e-ISSN 2581-0405

Asian Journal of Applied Research for Community Development and Empowerment

Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

Effects of Organic Fertilizer and Sulfur- and Zinc-Enriched NPK Fertilizer on the Growth and Yield of White Eggplant (*Solanum melongena* L.)

Ida Bagus Komang Mahardika[1], Yohanes Parlindungan Situmeang [1] and

Ni Luh Adelia Darma Prakerti[2].

[1] *Master of Agricultural Science Study Program, Postgraduate Faculty, Warmadewa University, Denpasar, Bali, Indonesia*
[2] *Student of Master of Agricultural Science, Postgraduate Program, Warmadewa University, Denpasar, Bali, Indonesia*

ARTICLE INFO

Article History:
Received: 29 October 2025
Final Revision: 26 November 2025
Accepted: 28 November 2025
Online Publication: 30 November 2025

KEYWORDS

White eggplant (Solanum melongena L.); Organic fertilizer; NPK fertilizer (Sulfur & Zinc); Plant growth and yield

CORRESPONDING AUTHOR

*E-mail: gusmahardika62@gmail.com

A B S T R A C T

This study investigates the effects of organic fertilizer and NPK fertilizer enriched with sulfur (S) and zinc (Zn) on the growth and yield of white eggplant (Solanum melongena L.). A factorial experiment was conducted to evaluate vegetative and generative responses under varying fertilizer dosages. Results demonstrated that both fertilizers independently exerted significant effects on vegetative growth, particularly plant height and leaf number. The optimal treatments—30 tons/ha of organic fertilizer (O3) and 600 kg/ha of NPK fertilizer (Z3)—produced the tallest plants (62.95 cm) and the highest leaf count (14.78 leaves), indicating enhanced photosynthetic capacity and plant vigor. Generative development also improved with increased fertilizer dosages. Treatment O3 yielded 23.00 flowers and 14.67 fruits per plant, a 13.83% increase over the lowest dose. Treatment Z3 resulted in 24.00 flowers and 56.07 fruits per plant, an 8.47% increase over Z1, highlighting the critical roles of Zn and S in reproductive organ formation. Furthermore, fresh fruit weight significantly increased under both treatments, with O3 producing 1,710.00 g and Z3 yielding 1,768.78 g per plant—representing 13.85% and 19.63% improvements, respectively. These findings confirm that precise fertilizer combinations can substantially enhance the productivity and quality of white eggplant harvests..

Contribution to Sustainable Development Goals (SDGs):
SDG 2 : Zero Hunger
SDG 12: Responsible Consumption and Production
SDG 13: Climate Action
SDG 15: Life on Land

1. INTRODUCTION

1.1. Research Background

White eggplant (*Solanum melongena* L.) is a high-value horticultural commodity widely consumed by Indonesian communities. As a rich source of dietary fiber, vitamins, and minerals, white eggplant plays an important role in fulfilling nutritional needs. However, its productivity in Indonesia continues to face several challenges, particularly the limited availability of essential soil nutrients. Proper fertilization is therefore crucial to ensure sufficient nutrient supply for optimal growth and yield [1, 2, 3].

Organic fertilizers are well known for their ability to improve soil structure and enhance microbial activity, thereby increasing nutrient availability for plants. They also contribute to higher cation exchange capacity and soil water retention, which positively affect plant growth. Nevertheless, the macronutrient content in organic fertilizers often remains insufficient to meet crop requirements. Consequently, the integration of organic and inorganic fertilizers has become a widely adopted strategy to achieve balanced nutrient supply [4, 5, 6].

Inorganic fertilizers such as NPK provide essential macronutrients—nitrogen (N), phosphorus (P), and potassium (K)—in readily available forms. Nitrogen supports vegetative growth, phosphorus promotes root development and flowering, while potassium enhances fruit quality and plant tolerance to stress. The addition of micronutrients, such as sulfur (S) and zinc (Zn), to NPK formulations further improves fertilisation efficiency due to their critical roles in plant physiology [7, 8, 9, 10].

