Trop J Nat Prod Res, September 2023; 7(9):4043-4048 ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Tropical Journal of Natural Product Research

Available online at https://www.tjnpr.org

Original Research Article

Analysis of the Effects of Potassium Fertilization and Shade Level on Two Kencur Accessions' Yield Quality (*Kaempferia galanga* L)

Eko Widaryanto[1], Akbar Saitama[1], Fathullah Zaini[1], Akbar H. Zaini[2], Oktavia R. Adianingsih[3]

[1]*Department of Agronomy, Faculty of Agriculture, Universitas Brawijaya, Malang 65145, East Java, Indonesia*
[2]*Department of Food Plant Cultivation, Lampung State Polytechnic, Bandar Lampung 35144, Lampung, Indonesia.*
[3]*Department of Pharmacy, Faculty of Medicine, Universitas Brawijaya, Malang 65145, East Java, Indonesia*

ARTICLE INFO

Article history:
Received 10 August 2023
Revised 22 August 2023
Accepted 25 September 2023
Published online 01 October 2023

ABSTRACT

Kencur (*Kaempferia galanga* L.) widely cultivated in shaded dry land because it is one of the plants with a good level of tolerance to shade. The low sunlight intensity will have an impact on the low nutrient uptake because transpiration will be reduced, so the kencur plant needs more nutrients in the soil, particularly potassium. The study aim to investigate the influence of shade and potassium fertilizer in *Kaempferia galanga* plant. The experimental farm of Agro Techno Park, Faculty of Agriculture, University of Brawijaya, Jatikerto Village served as the site of this study from October 2021 to May 2022. Three replications of a split-split plot were used in this study. The two shade levels that make up the main plot are (N25) for 25% shade and (N50) for 50% shade. The subplots is potassium fertilizer doses with four levels, namely (K0) fertilizer 0 kg ha^{-1} K^2O; (K120) Fertilizer 120 kg ha^{-1} K^2O; (K180) Fertilizer 180 kg ha^{-1} K^2O; and (K240) Fertilizer 240 kg ha^{-1} K^2O. The sub-plots consist of 2 accessions (A1) Lumajang and (A2) Nganjuk. The parameters that are divided up include chemical content analysis, yield parameters, and shade observation. According to the findings, kencur plants produced their highest yields in 50% shade. Based on the highest EPMC value content, the treatment of 50% shade and application of potassium fertilizer at a dose of 240 kg ha^{-1} also demonstrated the best quality of kencur. The results also indicate that the Lumajang accession has lower yields than the Nganjuk accession.

Keywords: ethyl P-methoxycinnamate, K2O, Light Intensity, Quality

Introduction

Kencur (*Kaempferia galanga* L.) is a medicine that lives in tropical and subtropical areas. In addition to being used as medicine, kencur can also be used to make foods and beverages packed with health benefits in both industry and households.[1] The rhizome is typically where kencur plants obtain their benefits.[2] The kencur plant's rhizome can also be used as a raw material for manufacturing traditional medicines, cooking spices, food additives, vinegar fragrances, hair products, and other hydrating beverages.[3]
When the plant is in the vegetative phase, kencur plants grow with the intensity of full sun or shade with a percentage of 25–30%, whereas, for the generative phase, kencur plants do not require whole light or shade up to 50–65%.[4] The light intensity factor is one of the conditions for plant growth that must be considered to get optimal results and growth.[5]
When K moves, potassium participates in the opening and closing of the stomata. Tomata will open and gas exchange takes place as a result of the surrounding protective cells swelling. contained, but has a sizable impact on K-element nutrient absorption.

*Corresponding author. E mail:e ko.widar@ub.ac.id
akbarsaitama@ub.ac.id
Tel: +62811361030, +628113661211

Citation: Widaryanto EW, Saitama A, Zaini F, Zaini AH, Adianingsih OR. Analysis of the Effects of Potassium Fertilization and Shade Level on Two Kencur Accessions' Yield Quality (*Kaempferia galanga* L). Trop J Nat Prod Res. 2023; 7(9):4043-4048 http://www.doi.org/10.26538/tjnpr/v7i9.29

Official Journal of Natural Product Research Group, Faculty of Pharmacy, University of Benin, Benin City, Nigeria

