Jurnal Agronomi Indonesia
(Indonesian Journal of Agronomy)

ISSN 2085-2916 | e-ISSN 2337-3652
December 2024, *52*(3), 410-416
DOI: https://dx.doi.org/10.24831/jai.v52i3.58995

Research Article

Application of phosphorous fertilizer to increase the production of several parijoto (*Medinilla speciosa* Blume) accessions

Indah Fatika Sari [1], Muhammad Ahmad Chozin [2], and Dwi Guntoro [2,*]

[1] Agronomy and Horticulture Study Program, Faculty of Agriculture, IPB University (Bogor Agriculture University), Jl. Meranti, IPB Dramaga Campus, Bogor 16680, INDONESIA

[2] Department of Agronomy and Horticulture, Faculty of Agriculture, IPB University (Bogor Agriculture University), Jl. Meranti, IPB Dramaga Campus, Bogor 16680, INDONESIA

* Corresponding author (✉ dwi_guntoro@apps.ipb.ac.id)

ABSTRACT

Parijoto fruit (Medinilla speciosa Blume) is a plant known as a medicinal plant in Indonesia. Parijoto fruit production is still low. Phosphorous (P) fertilization can enhance fruit production, but the optimal dosage for parijoto has yet to be determined. The research objective was to obtain the P fertilizer dosage to improve the production of several parijoto accessions. The research was conducted from January to June 2023 at Agribusiness and Technology Park IPB. The study used a split-plot randomized complete block design with four replications. The main plot's accession factor consisted of Bogor, Kudus, and Nganjuk. The fertilizer dosage per polybag, as the subplot, consisted of without P_2O_5 (P0), 1.8 g P_2O_5 (P1), 3.6 g P_2O_5 (P2), 5.4 g P_2O_5 (P3), 7.2 g P_2O_5 (P4), 9.0 g P_2O_5 (P5). The results showed that applying P fertilizer at 7.2 g P_2O_5 produced the highest fruit weight per plant for the Bogor and Nganjuk accessions. For the Kudus accession, it was at a fertilization dosage of 5.4 grams of P_2O_5. There was an interaction between accession and P dosage on fruit weight per plant.

Keywords: dosage; fruit production; medical plant

Edited by:
Abdullah Bin Arif
BRIN

Received:
30 September 2024
Accepted:
24 December 2024
Published online:
31 December 2024

Citation:
Sari, I. F., Chozin, M. A., & Guntoro. D. (2024). Application of phosphorous fertilizer to increase the production of several parijoto (*Medinilla speciosa* Blume) accessions. *Jurnal Agronomi Indonesia (Indonesian Journal of Agronomy)*, *52*(3), 410-416

INTRODUCTION

Indonesia is a tropical country with abundant biodiversity that needs to be preserved. One of the plants that can thrive in tropical regions is parijoto (*Medinilla speciosa* Blume). Parijoto is a medicinal plant that typically grows on mountain slopes and is commonly found on the slopes of Mount Muria (Yugeswari et al., 2022). In the past, parijoto was often considered a weed. Weeds are plants whose presence is undesirable as they can interfere with the growth of main crops. However, the communities on the slopes of Mount Muria utilize parijoto as a medicinal plant, and it is even believed to enhance fetal fertility and the health of pregnant women (Anggana, 2011).

The active ingredients found in parijoto are tannin, flavonoids, saponins, and glycosides (Wachidah, 2013). Based on the active ingredients, parijoto has the potential to be used as a natural source in the development of alternative treatments to help reduce glucose levels (Rudianto & Megawati, 2017). The flavonoid content in parijoto can be beneficial in inhibiting tumor spread, restraining cancer cell growth, and hindering the activity of enzymes that trigger inflammation and diseases in the immune system. Flavonoids are a polyphenolic compound known for their antioxidant properties (Hamidah et al., 2020). Methanol extract showed the most potent activity against *Trichophyton rubrum*. The presence of alkaloids, polyphenols, tannins, flavonoids, quinones, and saponins has the potential to be used as an antifungal activity (Milanda et al., 2021).

Now, many businesses have developed products from parijoto fruit. This requires an adequate supply of raw parijoto to support the business's sustainability, necessitating high-quality and high-yield parijoto fruit production. In efforts to enhance parijoto fruit production, precise cultivation techniques are essential. One cultivation technique that can boost fruit production is fertilization (Ali, 2015).

