3) which was 81.83 g.

The application of mycorrhizal biofertilizer and NPK fertilizer to edamame plants affects the fresh weight of seeds per plant, the average fresh weight of seeds obtained at the dose treatment of mycorrhizal fertilizer is 22.5 g plant^{-1} (M3) which is 22.92 g and the dose of NPK fertilizer is 3.75 g plant^{-1} (N3) which is 25.75 g. In this study, the higher the dose given, the higher the fresh weight of the seeds produced. As stated by [21], biofertilizer is assumed to help increase soybean growth and yield through the mechanism of increasing nutrient and water uptake and the root system. Mycorrhiza also plays a role in increasing root expansion to maximize nutrient absorption, explore the soil more widely, and increase photosynthesis. The increased rate of photosynthesis is due to the availability of balanced nutrients, so the photosynthates produced also increase and are further used in the formation/filling of edamame pods. NPK has a function that is very closely related to the process of photosynthesis and the production of photosynthetic products, NPK can also increase plant growth through the mechanism of converting NPK nutrients into organic compounds or energy called metabolism, NPK nutrients are nutrients that cannot be replaced with other nutrients to meet the plant life cycle [22].

4. Conclusion

The application of mycorrhizal biofertilizer has no real effect on all variables observed, except for the variable of fresh weight of edamame seeds, which is a real effect. Application of

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mycorrhizal biofertilizer 22.5 g plant^{-1} resulted in the highest fresh weight of seeds 22.92 g plant^{-1} with an increase of 34.19% compared to without mycorrhizal fertilizer (M0) treatment which was 17.08 g plant^{-1}. The application of NPK fertilizer to the growth and yield of edamame plants has a real to very real effect on all observation variables. The treatment dose of NPK fertilizer 3.75 g plant^{-1} resulted in the highest fresh weight of seeds of 25.75 g plant^{-1} or an increase of 101.96% compared to treatment without NPK fertilizer which was 12.75 g plant^{-1}. The interaction between mycorrhizal biofertilizer and NPK fertilizer has a very real effect on plant growth which produces the highest average number of leaves in M2N3 treatment, which is 23.67 strands.

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