Based on Research from Prajapati *et al*.[6] explains that if the K content is inadequate then the process of opening and closing the stomata will be sluggish and a lot of water vapor is lost so that plants become susceptible to drought, and can also result in stunted plant growth.
Low sunlight intensity will have an impact on low nutrient uptake because transpiration and mass flow of nutrients will both decrease. As a result, soil nutrients, particularly potassium nutrients, must be more readily available. For ginger plants to thrive in shaded environments, K fertilization at high levels is necessary.[7] This is because potassium plays an important role in the transportation of water and plant nutrients. When potassium levels are low, other nutrients like N, P, Ca, Mg, and amino acids won't be absorbed as well, leaving plants nutritionally deficient.[8] In East Java, there are numerous kencur plant accessions. The Nganjuk and Lumajang accessions are two of the 12 accessions that have been studied and exhibit higher rhizome yields and better rhizome quality in comparison to other plants.[4]
The amount of light received and the proper amount of fertilizer to support the growth of the kencur plant are two factors that must be taken into account in order to increase the production and quality of kencur. In addition to determining the ideal K dose and shade level for the yield and high quality of kencur in Lumajang and Nganjuk accessions, this research sought to determine the acceptable level of shading on the growth of the two accessions.

Materials and Methods

Research design
The study was conducted at the Experimental Garden of the Agro Techno Park, Faculty of Agriculture, Universitas Brawijaya, Jatikerto village, DMS latitude longitude coordinates of 8° 07' 33.8" Northsouth and latitude 112° 31' 48.4 from October 2021 to May 2022. Three replications of the split-plot design were employed in this study. The

two shade levels that make up the main plot are (N25) for 25% shade and (N50) for 50% shade. The subplots is potassium fertilizer doses with four levels, namely (K0) fertilizer 0 kg ha^{-1} K^2O; (K120) Fertilizer 120 kg ha^{-1} K^2O; (K180) Fertilizer 180 kg ha^{-1} K^2O; and (K240) Fertilizer 240 kg ha^{-1} K^2O. The sub-plots consist of 2 accessions (A1) Lumajang and (A2) Nganjuk. A total of 48 treatment combination units were created from 16 treatment combination units that were repeated 3 times. This research was conducted once a season. There were 80 plants total in each of the two accessions present in each treatment plot, making a total of 7680 plants. The used spacing measures 10 cm by 15 cm. Selection criteria included having two buds and a seed weight per hole of 5-8 g for kencur. With a 5 cm depth, the plant was planted with the upward direction of the buds.

Observation of Rhizome Fresh Weight and Yield

At 180 days after harvest, the fresh weight of the kencur was observed destructively by weighing the rhizome (Figure 1), which was performed after harvest. Eight plants per treatment served as the sample, which was weighed five times: at harvest, at 7, 14, and at 28 DAH (Days After Harvest). We measured the weight of rhizomes using a Denver Instrument AA-250 scale. The following formula is utilized to calculate productivity conversion from the best average rhizome weight of ten (10%) plant populations in one plot:

$$Yield\ t\ ha^{-1} = \frac{10000}{harvested\ plot\ area} x\ yield\ per\ harvest\ plot\ x\ effective\ area\ of\ land$$

Analyses of Growth (Leaf Area Index and Crop Growth Rate)

A variable called the Leaf Area Index (LAI) depicts the correlation between the amount of leaf cover and the size of the covered area. The quality of metabolism during plant growth determines how quickly the LAI value changes. As one of the factors to determine the intensity of radiation intercepted by the leaves so that the value of biomass can be assumed, LAI is frequently utilized as an indicator of plant growth. The equation of LAI calculation is as follow:[9]

LAI = LA/GA

where, LAI is the leaf area index, LA is the leaf

Area and GA refer to the ground area, which is a region that is covered in a canopy of leaves. Based on the observational findings and measurements of the leaf area taken at the same interval, the LAI is calculated.

Crop Growth Rate (CGR): A plant's capacity to produce dry weight over time is referred to as its crop growth rate (CGR). The CGR can be calculated using the equation below:[9]

$$CGR = \frac{1}{GA}\ x\ \frac{W2-W1}{T1-T2}$$

where, W2 are planted dry weights on the second observation, and W2 are planted dry weights on the first observation. T2 and T1 are time periods of observation as indicated on W2 and W1 taken periods. GA is the ground area, which refers to the area that is shaded by the leaf canopy.

Analyses of yield

The yield parameter was measured with weighing fresh weight of kencur rhizome and weight loss after harvest in every plot. The weight of kencur rhizome then converted to ton/hectare to get the yield productivity of kencur.[5]

Analyses of Chemical Composition in the Oil

The Chemical Engineering Laboratory at Malang State Polytechnic employed the Gas Chromatography-Mass Spectrophotometer (GC-MS) method to conduct the EPMC test. Gas chromatography (GC) and mass spectroscopy (MS) were used to analyze the oil and identify its constituent compounds. The QP2010 ULTRA type of Gas Chromatography-Mass Spectrophotometer (GC-MS) is employed.