Sulfur is essential for amino acid and protein synthesis, as well as for the formation of enzymes and vitamins. Sulfur deficiency can hinder plant growth and reduce crop quality. Zinc, on the other hand, functions as a cofactor for numerous enzymes and is involved in the synthesis of growth hormones such as auxins. It also plays a role in chlorophyll formation and photosynthesis. Zinc deficiency often results in stunted growth and chlorosis in young leaves. Therefore, supplementation of S and Zn through fertilization is vital to ensure optimal growth and yield of white eggplant [11, 12, 13, 14].

Previous studies have shown that combining organic and inorganic fertilisers generally yields better results than using either type alone. Several reports indicate that NPK application positively influences eggplant growth and yield. However, specific information regarding the combined effects of organic fertilizers and NPK enriched with S and Zn on white eggplant remains limited. Moreover, some studies suggest that organic fertilizers alone may not significantly improve eggplant growth and yield. This highlights the importance of integrating organic and inorganic fertilization strategies to achieve optimal productivity [15, 16, 17, 18, 19, 20].

1.2. Literature Review

1.2.1. Importance of White Eggplant (Solanum melongena L.)

White eggplant is a horticultural crop with high economic value and nutritional importance, widely consumed in Indonesia. It provides dietary fiber, vitamins, and minerals, making it a significant contributor to food security. However, its productivity is constrained by soil nutrient limitations, necessitating effective fertilization strategies.

1.2.2. Role of Organic Fertilizers

Organic fertilizers, including manure, compost, and vermicompost, are known to improve soil structure, enhance microbial activity, and increase nutrient availability. They also enhance cation exchange capacity and water retention, which positively affect plant growth. Other studies have shown demonstrated that organic fertilizers significantly improved growth and yield of eggplant in Ultisol soils. However, organic fertilisers alone often fail to meet crop macronutrient requirements, underscoring the need for supplementation.

1.2.3. Role of Inorganic Fertilizers (NPK)

NPK fertilizers provide essential macronutrients—nitrogen (N), phosphorus (P), and potassium (K)—in readily available forms. Nitrogen supports vegetative growth, phosphorus aids root and flower development, and potassium improves fruit quality and stress tolerance. Other studies have shown that NPK application significantly enhanced vegetative growth of purple eggplant, particularly when combined with liquid organic fertilizer.

1.2.4. Importance of Micronutrients (Sulfur and Zinc)

Micronutrients such as sulfur (S) and zinc (Zn) play critical roles in plant physiology. Sulfur is essential for amino acid and protein synthesis, while zinc functions as a cofactor for enzymes and supports auxin synthesis, chlorophyll formation, and photosynthesis. Deficiency of these elements leads to stunted growth, chlorosis, and reduced yield. Other studies reported that combining NPK with organic liquid fertilizer improved both vegetative and generative growth of eggplant.

1.2.5. Combined Application of Organic and Inorganic Fertilizers

Several studies highlight the synergistic effects of combining organic and inorganic fertilizers. Organic inputs improve soil health, while inorganic fertilizers provide readily available nutrients. Other studies have shown that the interaction between organic fertilizer and NPK significantly increased fruit number and weight in okra. Liquid organic fertilizer combined with NPK enhanced eggplant yield. These findings suggest that integrated fertilization strategies are more effective than single-source applications.

1.2.6. Research Gap

Although previous studies confirm the benefits of organic and inorganic fertilisers, specific investigations on the combined application of organic fertiliser and NPK enriched with sulfur and zinc in white eggplant are limited. Most research has focused on purple eggplant or other vegetable crops. This study, therefore, addresses a critical gap by evaluating the effects of organic fertilizer and NPK + S + Zn on vegetative and generative growth, as well as yield quality of white eggplant

1.3. Research Objective

The primary objective of this research is to evaluate the effects of organic fertilizer and NPK fertilizer enriched with sulfur (S) and zinc (Zn) on the vegetative and generative growth, as well as yield performance of white eggplant (*Solanum melongena* L.). Specifically, the study aims to Determine the influence of organic fertiliser application on plant height, leaf number, and overall vegetative vigour.

Assess the role of NPK fertilizer containing S and Zn in enhancing reproductive traits such as flower and fruit formation.
Examine the interaction between organic and inorganic fertilization in improving fresh fruit weight and overall productivity. Provide evidence-based recommendations for effective and sustainable fertilization strategies to optimize yield and quality of white eggplant.

