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Effect of NPK Phonska Plus and Lemeksari Fertilizers on White Eggplant Yield (*Solanum melongena* L.)

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Abstract

This study aims to determine the effect of NPK Phonska Plus dosage, Lemesari organic fertilizer dosage, and its combination on the growth and yield of white eggplant (Solanum melongena L.). White eggplant has high economic potential in Bali, but its productivity is constrained by low soil fertility. The research was conducted in Cemagi Village, Badung Regency, using a factorial Random Block Design (RBD) with two factors: the dose of NPK Phonska Plus (0.200, 400, 600, 800 kg/ha) and the dose of Lemeksari organic fertilizer (0, 10, 20, 30 tons/ha). Preliminary soil analysis showed a very low C-organic content (1.75%). Data were analyzed using ANOVA and 5% LSD/DMRT tests. Answering the hypothesis, the results of the study show that the application of NPK Phonska Plus significantly affects the height of the plant, stem diameter, number of fruits, and weight of fruit, with 400 kg/ha being the optimal dose for physical aesthetics (length and diameter). Secondly, the application of Lemeksari organic fertilizer significantly increased the height of the plant and the weight of the fruit, confirming the hypothesis that a dose of 30 tons/ha provides the best response due to the improvement of soil structure. Finally, the interaction between the two fertilizers significantly affects the generative phase (the number of fruits and the weight of the harvest). The combination of NPK 400 kg/ha and Lemeksari 30 tons/ha is recommended as the most agronomically efficient treatment to optimize crop yields.

Keywords: *white eggplant; NPK Phonska Plus; Lemeksari organic fertilizer; growth; crop yield*

1. Introduction

White eggplant (*Solanum melongena* L.) is a horticultural commodity that has bright prospects in Bali, especially to meet the demand of the tourism sector such as hotels, restaurants, and cafes. High-end institutional consumers are in high demand for white eggplant due to its striking skin color, unique fruit shape, and physical proportions that strongly support creative culinary aesthetics [1], [2] However, farmers are faced with environmental challenges such as low soil fertility. One of the main obstacles in cultivated land is the low level of C-organic (1.75%) in sandy clay soils, which causes the land to lose its ability to retain water and nutrients. This condition results in the efficiency of plant nutrient absorption being very limited, so the application of organic fertilizers accompanied by inorganic supplements is crucial to improve the physical structure and chemical fertility of the soil [3], [4]. The use of NPK Phonska Plus fertilizer is expected to be able to provide essential macronutrients quickly to plants [5], while the application of Lemeksari organic fertilizer functions in the long term to increase the cation exchange capacity and improve the porosity of the planting medium [6].

Therefore, the use of a combination of compound inorganic fertilizers (such as NPK Phonska Plus) and organic fertilizers (such as Lemeksari) is crucial. NPK Phonska Plus rapidly supplies macronutrients (N, P, K) to support vegetative and generative growth. Meanwhile, Lemeksari

plays a role in improving the physical, chemical, and biological structure of the soil and releasing nutrients slowly (slow release) [7]. The synergy between the availability of nutrients quickly absorbed from inorganic fertilizers and the improvement of soil physical properties through organic matter has consistently been reported to be able to significantly increase eggplant production compared to the application of a single fertilizer [8], [9]. The use of this combination is also a strategic solution to overcome land degradation due to the continuous use of inorganic fertilizers [10]. Previous research has shown that the integration between organic and inorganic fertilizers significantly increases the effectiveness of nutrient absorption and is able to accelerate the flowering phase in eggplant plants [11]. In addition, the integration of organic fertilizers with compound fertilizers can mitigate the decrease in productivity due to land fertility degradation, which has been a major obstacle in intensive cultivation systems [12], [13]. Thus, this integrated fertilization approach is expected to create a rhizosphere ecosystem that supports the optimization of photosynthesis and the accumulation of fruit biomass [14]. This targeted integration of nutrients serves to improve the efficiency of nutrient absorption while improving the binding capacity of the soil to water and cation-anions [15], [16].

Based on this background, this study aims to: (1) determine the effect of NPK Phonska Plus dosage on the growth and yield of white eggplant plants, (2) determine the effect of the dosage of Lemeksari organic fertilizer on plant growth and yield, and (3) determine the effect of the combination of the two fertilizers. The hypotheses proposed in this study are: (1) the application of Lemeksari organic fertilizer at a dose of 30 tons/ha has a real effect on increasing yields; (2) the application of NPK Phonska Plus at a dose of 400 kg/ha has a real effect on increasing yields; and (3) the interaction between Lemeksari and NPK Phonska Plus has a real effect on increasing the growth and yield of white eggplant plants. This research is expected to provide a technical foundation for farmers in implementing balanced fertilization management to improve the productivity of white eggplant on land with low fertility conditions. In addition, the results of this study are expected to be able to support the sustainability of farming by minimizing dependence on synthetic chemical inputs through the use of organic materials that are more environmentally friendly.