Statistical analyses

Analysis of variance (F test) was employed to examine the findings of the study's observations at the levels of 5% and 1%. The LSD test at the 5% level will be applied if the results are noticeably different.[10] If the results of the follow-up test reveal a significant difference, additional analysis will be performed with the correlation test, which measures the degree of association between two variables, as opposed to the regression test, which uses mathematical models.

Results and Discussion

Interaction of Shade, Accession and Potassium Fertilizer on Fresh Weight from Harvest until 28 Days After Harvest

Based on Table 1, there was an interaction between the three treatments and a significant response to the rhizome's weight loss from 7 DAP to 28 DAP. The weight loss of the rhizome was 4.68% to 35.56%; however, there was a higher significant weight loss in the treatment that did not receive potassium fertilizer, which is equal to 35.56% in the shade of 25%, compared to the application of fertilizer doses of 120 kg ha^{-1}, which resulted in a lower weight loss in the shade of 25%. While the lowest weight loss was found in accession nganjuk shade of 50% with a dose of 240 kg kg ha^{-1} of 21.23%.

Plants in the shade will have a large rhizome weight and a high proportion of nutrients. When potassium fertilizer is applied, the amount of photosynthesis products that are transported to the rhizomes also rises because element K serves as a transport ion for nutrients, water, and the products of photosynthesis. Potassium affects the process of tuber enlargement in plants by aiding in the translocation of photosynthetic products, such as water and carbohydrates, to the tubers.[11] If K nutrients are provided, kencur plants can grow as efficiently as possible. Kencur fertilization plants typically use a dose of 200–300 kg ha^{-1} potassium fertilizer.[12] The amount of nutrient fulfillment has an impact on the weight of the rhizomes that plants produce.

The decrease in rhizome weight gave a significant response from 7 DAP to 28 DAP, and there was an interaction between the three treatments, according to the interaction test of shade, accession, and potassium fertilizer. The size of the product is an internal factor that influences how quickly the respiration process moves along, with a small product having a higher respiration rate than a large product.[13] The number of food reserves in the rhizome are decreasing the more the weight of the rhizome is lost. The growth and yield of shallots are not always benefited by fertilization at High doses; in fact, there is a propensity for the weight loss of the tubers to increase.[14]

Leaf Area Index (LAI)

The results contained in Table 2 illustrate that there was an interaction between the 3 treatments where the results demonstrated the doses of fertilizers K120, K180 and K240 displayed the same effect in the two accessions where the Nganjuk accession planted in 50% shade had the highest Leaf Area Index compared to the Lumajang accession with the shade treatment of N25% and N50%. Young leaves, which can absorb the most light intensity and thus have a high rate of CO^2 assimilation, are what give plants with high leaf index values their high leaf index value. With increasing plant age in the two accessions, the value of the leaf area index revealed a significant difference. The impact of the two accessions' various responses, as measured by the leaf area index, has its adaptability to environmental biophysical conditions. When potassium fertilizer was applied, the leaf area index increased up to a dose of 100 kg ha^{-1}; however, subsequent applications up to a dose of 200 kg ha^{-1} tended to demonstrate a decline. With a treatment of 0 kg ha^{-1} potassium, the increase was 2.6; with a treatment of 100 kg ha^{-1} potassium, it was 3.9. The value of standard potassium is very close to potassium 100 kg ha^{-1}.

Crop Growth Rate (CGR)

Based on the results in Table 3 Crop Growth Rate (CGR) or due to shade gave a significant effect at observations from 0-60 DAT where N50 was higher than N25. However, the effect of accession became apparent between observations 120 and 180 DAP, where Nganjuk accession had a value that was higher than Lumajang accession at 0.010 g cm^{-2} day^{-1}. When potassium fertilizer was dosed, it was found that K0 and K240 had no discernible impact between 0 and 60 DAP. However, K120 had a higher plant growth rate than K0 and K240, and between 120 and 180 DAP, the dose of K120 fertilizer had a higher

CGR value than the dose of fertilizer. 0; 180; and 240. Shade and accession selection has an impact on the rate of plant growth. Better than those without shade are plants that receive shade. This is due to the fact that kencur grows better in shaded areas, and choosing accessions based on the suitability of the planting site is obviously necessary to get the best results.[15] Accessions are widely dispersed throughout Indonesia, but for optimal growth and high rhizome yields, an area with the right agroecology is required. Under coconut tree stands, kencur rhizome plants can tolerate 40 to 50 percent shade.[16] Red ginger's growth and yield were impacted by the use of paranet shade at shade intensities of 25 and higher, whereas Ernprit ginger thrived at 50% shade intensity.[5] Generally speaking, the season will have an impact on the light intensity for each specific area. From dawn until noon, the amount of light gradually increases, and in the late afternoon, it gradually decreases.