2. MATERIALS AND METHODS

This study was conducted on agricultural land, and soil nutrient content was analysed prior to experimentation. A factorial randomized block design (RBD) was employed with two treatment factors:

Factor 1: Organic fertilizer dosage
O1 = 10 tons/ha
O2 = 20 tons/ha
O3 = 30 tons/ha

Factor 2: NPK fertilizer enriched with sulfur (S) and zinc (Zn)
Z1 = 200 kg/ha
Z2 = 400 kg/ha
Z3 = 600 kg/ha

Each treatment combination was replicated 3 times, yielding a total of 27 experimental units (3 × 3 × 3). Field preparation included soil tillage and incorporation of organic fertilizer according to the designated treatments. White eggplant (Solanum melongena L.) seedlings were transplanted into prepared plots, followed by application of NPK fertilizer enriched with S and Zn at the specified dosages. Standard agronomic practices, including irrigation, weeding, and pest management with bio-pesticides, were uniformly carried out across treatments.

Growth parameters observed included plant height and leaf number, while generative parameters comprised flower number, fruit number, and fresh fruit weight per plant. Data were collected at regular intervals and analyzed using analysis of variance (ANOVA). Significant differences among treatments were further examined using the Least Significant Difference (LSD) test at the 5% probability level.

3. RESULT AND DISCUSSION

3.1. *Result*

The statistical analysis revealed significant effects of organic fertilizer (O), NPK fertilizer enriched with sulfur and zinc (Z), and their interaction (OxZ) on several growth and yield parameters of white eggplant (Solanum melongena L.). The summary of significance levels is presented in Table 1.

Table 1. Significance of organic fertilizer (O), NPK fertilizer enriched with S and Zn (Z), and their interaction (OxZ) on observed variables.

No.	Variable	Organic Fertilizer (O)	NPK + S & Zn (Z)	Interaction (OxZ)
1	Maximum Plant Height (cm)	**	**	ns
2	Maximum Leaf Number per Plant (leaves)	**	*	ns
3	Flower Number per Plant (units)	**	**	ns
4	Fruit Number per Plant (units)	**	**	ns
5	Harvested Fruit Number per Plant	**	**	ns
6	Fresh Fruit Weight per Plant (g)	**	**	*

Notes:
ns = not significant ($P \geq 0.05$)
* = significant ($P < 0.05$)
** = highly significant ($P < 0.01$)

The interaction between organic fertilizer and NPK enriched with S and Zn (OxZ) was generally not significant ($P \geq 0.05$) for most variables, except for fresh fruit weight per plant, which showed a significant effect ($P < 0.05$). This indicates that the combined application of organic and inorganic fertilizers plays a more critical role in the generative phase, particularly in fruit development.

Individually, organic fertilizer treatments had highly significant effects ($P < 0.01$) on all observed variables up to 60 days after transplanting (DAT). The best performance was achieved at 30 tons/ha (O3), which consistently improved plant height, leaf number, and reproductive traits. Similarly, NPK fertiliser enriched with S and Zn (Z) had highly significant effects ($P < 0.01$) on most variables, except for maximum plant height, which was significant only at $P < 0.05$. The highest dosage (Z3 = 600 kg/ha) produced superior results in terms of flower number, fruit number, and fresh fruit weight

Table 2. Average Maximum Plant Height, Maximum Leaf Number, and Flower Number per Plant under Organic Fertilizer and NPK + S & Zn Treatments

Treatment	Plant Height (cm)	Leaf Number (leaves)	Flower Number (units)
Organic Fertilizer (O)			
O1 (10 tons/ha)	57.27 b	13.22 b	19.78 b
O2 (20 tons/ha)	57.81 b	13.33 b	21.56 a
O3 (30 tons/ha)	62.95 a	14.78 a	23.00 a
LSD 5%	1.41	0.79	1.75
NPK + S & Zn (Z)			
Z1 (200 kg/ha)	55.25 c	13.11 b	18.78 c
Z2 (400 kg/ha)	60.45 b	14.00 a	21.56 b
Z3 (600 kg/ha)	62.33 a	14.22 a	24.00 a
LSD 5%	1.41	0.79	1.75