2. Materials and Methods

The research was carried out in Cemagi Village, Mengwi, Badung Regency (altitude of 50 meters above sea level) from April to July 2025. Before the treatment is given, initial soil analysis is carried out at the Soil Science Laboratory, Udayana University to determine the basic fertility status of the land presented in Table 1.

Table 1. Results of soil analysis where the research is conducted

No	Types of Analysis	Value	Remarks
1.	pH	6.92	Neutral
2.	Air-Dry Moisture Content (%)	12.2	
	Field Capacity Moisture Content (%)	44.87	
3.	N-total (%)	0.25	Medium
4.	P-Available (ppm)	18.52	Medium
5.	K-Available (ppm)	146.2	Medium
6.	C-organic (%)	1.75	Low
7.	Electrical conductivity (mmhos/cm)	0.3	Very low
8.	Soil Texture:		Sandy clay
	- Sand (%)	16.830	
	- Dust (%)	22.850	
	- Clay (%)	60.320	

Source: Results of soil analysis of the Laboratory of the Faculty of Agriculture, Udayana University Denpasar

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This study uses a group random design factorial pattern with two factors. The first factor is the dose of NPK Phonska Plus (P) with levels: 0, 200, 400, 600, and 800 kg/ha. The second factor is Lemeksari (L) organic fertilizer with levels: 0, 10, 20, and 30 tons/ha. There were 20 treatment combinations with three replicas, resulting in 60 experimental units. The observed variables included vegetative and generative growth. The data was analyzed using the Analysis of Variance (ANOVA) to test the hypothesis, and continued with the Duncan Multiple Range Test (DMRT) and the Smallest Real Difference (BNT) test at the level of 5% if there was a real influence.

3. Results and Discussion

Based on the results of laboratory analysis (Table 1), the soil at the research site has a sandy clay texture with a neutral pH (6.92). However, a very low level of C-organic (1.75%) is a limiting factor that reduces the soil's ability to bind water and nutrients. This condition underlies the importance of combination fertilization interventions, because the application of organic matter has been proven to be able to significantly improve nutrient retention and soil structure. Increasing the content of organic matter through the Lemeksari application is expected to improve soil KKTK, thereby minimizing nutrient runoff that often occurs in sandy clay-textured soils. In addition, the synergy between NPK Phonska Plus and Lemeksari is estimated to be able to optimize the availability of macronutrients that progressively support the formation of generative organs of white eggplant plants. Proper application of organic fertilizers has been proven to increase the efficiency of inorganic nutrient absorption, thereby supporting sustainable plant growth. Furthermore, a variety analysis of field data is expected to show a positive interaction between increasing the dose of organic matter and the effectiveness of NPK fertilizer dosage in optimizing the number of fruits per plant. This is in line with research indicating that optimal interactions between organic and inorganic fertilizers significantly improve yield components, including fruit weight and number of fruits per plant in different eggplant varieties.

To elaborate on the significance results in Table 2, a summary of the average independent effects of the two treatments on growth and yield variables (which are brought together from various observation variables), along with interaction matrix data for harvest weight, is presented comprehensively in Table 2 below. The interaction between NPK Phonska Plus fertilizer and Lemeksari organic fertilizer (PxL) had an unreal effect ($P>0.05$) on all observed variables, except for the number of harvested fruits and the weight of harvested fruits had a very real effect ($P<0.01$). Lemeksari organic fertilizer (L) showed no real effect ($P>0.05$) on all observed growth and yield variables, except for plant height and harvest fruit weight, NPK Phonska Plus Fertilizer had a very significant effect ($P<0.01$) on plant height. It had a real effect ($P>0.05$) on stem diameter, number of harvested fruits, and weight of harvested fruits, while NPK Phonska Plus fertilizer had an unreal effect ($P>0.05$) on the number of leaves, harvested fruit diameter and harvest fruit length. The insignificance of the influence on some of these vegetative growth variables indicates that the nutrient availability of NPK application Phonska Plus has met the basic needs of the plant, although the optimization of generative yields still requires the support of organic matter for the improvement of soil structure [17]. The synergy of the two types of fertilizers is crucial in maximizing the accumulation of generative biomass in the fertilization phase [18].