Kencur Yield

Based on Table 4 the productivity of kencur planted in different shade, the yield of 50% shade illustrated the highest productivity of 25.49 t ha^{-1} or 15.88% greater than the 25% shade with a yield of 21.44 tons ha^{-1}. When compared to Lumajang accessions, which had yields of 21.57 tons ha^{-1}, Nganjuk accessions' productivity was 25.37 tons ha^{-1}, or 14.97% more. Figure 2 illustrates the relationship between the fresh weight of the kencur rhizome at harvest and the fresh weight at 28 DAP, which is denoted by the regression value of R^2 of 0.975. with the polynomial equation $y = -0.0052x^2 + 1.0614x - 4.4602$. it can conclude that the final weight of rhizome at 28 DAP is greatly affected by the rhizome harvest weight.

The assessment of each accession of kencur's high and low productivity is aided by environmental changes that take place around cultivated plants. The interaction between genetic and environmental traits determines how a variety adapts.17 When potassium levels are low, the process of opening and closing stomata will be sluggish and respiration will be high, making plants more vulnerable to drought. Potassium also regulates the turgidity of plant cells. In the absence of K, photosynthesis and ATP production slow down, and all ATP-dependent chemical reactions become slower. Respiration in plants increases, which can also lead to stunted plant growth.[6] When K requirements are met, ATP production can be optimized, respiration is low, and the photosynthesis process is optimal, shade can create the ideal environmental conditions for ginger plants. While ginger is required to move photosynthate from the ectoderm to the rhizome, potassium also aids in the movement of starch and carbohydrates.

Rhizome-producing plants like ginger need a lot of nutrients, especially N, P, and K, to produce optimal growth.[18] In contrast to N and P, nutrient K is more widely absorbed by ginger plants, with an uptake ratio of 2.5: 1.0: 3.8. When given 400 kg ha^{-1} of K2O fertilizer, ginger plants can absorb up to 235 kg ha^{-1} of K at their highest rhizome production rate of 45.65 t ha^{-1}.[19] In addition to absorbing more K nutrients than N and P, temulawak plants also do so, particularly absorbing 221.34 kg ha^{-1} of K, 193.44 kg ha^{-1} of N, and 21.05 kg ha^{-1} of P.[20]

Relationship of Potassium Fertilizer Dosage with Etil p-metoksisinamat (EPMC) Content

In this study, the chemical content of kencur rhizome was analyzed, which is the content of ethyl p-methoxycinnamate (EPMC).

Figure 3 illustrates the relationship between the dose of potassium fertilizer and the EPMC content of kencur rhizome of Nganjuk accession at 25% shade, R^2 0.99 and at 25% shade, R^2 0.98.

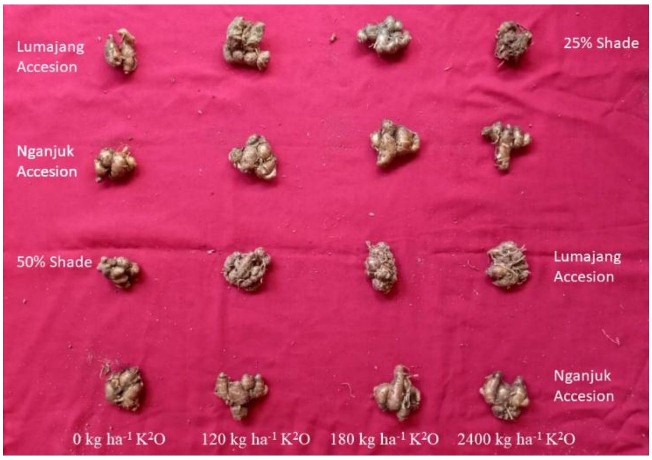


Figure 1: Kencur yields affect by shade, accession and potassium fertilizer

Table 1: Interaction of shade, accession, and potassium fertilizer on fresh weight of kencur rhizome at various ages of observation