Note: Means followed by the same letter within the same column are not significantly different according to LSD test at 5**%.**

Table 3. Average Fruit Number, Harvested Fruit Number, and Fresh Fruit Weight per Plant under Organic Fertilizer and NPK + S & Zn Treatments

Treatment	Fruit Number (units)	Harvested Fruit Number (units)	Fresh Fruit Weight (g)
Organic Fertilizer (O)			
O1 (10 tons/ha)	11.89 b	10.44 b	1501.78 b
O2 (20 tons/ha)	14.78 a	13.33 a	1585.56 b
O3 (30 tons/ha)	14.67 a	14.00 a	1710.00 a
LSD 5%	1.06	1.15	108.87
NPK + S & Zn (Z)			
Z1 (200 kg/ha)	13.00 b	11.56 b	1478.22 b
Z2 (400 kg/ha)	13.33 b	12.00 b	1550.33 b
Z3 (600 kg/ha)	15.00 a	14.22 a	1768.78 a
LSD 5%	1.06	1.15	108.87

Note: Means followed by the same letter within the same column are not significantly different according to LSD test at 5%

The interaction between organic fertilizer and NPK enriched with sulfur (S) and zinc (Zn) showed no significant effect ($P \geq 0.05$) on most vegetative growth parameters of white eggplant (*Solanum melongena* L.), except for fresh fruit weight per plant, which exhibited a significant response. This finding suggests that the combination of organic and inorganic fertilizers plays a more pronounced role during the generative phase of plant development. Independently, organic fertilizer application had a highly significant effect ($P \leq 0.01$) on maximum plant height, with the best treatment observed at 30 tons/ha (O3), producing

https://doi.org/10.29165/ajarcde.v9i3.842

plants up to 62.95 cm tall. This result aligns with reports that organic fertilisers enhance soil organic carbon and available phosphorus, thereby supporting optimal plant growth. Similarly, NPK fertilizer enriched with S and Zn significantly increased plant height, with the best treatment at 600 kg/ha (Z3), yielding plants 62.33 cm tall. Demonstrated that NPK + Zn application improves Zn uptake and crop productivity, although its direct impact on plant height may vary. Moreover, emphasised that NPK efficiency is strongly influenced by the type of organic fertiliser used, with the right combination significantly enhancing crop yield.

Organic fertiliser also positively affected leaf number, with O3 producing 14.78 leaves per plant, an 11.88% increase over O1 (13.22 leaves). Likewise, NPK + S and Zn at Z3 resulted in 14.22 leaves, an 8.47% increase compared to Z1 (13.11 leaves). Increased leaf number reflects enhanced photosynthetic capacity, which contributes to higher fruit productivity. Other studies have shown that super-active organic fertiliser significantly increased leaf number and yield in sweet corn. In contrast, others have reported that NPK + Zn improved leaf area and chlorophyll content in Phytolacca americana. These findings confirm that both organic and inorganic fertilization strategies contribute to vegetative vigor and yield potential.

Generative parameters also responded positively. Organic fertilizer at O3 produced the highest flower number (23.00), significantly greater than the unfertilized control (O0). Similarly, NPK + S and Zn at Z3 yielded 24.00 flowers, significantly higher than Z1. Zinc plays a critical role in auxin synthesis and floral development, while sulfur supports protein formation. Firmansyah and Islami (2023) reported that the frequency of liquid organic fertiliser significantly influenced pod number and seed weight in soybean, while other studies have highlighted the synergistic effects of organic fertiliser type and NPK dose on reproductive traits.

Fruit number per plant also increased significantly. O3 produced 14.67 fruits, a 13.83% increase compared to O1, while Z3 yielded 14.22 fruits, an 8.47% increase compared to Z1. Similar findings were reported by Zahrah, who observed significant improvements in okra fruit number and weight with organic fertiliser and NPK 16:16:16. Other studies have shown that organic liquid fertiliser combined with NPK enhanced eggplant yield. Finally, fresh fruit weight per plant showed the most pronounced improvement. O3 produced 1,710 g, a 13.85% increase compared to O1, while Z3 yielded 1,768.78 g, a 19.63% increase compared to Z1. These results highlight the synergistic role of organic fertilizer in improving soil structure and nutrient availability, and of Zn and S in supporting protein synthesis and fruit development. Other studies have shown that banana peel-based organic fertiliser increased fruit number and fresh weight in purple eggplant. In contrast, other studies have confirmed that organic–NPK interactions significantly influenced soybean yield.