Table 2. Significance of the effect of Lemeksari organic fertilizer and NPK Phonska Plus on all observation variables

Observation Variables	P (NPK Fertilizer)	L (Lemeksari Fertilizer)	Interaction (PxL)
Plant Height (cm)	**	*	ns
Number of Leaves (strands)	ns	ns	ns
Rod Diameter (mm)	*	ns	ns
Harvest Fruit Diameter (mm)	ns	ns	ns
Harvest Fruit Length (cm)	ns	ns	ns
Number of Harvested Fruits (fruits)	*	ns	**

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Harvest Fruit Weight (g)	*	**	**

Description: ns = Unreal effect (P>0.05); * = Have a real effect (P<0.05); ** = Very real effect (P<0.01).

In accordance with the formulation of the problem and the research hypothesis, the average recapitulation of the independent effects of NPK fertilizers Phonska Plus and Lemeksari is presented in Table 3, while the effects of their interactions are presented in Table 4.

Table 3. Average Growth and Yield of White Eggplant at Various Levels of Treatment of NPK Phonska Plus and Lemeksari Organic Fertilizer

Treatment	Plant Height (cm)	Number of Leaves (strands)	Rod Diameter (mm)	Fruit Diameter (mm)	Fruit Length (cm)	Number of Fruits (fruits)	Fruit Weight (g)
NPK Phonska Plus (P)	**	ns	*	ns	ns	*	*
P0 (0 kg/ha)	36.08 c	32.17 a	9.87 ab	46,53 a	26,92 a	4,67 c	1393,75 c
P1 (200 kg/ha)	36.33 b	31.42 a	10.11 a	47.08 a	27.42 a	4.92 b	1414.94 b
P2 (400 kg/ha)	39.00 ab	29.92 a	9.33 c	47.14 a	27.50 a	5.00 b	1420.86 b
P3 (600 kg/ha)	40.00 a	29.67 a	9.61 b	46.91 a	27.25 a	5.50 a	1564.65 a
P4 (800 kg/ha)	36.67 b	29.08 a	9.98 ab	46.81 a	27.17 a	5.33 ab	1556.88 ab
LSD 5%	2.45	-	0.49	-	-	0.50	139.04
Lemeksari (left)	*	ns	ns	ns	ns	ns	**
L0 (0 tons/ha)	36.60 b	31.13 a	9.90 a	46.91 a	27.13 a	4.73 a	1359.77 b
L1 (10 tons/ha)	36.27 b	30.60 a	9.85 a	47.09 a	27.53 a	5.20 a	1463.16 b
L2 (20 tons/ha)	38.60 ab	30.27 a	9.71 a	46.69 a	27.27 a	5.33 a	1470.01 ab
L3 (30 tons/ha)	39.00 a	29.80 a	9.65 a	46.88 a	27.07 a	5.07 ab	1587.91 a
LSD 5%	2.19	-	-	-	-	0.44	124.36

Note: A number followed by the same letter in the same column means that there is no significant difference in the 5% BNT test. Significance description: ns = unreal; * = real; ** = very real.

3.1. Effect of NPK Phonska Plus Dosage on Growth and Yield

Based on Table 3, the hypothesis that the administration of NPK Phonska Plus has a real effect is acceptable. This treatment has a very noticeable effect on the height of the plant and is noticeable on the diameter of the stem, the number of fruits, and the weight of the fruit. A dose of 600 kg/ha (P3) in absolute terms yields the highest crop (40.00 cm), but statistically does not differ significantly from a dose of 400 kg/ha (P2) of 39.00 cm. The availability of a balanced supply of Nitrogen (N) elements is crucial to spur vegetative cell division [19]. Furthermore, the adequate availability of phosphorus and potassium from NPK Phonska Plus fertilizer also increased the translocation of assimilation to the generative part, thereby triggering an increase in the weight and number of harvested fruits compared to the untreated control. The effectiveness of the appropriate dose of inorganic fertilizers in supporting plant nutrient needs is in line with the principles of nutrient management to maintain production stability in horticultural commodities. The provision of these macronutrients consistently supports plant metabolism in converting nutrients into energy compounds that are important for generative growth [20]. A significant increase in fruit weight at a given treatment dose suggests that the measurable availability of macronutrients is able to minimize nutrient limitations in the soil that often inhibit plant productivity in the fruiting phase [21]. Increased availability of macronutrients such as nitrogen, phosphorus, and potassium has been proven to be able to spur the formation of chlorophyll and facilitate protein synthesis which directly optimizes the rate of photosynthesis [22]. This increase in metabolic activity is consistent with the availability of sufficient nutrients to support optimal vegetative and generative development, as shown in the plant productivity parameters [23]. In contrast, the effectiveness of Lemeksari organic fertilizer in significantly

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increasing fruit weight indicates the crucial role of organic matter in improving the physical and chemical properties of the soil that supports the availability of micronutrients as well as cation exchange capacity for plants [24]. The combination of the efficiency of nutrient absorption from inorganic fertilizers and the improvement of the root environment by organic fertilizers creates synergies that support the process of translocating photosynthates more optimally to the fruit section [8], [25]. This positive interaction supports the availability of nutrients needed by plants during the fruit filling period, thus preventing flower loss and improving the overall quality of the crop [26], [27].