Nutritional levels in the leaves were highly correlated with fruit development (dos Reis et al., 2020). Phosphorus (P) is needed significantly for plant development. It plays a critical role in photosynthesis because it is a constituent of photosynthetic process-related proteins, including photosynthetic pigments, the enzyme RuBisCO (Singh et al., 2017), and stimulates stomata production (Seika et al., 2008).

In contrast, P-limited conditions impaired plants' photosynthesis due to reduced stomatal conductance (Salter et al., 2018). The deficiency of inorganic P causes reduced ATP production in the stroma and CO_2 fixation (Carstensen et el., 2018). High photosynthetic rates are expected to result in higher fruit yield and uniformity. The yield per plant is directly related to soluble solids production, and fruits are the leading sinks of photoassimilates during the reproductive stage (Duarte et al., 2011). Awliya et al. (2022) state that increasing fruit production can be achieved by supplementing with phosphorus (P) nutrients because phosphorus plays a role in stimulating flower and fruit formation and accelerating fruit ripening. However, the appropriate dosage of phosphorus fertilizer to promote the growth and fruit production of parijoto currently needs to be discovered. Therefore, research was conducted to determine the proper fertilizer dosage to achieve high parijoto fruit production.

MATERIALS AND METHODS

The materials used included parijoto (*Medinilla speciosa*) accessions (Bogor, Kudus, and Nganjuk), SP-36 with a content of 38% P_2O_5 based on the analysis results from the Testing Laboratory Department of Agronomy and Horticulture, KCl, propineb fungicide 70%, insecticide of prophenophose 500 g L^{-1}, and polybags 40 cm x 40 cm. The tools used included a sprayer, ruler, digital caliper, digital scale, spectrophotometer, and other supporting equipment.

The research used a split-plot design with two factors and four replications. The main factor was the parijoto accessions (Bogor, Kudus, and Nganjuk accessions). Fertilizer dosage per pot (g per pot) as subplot consisted of six levels: without P_2O_5 (P0), 1.8 g P_2O_5 (P1), 3.6 g P_2O_5 (P2), 5.4 g P_2O_5 (P3), 7.2 g P_2O_5 (P4), 9.0 g P_2O_5 (P5).

The research method consisted of preparing the planting medium by mixing soil, rice husk, and cow manure in a ratio of 2:1:1 based on volume, then placing it in polybags 40 cm x 40 cm with a diameter of 26 cm. Each polybag was filled with a planting medium of approximately 8 kg. Planting was carried out by planting parijoto seedlings in the vegetative phase, which was approximately three months old and had already been standardized based on plant height. Fertilization used 10 g of urea per plant, 10 g of KCl, and P_2O_5 with the prescribed dosage for each treatment. Fertilization was conducted weekly according to the treatment. The fertilizer was applied by sprinkling it in a circular manner around the roots. Maintenance included watering, weed control, and pest and disease management. Observations were conducted every two weeks until harvest.

RESULTS AND DISCUSSION

The initial nutrient analysis results indicated that the H_2O pH was moderately acidic, with a value of 6.06, while the KCl pH was neutral, with a value of 5.57 (Table 1). The weather conditions from January 2023 to June 2023 recorded a temperature range of 21-33 °C, an average humidity of 85%, and an average sunlight duration of 5.12 hours (BMKG, 2023). Parijoto thrived well in humus-rich soil with a pH of approximately 5.5. A suitable planting medium for parijoto growth consists of soil, husks, and manure to provide nutrients and good drainage. Parijoto can grow optimally at 13-27 °C (Maria et al., 2012). This indicated that the planting medium used was appropriate for the plant's needs, but the environmental conditions were less suitable due to temperatures exceeding the optimal range required for parijoto.

Table 1. Results of the initial nutrient analysis.