Treatment	Rhizome Fresh Weight (g $plant^{-1}$)				
	Storage Time (Days After Harvest)				
	Harvest	7	14	21	28
N25LMJK0	15.17 (100%)	13.49 a (88.93%)	11.80 a (77.79%)	10.85 a (71.40%)	9.79 a (64.54%)
N25LMJK120	22.74 (100%)	21.03 d (92.88%)	19.89 def (87.47%)	18.42 ef (82.01%)	17.34 ef (77.62%)
N25LMJK180	17.66 (100%)	16.00 ab (90.60%)	15.20 bc (86.07%)	14.66 bc (83.01%)	13.40 bc (77.29%)
N25LMJK240	17.14 (100%)	16.24 b (90.35%)	14.84 b (86.58%)	13.79 ab (80.46%)	12.91 b (75.32%)
N25NGJK0	21.84 (100%)	19.29 cd (88.32%)	17.84 cde (81.68%)	15.84 bcde (72.58%)	15.57 cd (71.29%)
N25NGJK120	23.10 (100%)	21.55 d (93.29%)	20.85 f (90.26%)	19.25 fg (83.33%)	18.11 f (78.40%)
N25NGJK180	22.70 (100%)	20.78 cd (91.54%)	19.74 def (86.96%)	17.86 def (80.79%)	16.37 def (75.35%)
N25NGJK240	21.09 (100%)	19.89 cd (94.31%)	18.12 cdef (85.92%)	16.87 cdef (79.99%)	15.35 cd (72.78%)
N50LMJK0	20.19 (100%)	18.20 bc (90.14%)	17.23 bcd (85.34%)	14.84 bcd (73.50%)	13.70 bc (67.86%)
N50LMJK120	23.44 (100%)	21.23 d (90.57%)	20.67 ef (88.19%)	19.43 fg (82.90%)	17.85 ef (76.15%)
N50LMJK180	21.05 (100%)	19.47 cd (92.49%)	18.06 cdef (85.80%)	17.45 def (82.90%)	16.23 def (77.10%)
N50LMJK240	21.56 (100%)	20.55 cd (95.32%)	19.21 def (89.10%)	17.53 def (81.31%)	16.13 de (74.81%)
N50NGJK0	28.90 (100%)	27.30 e (94.46%)	24.92 g (86.23%)	21.35 g (73.88%)	20.76 g (71.83%)
N50NGJK120	36.23 (100%)	34.46 f (94.46%)	31.98 h (88.27%)	29.84 i (82.36%)	27.22 i (77.89%)
N50NGJK180	30.03 (100%)	28.25 e (94.07%)	26.67 g (88.81%)	24.51 h (81.69%)	22.69 gh (75.56%)
N50NGJK240	29.81 (100%)	27.92 e (93.59%)	26.00 g (87.22%)	25.68 h (82.79%)	23.48 h (78.77%)

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

LSD (5%)	2.09	2.65	2.92	2.77	1.97

Description: Means followed by the same letter at the same row showed no significant difference based on LSD test at level 5%.

Table 2: Leaf area index (LAI) of kencur plants affect by shade, accession and potassium fertilizer treatment

Shade	**Leaf Area Index at 6 Month After Planting**			
	K0	K120	K180	K240
	Lumajang Accession			
N25	1.98 a	2.69 cde	2.36 b	2.02 a
N50	2.71 cde	3.40 h	3.27 gh	2.97 efg
	Nganjuk Accession			
N25	2.61 bcd	2.92 def	2.59 bc	2.50 bc
N50	3.18 fgh	3.47 h	3.19 fgh	3.27 gh
LSD (5%)	0.33			

Description: Means followed by the same letter at the same row and column showed no significant difference based on LSD test at level 5%.

Table 3: Crop growth rate (CGR) affect by shade, accession and potassium fertilizer treatment

Shade	**Crop Growth Rate (g cm^{-2} day^{-1}) at age- day**		
	0-60	60-120	120-180
N25	0.032 a	0.023 ns	0.010 ns
N50	0.036 b	0.019 ns	0.009 ns
LSD (5%)	0.0039	ns	ns
Accesion	0-60	60-120	120-180
Lumajang	0.0345 ns	0.0222 ns	0.008 a
Nganjuk	0.0337 ns	0.0211 ns	0.010 b
LSD (5%)	ns	ns	0.0008
Potassium	0-60	60-120	120-180
K0	0.0320 a	0.0241 ns	0.0078 a
K120	0.0359 b	0.0209 ns	0.0124 b
K180	0.0349 b	0.0204 ns	0.0091 a
K240	0.0336 a	0.0211 ns	0.0092 a
LSD (5%)	0.0026	ns	0.0019

Description: Means followed by the same letter at the same row showed no significant difference based on LSD test at level 5%.; ns: not signifiant difference based on LSD test at level 5%.