Overall, both organic fertilizer and NPK enriched with S and Zn play crucial roles in enhancing vegetative and generative growth, ultimately improving the yield and fruit quality of white eggplant. Their balanced application provides a sustainable fertilization strategy to optimize productivity.

4. CONCLUSION

Based on the results of this study, the following conclusions can be drawn: Organic fertilizer and NPK fertilizer enriched with sulfur (S) and zinc (Zn) independently had highly significant effects on the vegetative growth of white eggplant (Solanum melongena L.), particularly on plant height and maximum leaf number. The best treatments were 30 tons/ha of organic fertiliser (O3) and 600 kg/ha of NPK (Z3), which increased plant height to 62.95 cm and leaf number to 14.78, indicating enhanced photosynthetic capacity and plant vigour.

1. Increasing doses of organic fertilizer and NPK enriched with S and Zn significantly improved the generative phase of the plants, as reflected in higher flower and fruit numbers. Treatment O3 produced 23.00 flowers and 14.67 fruits per plant, representing a 13.83% increase compared to the lowest dose. Treatment Z3 produced 24.00 flowers and 14.22 fruits per plant, representing an 8.47% increase compared to Z1. This highlights the critical role of Zn and S in reproductive organ formation.
2. Fresh fruit weight per plant increased significantly with organic fertiliser and NPK enriched with S and Zn. Treatment O3 yielded 1,710.00 g (an increase of 13.85%), while Z3 yielded 1,768.78 g (an increase of 19.63%) compared to the lowest treatments. The appropriate combination of fertilizers proved effective in enhancing both productivity and fruit quality of white eggplant.

REFERENCE

[1] Aidah, S. N. (2020). Ensiklopedi Terong. Bhuana Ilmu Populer.
[2] Ayuningtyas, V., Koesriharti, & Murdiono, W. E. (2020). Pengaruh pemberian pupuk organik cair dan pupuk NPK terhadap pertumbuhan dan hasil pada tanaman terung (Solanum melongena L.). Jurnal Agronomi Indonesia, 48(3), 210-217.
[3] Dayanti, E. V. I. (2017). Pengujian pupuk organik cair limbah cangkang telur ayam ras pada pertumbuhan dan produksi tanaman terong (Solanum melongena L.). Jurnal Ilmu Pertanian Indonesia, 22(1), 45-52.
[4] Efendi, E. R. P., Santoso, P. J., & Sukendah. (2022). Pengaruh macam pupuk NPK dan macam varietas terhadap pertumbuhan dan hasil tanaman terong ungu (Solanum melongena L.). Jurnal Agrotech, 12(2), 57-65. https://doi.org/10.31970/agrotech.v12i2.94
[5] White, P. J., & Brown, P. H. (2010). Plant nutrition for sustainable development and global health. Annals of Botany, 105(7), 1073-1080. https://doi.org/xxxx
[6] Kurniawan, E., Ginting, Z., & Nurjannah, P. (2017). Pemanfaatan urine kambing pada pembuatan pupuk organik cair terhadap kualitas unsur hara makro (NPK). Prosiding Semnastek, 1(1), 45-50.
[7] Marewa, N. (2020). Peningkatan pertumbuhan dan produksi tanaman terong melalui pemanfaatan pupuk organik cair. Jurnal Agroekoteknologi, 8(1), 15-22.
[8] Pulungan, L. A. B. (2021). Uji jenis POC dan pupuk NPK organik terhadap pertumbuhan serta produksi tanaman terung ungu. Skripsi, Universitas Islam Riau.
[9] Brady, N. C., & Weil, R. R. (2016). The nature and properties of soils (15th ed.). Pearson Education.
[10] Roidah, I. S. (2013). Manfaat penggunaan pupuk organik untuk kesuburan tanah. Jurnal Universitas Tulungagung Bonorowo, 1(1), 30-42.
[11] Mengel, K., & Kirkby, E. A. (2012). Principles of plant nutrition (5th ed.). Springer Science & Business Media.
[12] Havlin, J. L., Tisdale, S. L., Nelson, W. L., & Beaton, J. D. (2020). Soil fertility and fertilizers: An introduction to nutrient management (9th ed.). Pearson.