Parameter	Unit	Value	Status*)
pH H_2O		6.06	Slightly acidic
pH KCl		5.57	Neutral
C-organic	%	3.66	High
N-Total	%	0.47	Moderate
P-available	ppm	762.14	Very high
KTK		20.99	Moderate
Mg-dd	cmol kg^{-1}	3.42	High
Ca-dd	cmol kg^{-1}	7.71	Moderate
K-dd	cmol kg^{-1}	4.52	Very high
Na-dd	cmol kg^{-1}	0.45	Low
Al-dd	cmol kg^{-1}	0.22	Very low
H-dd		0.21	-
P-potential	mg $100g^{-1}$	457.52	Very high
K-potential	mg $100g^{-1}$	223.56	-

Note: Source: Testing Laboratory, Department of Agronomy and Horticulture, Faculty of Agriculture, IPB University (2023).
*) Source: Center of Soil Research (2009).

Flowering time

The accession had no significant effect on the flowering time, but the P fertilizer dosage treatment could accelerate flowering, and there was no interaction between accession and P fertilizer dosage (Table 2). Fertilizer dosages of 7.2 g P_2O_5 and 9.0 g P_2O_5 resulted in flowering times of 4.7 weeks after treatment (WAT) and 3.9 WAT, faster than plants without P_2O_5 fertilization (9.5 WAT). This indicated that the higher the P fertilizer dosage, the faster parijoto flowers, as it contains more phosphorus. Increasing the P_2O_5 dosage in plants accelerates the flowering age, and the higher the P_2O_5 dosage, the better the provision of phosphorus in the medium. Phosphorus is utilized to form energy for the flowering process (Robby et al., 2019). Kurniawan et al. (2014) stated that genetic and environmental variations may influence plant flowering patterns.

Table 2. Flowering time of parijoto under various accessions and P fertilizer dosages.

Treatment	Flowering time (weeks after treatment)
Accession	
Bogor	6.1a
Kudus	6.5a
Nganjuk	7.3a
Doses of P_2O_5 (g per pot)	
0.0	9.5a
1.8	7.2b
3.6	6.4bc
5.4	6.2bc
7.2	4.7cd
9.0	3.9d

Note: Numbers followed by the same letter in the same column were not significantly different based on the DMRT test at α = 5%.

(a) (b) (c)

Figure 1. Parijoto flowers. (a) Bogor accession; (b) Kudus accession; (c) Nganjuk accession.

Harvest time

All accessions showed no significant difference in harvest time (Table 3). Different doses of P fertilizer affected the harvest time. There was no interaction between accession and P fertilizer dosage. Fertilization with doses of 5.4 g P_2O_5 and 7.2 g P_2O_5 resulted in harvest times of 14.0 WAT and 14.7 WAT, significantly faster than plants without P_2O_5 fertilization (18.8 WAT). However, fertilization with doses of 1.8 g P_2O_5 and 3.6 g P_2O_5 did not differ substantially in harvest time compared to the control without P_2O_5 fertilization. This indicated that fertilization with doses of 5.4 g P_2O_5 and 7.2 g P_2O_5 was the most effective as it produced the fastest harvest time. Phosphorus fertilizers play a role in plant metabolism, promoting plant growth and development, including the harvesting period (Robby et al., 2019).

Table 3. Harvest time of parijoto under various accessions and P fertilizer dosages.

Treatment	Harvest time (week after treatment)
Accession	
Bogor	13.7a
Kudus	14.6a
Nganjuk	13.5a
Doses of P_2O_5 (g per pot)	
0.0	18.8a
1.8	18.3a
3.6	18.0a
5.4	14.0b
7.2	14.7b
9.0	0.0c

Note: Numbers followed by the same letter in the same column were not significantly different based on the DMRT test at α = 5%.

Fruit weight per plant, fruit number per bunch, and fruit weight

Fertilizer dosage and accession significantly affected fruit weight per plant, fruit number per bunch, and the weight of 10 fruits. There was an interaction between fertilizer dosage and accession on fruit weight per plant, the number of fruits per bunch, and the weight of 10 fruits (Table 4). In the Bogor accession, all fertilizer dosages resulted in fruit weight per plant, the number of fruits per bunch, and the weight of 10 fruits that did not significantly differ from the control, ranging from 0.91 g to 7.56 g for fruit weight per plant, 15 to 20 fruits per bunch, and 0.58 g to 0.80 g for the weight of 10 fruits.