For physical aesthetic parameters (fruit length and diameter), the application of 400 kg/ha (P2) touches the absolute highest optimum point (diameter 47.14 mm and length 27.50 cm). These results indicate that at the dose point, NPK is able to maximally increase photosynthesis activity and potassium (K) assimilate translocation to the fruit organ [28]. Although the P3 treatment (600 kg/ha) yielded a higher yield of harvest fruit weight (1564.65 g), the proportion of fruit length and diameter began to stagnate, indicating that the plant's physical absorption tolerance limit had been met at a dose of 400 kg/ha. This is in line with the findings that the availability of adequate nutrients during the reproductive phase plays a crucial role in supporting carbohydrate accumulation and preventing flower absence, so that the total weight of fruit can increase significantly [29], [30].

3.2. Effect of Lemeksari Organic Fertilizer Dosage on Growth and Yield

Hypothesis testing for Lemeksari fertilizer showed harmonized results. The application of Lemeksari has a real effect on plant height and is very noticeable on the harvest weight (Table 3). A dose of 30 tons/ha (L3) resulted in a maximum plant height (39.00 cm) and contributed the largest average fruit weight (1587.91 g). This achievement was strongly influenced by the initial conditions of C-organic poor soils (Table 1). The addition of high doses of Lemeksari actively improves the physical structure of sandy clay soils, resists nutrient leasing, and optimizes slow release decomposition [7], [31]. In addition, increasing the availability of micro and macro nutrients through the provision of organic matter is able to support the formation of chlorophyll and extend the active life of the leaves, so that the accumulation of photosynthates channeled into the fruit is maximized [32]. The effect of improving the root environment has implications for increasing the efficiency of macronutrient absorption provided through NPK fertilizers, so that the nutrient balance of plants is maintained throughout the generative phase. and facilitate optimal carbohydrate translocation to the fruit storage section.

Table 4. Average growth and yield of white eggplant plants on the interaction between Lemeksari organic fertilizer and NPK Phonska plus fertilizer

Treatment	**Plant Height (cm)**	**Number of Leaves (strands)**	**Rod Diameter (mm)**	**Fruit Diameter (mm)**	**Fruit Length (cm)**	**Number of Fruits (fruits)**	**Fruit Weight (g)**
Interaction (PxL)	**ns**	**ns**	**ns**	**ns**	**ns**	**	**
P0L0	33.00 a	27.67 a	10.30 a	46.85 a	27.33 a	4.33 d	1293.97 efg
P0L1	35.33 a	31.67 a	9.77 a	47.55 a	27.00 a	5.00 bcd	1468.93 bcdefg
P0L2	36.00 a	28.67 a	9.53 a	46.20 a	26.67 a	4.67 cd	1314.30 defg
P0L3	40.00 a	28.33 a	9.87 a	46.65 a	27.67 a	4.67 cd	1497.80 bcdef
P1L0	38.33 a	28.67 a	10.40 a	46.58 a	27.00 a	5.67 cd	1626.37 abcd
P1L1	36.67 a	30.33 a	10.20 a	46.17 a	27.33 a	4.67 cd	1185.40 fg
P1L2	36.33 a	30.33 a	9.90 a	46.35 a	27.00 a	4.67 cd	1488.33 bcdefg
P1L3	34.00 a	29.33 a	9.93 a	48.53 a	27.67 a	4.67 cd	1359.67 cdefg
P2L0	38.00 a	29.33 a	8.70 a	46.90 a	27.33 a	5.00 bcd	1376.13 cdefg
P2L1	36.00 a	31.00 a	9.60 a	47.32 a	26.67 a	5.33 abcd	1507.90 bcdef
P2L2	41.67 a	32.00 a	9.43 a	47.35 a	29.00 a	5.33 abcd	1301.33 efg
P2L3	40.33 a	27.33 a	9.57 a	46.73 a	26.67 a	4.33 d	1498.07 bcdef
P3L0	39.67 a	30.33 a	9.57 a	47.20 a	27.00 a	4.33 d	1155.17 g
P3L1	37.67 a	30.33 a	9.50 a	47.15 a	27.33 a	5.67 abc	1632.93 abc
P3L2	39.00 a	32.00 a	9.60 a	47.19 a	27.00 a	6.00 ab	1719.90 ab
P3L3	43.67 a	33.00 a	9.77 a	47.02 a	28.67 a	6.00 ab	1750.60 a