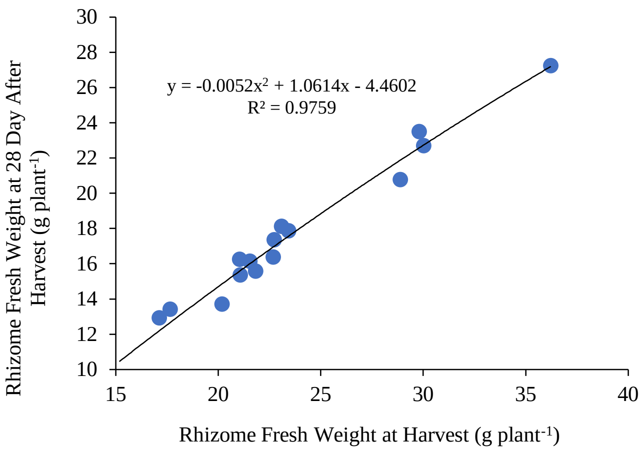
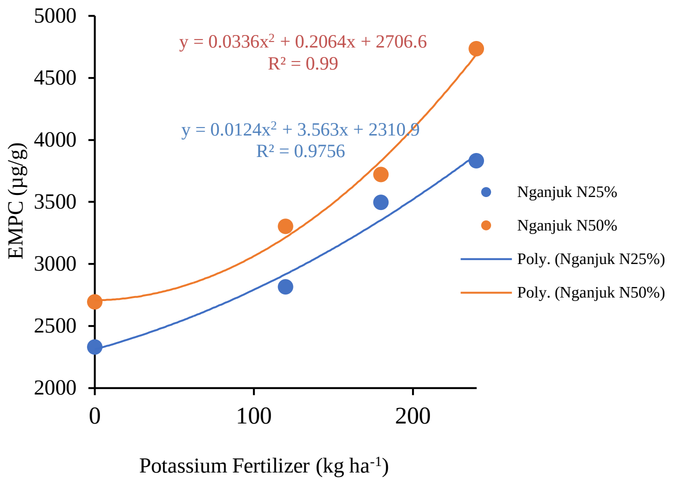


Figure 2: Relationship between kencur rhizome fresh weight at harvest time and rhizome fresh weight at 28 day after harvest

In Figure 3, the relationship between the dose of potassium fertilizer and the EPMC content of kencur rhizome of Lumajang accession at 25% shade, R^2 is 0.99 and at 25% shade, R^2 is 0.93. The quality of the chemical composition of the kencur rhizome can be impacted by the nutrients absorbed by kencur. The kencur plant contains essential oils in almost every part. The rhizome, which contains 2.4%–3.9% essential oil as well as cinnamal, aldehyde, p-cumaric motile acid, ethyl ester, and pentadecane, contains chemical compounds that have been extensively studied. According to other academic works, the rhizome of kencur contains the following compounds: cineol, paraeumarin, anisic acid, gum, starch (4.14%), and minerals (13.73%).[21] In this study, the chemical composition of the kencur rhizome—specifically, the amount of ethyl p-methoxycinnamate (EPMC)—was examined. One of the key bioactives in kencur rhizome is EPMC. The bioactive content of the 12 East Javan kencur accessions' rhizomes was evaluated by Adianingsih *et al.*[22]; EPMC was found to be the most prevalent component. Subaryanti *et al.*[23], also supported these findings. The highest bioactive plant content in kencur rhizome is EPMC. Due to their advantages as a fundamental component of sunscreen—which shields the skin from the sun's rays—EPMC compounds are frequently used as research materials. has antifungal, antibacterial, and asthmatic effects.[24]

 ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Kencur plant has the potential to be a medicinal plant because it contains secondary metabolites that are produced when plants adapt to their surroundings or when they are under stress.[23] According to a study by Karimi et al.[25], variations in the secondary metabolite profile of plants are related to changes in geographical, climatic, and edaphic factors. Because plants depend on sunlight for photosynthesis, sunlight has an impact on the synthesis of secondary metabolites. This study demonstrates that the intensity of light radiation varies between 60.9 and 75.5%. Maheswarappa *et al.*'s study[26] revealed that kencur plants shaded by coconut trees had an impact on the growth of kencur rhizomes. The shaded kencur plant contains a significant amount of nutrients.[27] Carbohydrates produced as a result of photosynthesis are then processed to produce bioactive compounds.[28] In addition to other environmental factors like soil chemical content, especially potassium and phosphorus content, kencur rhizome bioactive content will be greatly influenced by increasing humidity, which will stimulate the formation of secondary metabolites as a physiological defense mechanism.