Fertilization with a dosage of 5.4 g P_2O_5 in the Kudus accession produced the highest and significantly different fruit weight per plant (12.5 g), the fruit number per bunch (36 fruits), and the weight of 10 fruits (1.13 g) compared to the control. In the Nganjuk accession, fertilization with a dosage of 7.2 g P_2O_5 resulted in a significantly higher fruit weight per plant (20.15 g), the fruits number per bunch (37 fruits), and the weight of 10 fruits (1.55 g) compared to the control. Treatment with a dosage of 9.0 g P_2O_5 until harvest did not produce fruit because the flowers consistently dropped. This may occur due to excess P fertilizer dosage or environmental conditions. Phosphorus is crucial in enhancing the formation of proteins, carbohydrates, and starch, which are translocated to food reserves. However, excessive use of phosphorus fertilizers can reduce crop yields because high fertilizer doses result in the densification of the soil solution, making it difficult to be absorbed by roots (Nuryani et al., 2019). Reducing nitrogen and phosphorus fertilizer may improve fruit yield and quality of Guanxi pomelo fruit (Wei et al., 2018)

Table 4. The interaction effect of accession and P fertilizer dosage on fruit weight per plant, fruit number per bunch, and weight of 10 fruits.

Accession	Dosage of P_2O_5 (g per pot)				
	0.0	1.8	3.6	5.4	7.2
			Fruit weight per plant (g)		
Bogor	5.27bc	0.91c	2.00c	3.76bc	7.56bc
Kudus	3.25bc	3.00bc	4.40bc	12.50ab	7.07bc
Nganjuk	2.49bc	3.68bc	4.03bc	4.62bc	20.15a
			Fruit number per bunch		
Bogor	15.0b	15.0b	17.0b	15.5b	20.0b
Kudus	17.5b	25.5bcd	28.0ab	36.0a	18.5b
Nganjuk	16.0b	19.5b	22.0b	28.0ab	37.0a
			Weight of 10 fruits (g)		
Bogor	0.75cd	0.60d	0.80bcd	0.58d	0.70cd
Kudus	0.57d	0.66cd	0.92bcd	1.13abc	0.60d
Nganjuk	0.56d	0.94bcd	1.22ab	0.62d	1.55a

Note: Numbers followed by the same letter at the same column and row were not significantly different based on the DMRT test at $\alpha = 5\%$.

The relation between accession and P fertilizer dosage on fruit weight per plant showed a linear response (Figure 2). Based on Figure 2, the regression equation for the Bogor accession was $y = 0.1248x + 2.414$ ($R^2 = 0.1983$). The regression curve for the Kudus accession was represented by the equation $y = 0.9522x + 2.616$ ($R^2 = 0.47$). The Nganjuk accession had a regression curve with the equation $y = 2.0144x + 0.258$ ($R^2 = 0.601$). Therefore, the optimum fertilizer dosage for parijoto plants in the Bogor, Kudus, and Nganjuk accessions has not been determined yet. The dose of P fertilizer at 7.2 g P_2O_5 per pot showed the highest fruit weight per plant for the Bogor and Nganjuk accessions (Table 3). The fertilizer dosage at 5.4 g P_2O_5 per pot showed the highest fruit weight per plant for Kudus accession. Taines et al. (2022) state that increasing the P supply expands the waterlily's growth and total flower production, but increasing the K supply decreases leaf P concentration and plant size.

One factor contributing to the high fertilizer P requirement is soil pH. The maximum P availability reached near-neutral pH (Penn & Camberato 2019). P uptake at near-neutral pH is relatively low, which they attributed in part to effects on the uptake system of plant roots (Barrow, 2017; Barrow and Debnath, 2020; Barrow et al., 2020). Lambers and Oliveira (2019) state that the capacity of roots for nutrient uptake decreases by a root structure.