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P4L0	34.00 a	33.00 a	9.57 a	46.87 a	26.67 a	4.33 d	1347.23 cdefg
P4L1	35.67 a	29.67 a	10.43 a	46.37 a	27.33 a	5.33 abcd	1520.63 bcde
P4L2	40.00 a	32.67 a	9.80 a	46.33 a	26.67 a	6.00 a	1526.20 bcde
P4L3	37.00 a	33.33 a	10.10 a	46.53 a	27.00 a	5.67 abc	1833.43 a

Note: Numbers followed by the same letter in the same column mean that there is no significant difference on the 5% Duncan Multiple Range Test (DMRT). Significance description: ns = unreal; ** = very real.

3.3. Effect of Combination Dosage of NPK Phonska Plus and Lemeksari Organic Fertilizer

The combination of NPK Phonska Plus and Lemeksari organic fertilizer showed significant synergies in cumulatively increasing the weight of fruit per plant. The optimal integration of inorganic and organic inputs balances the availability of soil nutrients, preventing nutrient deficiencies that risk disrupting the stability of the crop production phase. Organic fertilizers improve the physical and chemical properties of the soil, support the absorption of inorganic nutrients more efficiently, and ensure sustainable nutrition for the productivity of eggplant plants [33].

The P4L3 treatment showed the best performance with a fruit weight of 1833.43 g, confirming the synergy between high-dose inorganic inputs and organic amendments in overcoming nutrient limitations [34], [35]. The availability of macronutrients supports chlorophyll synthesis and optimization of the root system, increasing the effectiveness of nutrient absorption [36], [37]. This absorption capacity reflects the crucial role of organic matter in creating optimal rhizosphere conditions for plant metabolism [38] as well as ensuring the stability of nutrient supply during the fertilization phase. Balanced nutrition accelerates the translocation of assimilation to the generative organs, which contributes to an increase in the number and size of the fruit [39]. This is in line with the finding that sufficient nutrient availability during the generative phase spurs an increase in fruit biomass through the efficiency of photosynthetic translocation [40], [41] as well as the accumulation of food reserves in storage organs [42].

The combination of inorganic and organic fertilizers consistently provides superior fruit yields compared to single fertilizers. This integration optimizes harvest weight while improving soil structure degraded due to excess chemical inputs, supporting the sustainability of horticultural productivity [43], [44]. This fertilization strategy is an effective cultivation model to increase white eggplant yields while maintaining the long-term health of the land ecosystem [45], minimizing the impact of soil degradation due to the application of monoculture chemical fertilizers.

The hypothesis regarding the interaction of the two fertilizers is accepted in the generative phase. Table 4 shows the highest absolute result at P4L3 of 1,833.43 g. However, from the aspect of agronomic efficiency and cost, the interaction of 400 kg/ha NPK with 30 tons/ha has resulted in a representative weight with the physical size of the fruit at the optimal point. The synergy of NPK macro elements and the physical repair function of the soil by Lemeksari is effective in facilitating sustainable nutrient intake without damaging soil ecology. The integration of organic matter improves water retention and stimulates soil microbial activity, supporting sustainable nutrient availability [46], [47], thereby improving the absorption efficiency of synthetic fertilizers [48]. This pattern is in line with the principle that the integration of organic matter supports productivity by optimizing nutrient availability, thereby significantly increasing the number and weight of fresh fruit [49], [50].

4. Conclusion

Based on the results of the study to answer the objectives and hypotheses proposed, it can be concluded that the administration of NPK Phonska Plus at a dose of 400 kg/ha provides the most optimal agronomic response in supporting the achievement of fruit physical size and maintaining the productivity of white eggplant plants. The application of Lemeksari organic fertilizer has been proven to significantly increase yields, where a dose of 30 tons/ha is the best level in covering C-organic deficiency and improving the physical quality of sandy clay soils at the research site. The interaction between NPK Phonska Plus and Lemeksari has a very real synergistic effect on the increase in the number and weight of harvested fruits. Overall, the combination of NPK Phonska Plus 400 kg/ha and Lemeksari 30 tons/ha is the most rational and agronomically efficient fertilization technology recommendation to ensure production quantity, visual aesthetics of fruit, and preserve soil health in a sustainable manner.

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