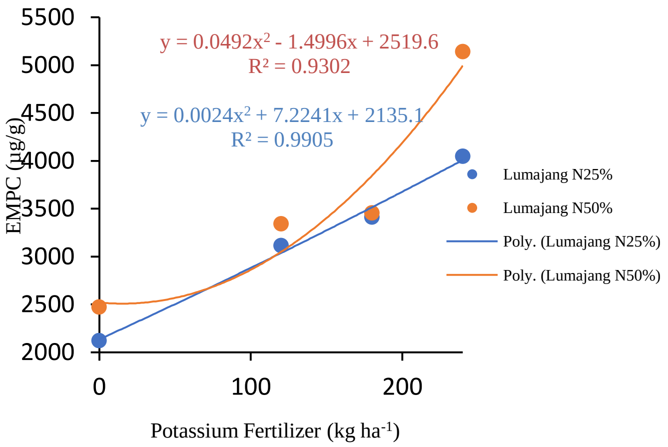


Figure 3: Relationship of Potassium Fertilizer Dosage with etil p-metoksisinamat (EPMC) content in Lumajang Accession (1) and Nganjuk Accession (2) Kencur Rhizome at 25 and 50% Shade

Conclusion

The findings indicated that both accessions produced the best yields, reaching 25.49 t ha^{-1} when 50% shade (or 50% light intensity) was used. With a value of 25.37 t ha^{-1}, the Nganjuk accession had higher yields than the Lumajang accession's 21.57 t ha^{-1}. Both accessions displayed the highest EPMC content in the 50% shade treatment and the addition of potassium fertilizer at a dose of 240 kg ha^{-1}, indicating that the amount of shade and the use of potassium fertilizer have an impact on the quality of the rhizomes.

Conflict of Interest

The authors declare no conflict of interest.

Table 4: Kencur yields affect by shade, accession and potassium fertilizer

Shade	Yield (t ha^{-1})
N25	21.44 a
N50	25.49 b
LSD (5%)	2.68
Accession	
Lumajang	21.57 a
Nganjuk	25.37 b
LSD (5%)	0.92
Potassium	
K0	21.10 a
K120	27.42 d
K180	23.79 c
K240	21.56 ab
LSD (5%)	1.19

Description: Means followed by the same letter at the same row and column showed no significant difference based on LSD test at level 5%.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

References

1. Julianti TB, Bakar MFA,Wikantyasning. Phytochemical, Antioxidant Analysis and In Vitro Xanthine Oxidase Inhibitory Activity of *Kaempferia parviflora* and *Kaempferia galanga*. Trop. J. Nat. Prod. Res. 2022; 6(12): 1981-1985.
2. Laksemi DAAS, Sukrama DM, Sudarmaja M, Damayanti PAA, Swastika K, Diarthini NLPE, Astawa NM, Tunas, K. Medicinal Plants as Recent Complementary and Alternative Therapy for COVID-19. Trop. J. Nat. Prod. Res. 2020; 4(12): 1025–1032.
3. Srivastava N, Ranjana, Singh S, Gupta CA, Shanker K, Bawankule DU, Luqman S. Aromatic ginger (*Kaempferia galanga* L.) extracts with ameliorative and protective potential as a functional food, beyond its flavor and nutritional benefits. Toxicol. Rep. 2019; 6: 521-528.
4. Setiawan TW, Widaryanto E, Saitama A, Zaini AH. Growth Test of Six Kencur (*Kaempferia galanga* L.) Accessions Under Teak Stand. Plantropica: J. Agric. Sci. 2021; 5(2): 136-143.
5. Friska ARR, Saitama A, Zaini AH, Widaryanto E, Nurlaelih EE. The Effect of Potassium Fertilizer on Growth and Yield of Galangal (*Kaempferia galanga*) Lumajang Accession and Nganjuk Accession at 25% Shade Level. J. Prod. Tan. 2021; 9(11): 678-685.

 ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

6. Prajapati K, Modi HA. The importance of potassium in plant growth–a review. Indian J. Plant Sci. 2012; 23(19): 382-402.
7. Mustika DM, Saitama A, Zaini AH, Widaryanto E. The Effect Application of Potassium Fertilizer on Kencur Grown at Various Shade Levels. J. Prod. Tan. 2021; 9(10): 599-605.
8. Gupta M, Paul S, Karmakar N, Sasmal S, Chowdhury S. Free Radical Scavenging Activity of Sida cordifolia Linn. Extracts Measured by Hydrogen Peroxide, DPPH, ABTS and Ferric Reducing Antioxidant Methods. Int. J.Curr. Res. Biosci. Plant Biol. 2016; 3(8): 114-122.
9. Widaryanto E, Saitama A. Analysis of Plant Growth of Ten Varieties of Sweet Potato (*Ipomoea batatas* L.) Cultivated in Rainy Season. Asian J. Plant Sci. 2017; 16(4): 193- 199.
10. Gomes KA, Gomes AA. Statistical Procedures For Agricultural Research. 1976
11. Ashfaq, A, Hussain N, Athar M. Role of Potassium Fertilizers in Plant Growth, Cropyield and Quality Fiber Production of Cotton an Overview. J. Biol. 2015; 5(1): 27-35.
12. Zaini F, Friska ARR, Mustika DM, Tyasmoro SY, Saitama A, Zaini AH, Widaryanto E. Analysis on rhizome shrinkage of two expected kencur (*Kaempferia galanga*) accessions from east java using $MgSO_4$ fertilizer under shading. IOP Conf. Ser.: Earth Environ. Sci. 2021; 913
13. Sudjatha W, Wisaniyasa NW. Fisiologi dan Teknologi Pasca Panen (Postharvest Physiology and Technology). Udanaya University Press. Bali. 2017; p.171
14. Gunadi N. Kalium Sulfat dan Kalium Klorida Sebagai Sumber Pupuk Kalium pada Tanaman Bawang Merah (Potassium Sulfate and Potassium Chloride as Sources of Potassium Fertilizer on Shallots). J. Hort. 2009; 19(2)*:* 174-185.
15. Rostiana O, Haryudin W, Osita SMD. Stabilitas hasil lima nomor harapan kencur [Stability of five promissing Galanga lines production]. J. Penelit. Tan. Ind. 2006; 12(4): 140-145.
16. Kumar G, Karthik L, Rao KB. A review on pharmacological and phytochemical properties of *Zingiber officinale* Roscoe (Zingiberaceae). J. Pharm. Res. 2011; 4(9): 2963-2966.
17. Finlay KW, Wilkinson GN. The analysis of adaptation in a plant-breeding programme. Aust. J. Agric. Res. 1963; 14(6): 742-754.
18. Rosita SMD, Rostiana O, Haryudin W. Respon Lima Nomor Unggul Kencur Terhadap Pemupukan [Response of five galanga promising lines to fertilization]. J. Littri. 200*7;* 13(4): 130-135.
19. Li L, Chen F, Yao D, Wang J, Ding N, Liu X, Zn C FM. Balanced fertilization for ginger production–Why potassium is important. Better Crops. 2010; 94(1): 25-27.
20. Rahardjo M and Rostiana. Standar Prosedur Operasional Jahe, Kencur, Kunyit dan Temulawak (Standard Operating Procedures for Ginger, Kencur, Turmeric and Temulawak). Badan Litbang Pertanian, Balittro. 2009
21. Barus, R. Amidasi p-metoksisinamat yang Diisolasi dari Kencur (*Kaempferia galanga* L.) [*Amidation of p-methoxycinnamate isolated from Kencur* (*Kaempferia galanga* L)]. University of North Sumatra Postgraduate Thesis. 2009
22. Adianingsih OR, Widaryanto E, Saitama A, Zaini AH. Analysis of bioactive compounds present in Kaempferia galanga rhizome collected from different regions of East Java, Indonesia. IOP Conf. Ser.: Earth Environ. Sci. 2021;913.
23. Subaryanti, Sulistyaningsih YC, Iswantini D, Triadiati T. Essential oil components, metabolite profiles, and idioblast cell densities in galangal (*Kaempferia galanga* L.) at different agroecology. Agrivita. 2021; 43(2): 245-261.
24. Farezaa MS, Rehanaa R, Nuryantib N, Mujahidin D. Transformasi Etil-P-Metoksisinamat Menjadi Asam P-Metoksisinamat Dari Kencur (*Kaempferia Galanga* L.) Beserta Uji Aktivitas Antibakterinya [Transformation of Ethyl-P-Methoxycinnamic To P-Methoxycinnamic Acid From Kencur (*Kaempferia Galanga* L.) and Their Antibacterial Activity Test]. J. Penelit. Kimia. 2017; 13(2): 176-19.
25. Karimi A, Krähmer A, Herwig N, Schulz H, Hadian J, Meiners T. Variation of secondary metabolite profile of *Zataria multiflora* Boiss. populations linked to geographic, climatic, and edaphic factors. Front. Plant Sci. 2020; 11: 1-15.
26. Maheswarappa HP, Nanjappa HV, Hegde MR, Biddappa CC. Nutrient content and uptake by galangal (*Kaempferia galanga* L) as influenced by agronomic practices as intercrop in coconut (*Cocos nucifera* L.). J. Spices and Aromat. Crops. 2000; *9*(1): 65-68.
27. Kurniawan R, Dalilah AR, Ridwan MD, Saitama A, Zaini AH, Widaryanto, Wicaksono KP. Analysis on rhizome shrinkage of two expected kencur (*Kaempferia galanga*) accessions from east java using $MgSO_4$ fertilizer under shading. IOP Conf. Ser.: Earth Environ. Sci. 2021;913.
28. Dalilah AR, Saitama A, Zaini AH, Widaryanto E. Weight Loss Analysis of Galangal Rhizome from Blitar and Banyuwangi Accessions in Under 50% Shade with $MgSO_4$ Fertilized. Plantropica: J. of Agric. Sci. 2023; 8(1):1-7