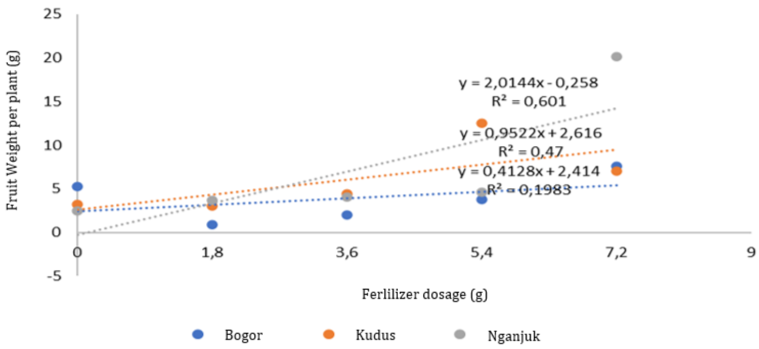

Figure 2. The relation between P fertilizer dosage and fruit weight per plant.

CONCLUSIONS

Interaction between accession and P fertilizer dosage affected fruit weight per plant, the fruit number per bunch, and the 10-fruit weight. The Bogor and Nganjuk accessions obtained the highest fruit weight per plant at 7.2 g P_2O_5 per pot, while the Kudus accession was at a fertilizer dosage of 5.4 g P_2O_5.

REFERENCES

Ali, M. (2015). The impact of NPK fertilizer dosage on the production and capsaicin content of chili pepper fruit (*Capsicum frutescens* L.). (In Indonesian.). *Agrosains*, 2(2), 171-178.

Anggana, A. F. (2011). The study of ethnobotany community in around Mount Merapi National Park (case study in Village Umbulharjo, Sidorejo, Wonodoyo and Ngablak). [Bachelor's Thesis, IPB University]. IPB University Digital Repository. https://repository.ipb.ac.id/handle/123456789/47610

Awliya, A., Nurrachman, N., & Ernawati, N. M. L. (2022). The effect of different of P and K fertilizer with different doses on the quality of melon fruit (*Cucumis Melo* L.). (In Indonesian.). *Jurnal Ilmiah Mahasiswa AGROKOMPLEK*, *1*(1), 48-56. https://doi.org/10.29303/jima.v1i1.1220

Barrow, N. J. (2017). The effects of pH on phosphate uptake from the soil. *Plant Soil, 410*, 401–410. https://doi.org/10.1007/s11104-016-3008-9

Barrow, N. J., & Debnath, A. (2020). Reply to: navigating limitations and opportunities of soil phosphorus fractionation: a comment on "The soil phosphate fractionation fallacy" by Barrow et al. 2020. *Plant Soil*, *453*, 595–596. https://doi.org/10.1007/s11104-020-04574-5

Barrow, N. J., Debnath, A., & Sen, A. (2020). Measurement of the effects of pH on phosphate availability. *Plant Soil, 454*, 217–224. https://doi.org/10.1007/s11104-020-04647-5

BMKG. (2023). *Daily climate report of West Java climatology station*. Indonesian Meteorology, Climatology and Geophysics Agency https://www.bmkg.go.id/profil/stasiun-upt.bmkg?id=0309

Carstensen, A., Herdean, A., Schimidt, S. B., Sharma, A., Spetea, C., Pribil, M., & Husted, S. (2018). The impacts of phosphorus deficiency on the photosynthetic electron transport chain. *Plant Physiology, 177*(1), 271–284. https://doi.org/10.1104/pp.17.01624

dos Reis, D. N., Silva, F. G., Santana, R. D. C., de Oliveira, T. C., Freiberger, M. B., da Silva, F. B., Júnior, E. M., & Müller, C. (2020). Growth, physiology, and nutrient use efficiency in *Eugenia dysenterica* DC under varying rates of nitrogen and phosphorus. *Plants, 9*(6), 722. https://doi.org/10.3390/plants9060722

Duarte, T.F., Bron, I.U., Ribeiro, R.V., Machado, E.C., Mazzafera, P., & Shimizu, M.M. (2011). Effect of crop loading on quality of 'Valencia' orange fruit. *Revista Brasileira de Fruticultura. 33*(3), 823–829.

Hamidah, S., Purwanto, P., & Sutanto, S. (2020). An analysis of ecotourism potency and its development in Merapi Mountain slopes area (a study at Deles Indah and Kalitalang tourism object, Kemalang District, Klaten Regency). In T. Setyaningrum et al. (Eds.). *Proceeding of the Seminar National Faculty of Agriculture UPN Veteran 2020* (pp. 109-116). UPN Veteran Yogyakarta.