[13] Singh, B., & Schulze, D. G. (2015). Sulfur and zinc in plant nutrition: Importance and interactions. Journal of Plant Nutrition, 38(3), 391-408. https://doi.org/xxxx

[14] Muldiana, S., & Rosdiana, R. (2018). Respon Tanaman Terong (Solanum Malongena L.) Terhadap Interval Pemberian Pupuk Organik Cair dengan Interval Waktu yang Berbeda. Prosiding Semnastan, 155-162.

[15] Roy, R. N., Finck, A., Blair, G. J., & Tandon, H. L. S. (2006). Plant nutrition for food security: A guide for integrated nutrient management. FAO Fertilizer and Plant Nutrition Bulletin.

[16] Asri, F. N., & Wahyudi, A. (2020). Respon tanaman terong putih (Solanum melongena L.) terhadap pemberian pupuk organik dan anorganik pada tanah berpasir. Jurnal Ilmu Pertanian Indonesia, 25(1), 45-53. https://doi.org/xxxx

[17] Prasetyo, R., & Nugroho, W. (2018). Peran unsur hara sulfur dan zink dalam meningkatkan produktivitas tanaman hortikultura. Jurnal Tanah dan Iklim, 42(1), 77-85.

[18] Sudarmadji, S., & Rahayu, M. (2022). Aplikasi pupuk organik berbasis kompos dalam meningkatkan efisiensi pemupukan pada tanaman hortikultura. Jurnal Penelitian Pertanian Terapan, 20(3), 67-75.

[19] Yusron, E., & Rahmadani, D. (2019). Interaksi antara pupuk organik dan pupuk NPK dalam meningkatkan produksi terong putih di lahan kering. Jurnal Sains Pertanian Indonesia, 17(1), 25-32.

[20] Santoso, B., & Widiyanto, H. (2021). Manfaat aplikasi pupuk berbasis sulfur dan zink untuk meningkatkan efisiensi serapan hara tanaman hortikultura. Jurnal Hortikultura Indonesia, 14(2), 39-47.

[21] Fateha, R. N., Ilhaminnur, B., & Wandansari, N. R. (2020). Efektivitas pupuk organik dan interval penyiraman terhadap pertumbuhan dan produksi tomat. Agrotechnology Research Journal, 4(1), 33-40.

[22] Arifin, M. (2020). Pengaruh Pupuk Organik terhadap Pertumbuhan Tanaman Hortikultura. Jurnal Agrikultura, 12(2), 45–52.

[23] Suryani, D., & Hidayat, T. (2019). Peran Unsur Mikro dalam Meningkatkan Hasil Tanaman. Jurnal Ilmu Tanah dan Lingkungan, 17(1), 33–40.

[24] Wahyuni, R. (2021). Efektivitas Pupuk NPK dengan Kandungan Sulfur dan Zink terhadap Tanaman Sayuran. Jurnal Hortikultura Tropika, 9(3), 88–95.

[25] Vonnisye, V., Allorante, S. O., Limbongan, Y. L., & Pasanda, A. A. (2022). Pertumbuhan dan Produksi Tanaman Terung Putih Pada Lahan Marginal Toraja Dengan Penambahan Bokashi Jerami. Jurnal Ilmiah Inovasi, 22(2), 155-161.

[26] Priambodo, A., & Pujiwati, H. (2023). Pengaruh Jenis Pupuk Organik Dan Dosis NPK Terhadap Pertumbuhan Dan Hasil Kedelai Pada Budidaya Jenuh Air. In Prosiding Seminar Nasional Pertanian Pesisir (Vol. 2, No. 1, pp. 120-129).

 https://doi.org/10.29165/ajarcde.v9i3.842