Kurniawan, S., Rasyad, A., & Wardati, W. (2014). Effect of phosphorus fertilizer on growth of some soybean varieties (*Glycine max* (L.) Merril). (In Indonesian.). *JOM Faperta*, *1*(2), 1-11.

Lambers, H., & Oliveira, R. S. (2019). *Plant Physiological Ecology.* Springer.

Maria, C., Erszebet, B., & Denisa, H. (2012). Medinilla: an exotic and attractive indoor plant with great value. *Journal of Horticulture, Forestry, and Biotechnology*, *16*(2), 9-12.

Milanda, T., Fitri, W. N., Barliana, M. I., Chairunnisaa, A. Y., & Sugiarti, L. 2021. Antifungal activities of *Medinilla speciosa* Blume fruit extracts against *Candida albicans* and *Trichophyton rubrum*. *Journal of Advanced Pharmacy Education and Research, 11*(3),], 1 – 8. https://doi.org/10.51847/XDBIHmqd2P

Nuryani, E., Haryono, G., & Historiawati, H. (2019). The influence of dosage and timing of P fertilizer application on the yield of upright-type green beans (*Phaseolus vulgaris* L.). (In Indonesian.). *VIGOR: Jurnal Ilmu Pertanian Tropika dan Subtropika*, *4*(1), 14-17.

Penn, C. J., & Camberato, J. J. (2019). A critical review on soil chemical processes that control how soil pH affects phosphorus availability to plants. *Agriculture, 9*(6), 120. https://doi.org/10.3390/agriculture9060120

Robby, A., Nurbaiti., & Murniati. (2019). The effect of phosphorus fertilizer and gibberellin on the growth and yield of eggplant (*Solanum melongena* L.). (In Indonesian.). *JOM Faperta*, *6*(1), 1-13.

Rudianto, R., & Megawati, A. (2017). The effect of parijoto fruit extract (*Medinilla speciosa* Blume) on the reduction of blood glucose levels in white rats. In E. Prasetyo et al., (Eds.). *Proceeding Hefa (Health Events for All)* (pp. 369-374). LPPM STIKES Cendekia Utama Kudus.

Salter, W. T., Turnbull, T. L., Okazaki, Y., Saito, K., Kreuzwieser, J., Rennenberg, H., & Adams, M. A. (2018). Plant and soil P determine the functional attributes of subalpine Australian plants. *Arctic, Antarctic, and Alpine Research, 50*(1). https://doi.org/10.1080/15230430.2017.1420246

Seika, N., & Yano, K. (2008). Stomatal density of cowpea correlates with carbon isotope discrimination in different phosphorus, water and CO_2 environments. *New Phytologist Foundation 179*(3), 799–807. https://doi.org/10.1111/j.1469-8137.2008.02518.x

Singh, S. K., Reddy, V. R., Fleisher, D. H., & Timlin, D. J. (2017). Relationship between photosynthetic pigments and chlorophyll fluorescence in soybean under varying phosphorus nutrition at ambient and elevated CO_2. *Photosynthetica*, *55*(3), 421–433. https://doi.org/10.1007/s11099-016-0657-0

Taines, M. H., Sassoon, K. L., & Lambers, H. (2022). Phosphorus and potassium nutrition of a tropical waterlily (*Nymphaea*) used for commercial flower production. *Plant and Soil*, *476*, 181-199. https://doi.org/10.1007/s11104-022-05392-7

Wachidah, L. N. (2013). Antioxidant activity and estimation of total phenolic and total flavonoid from *Medinilla speciosa* Blume fruits. [Bachelor's Thesis, Syarif Hidayatullah Islamic University], Syarif Hidayatullah Islamic University Digital Repository. https://repository.uinjkt.ac.id/dspace/handle/123456789/25895

Wei, G. S., Hu, C. X., Tan, Q. L., Zhu, D. H., & Li, X. B. (2018). The effect of nitrogen and phosphorus fertilizer reduction on yield and quality of Guanxi pomelo. *Journal of Plant Nutrition and Fertilizers, 24*(2), 471-478.

Yugeswari, V., Pebryani, N. D., & Paramita, N. P. D. P. (2022). The sacred offering: the blessing of parijoto. (In Indonesian.). *Bhumidevi: Journal of Fashion Design, 2*(1), 138-147.