AfricanJournalofBiological Sciences

A shade of TeakAgroforestry to Improves The Yield and Bioactive Compound Responseof12 Accessions of Kencur Originated from East Java

Akbar Saitama[1*], Eko Widaryanto[1], Akbar Hidayatullah Zaini[2]

[1)] Department of Agronomy, Faculty of Agriculture, UniversitasBrawijaya, Malang
[2)] Lampung State Polytechnic, Bandar Lampung

e-mail: akbarsaitama@ub.ac.id

Article History
Volume 6, Issue 5, 2024
Received: 22 May 2024
Accepted: 29 May 2024
doi:*10.33472/AFJBS.6.5.2024. 8295-8306*

Abstracts

Kencur (*Kaempferiagalanga* L.) is widely used as a raw material for herbal medicine, food and beverage flavoring, spices, and cosmetic ingredients. Kencur rhizomes have requirements to grow with the intensity of the full sun or shaded with a percentage of 25-30%. Kencur plants grow under trees and do not require a lot of high sunlight. However, kencur still needs light for photosynthesis. This study aims to determine the response of the kencur accessions from 12 regencies in East Java to shade. The research was carried out from November 2022 to May 2023 at the AgrotechnoparkUniversitasBrawijaya, Jatikerto Village. This study used a split-plot design with three replications. The main plot was shaded. The sub-plots consist of 12 accessions of kencur from 12 districts in East Java. The parameters in this study were the response of the yield and bioactive compounds of rhizome which was determined by the GC-MS method. The yield of kencur planted in open land was between 11.92-16.97 t/ha, whereas those planted under teak trees were 13.33-18.15 t/ha. In general, the bioactive compounds (EPMC content) of kencur rhizomes planted under teak tress was higher (74.15%) than kencur rhizomes planted in open land (without shade) (72.29%). It can be concluded that shade of teak improves the response of yield and bioactive compounds of 12 kencur accessions in different regions in East Java

Keywords: EPMC, *Kaempferiagalanga* L., Light intensity, Rhizome

Introduction

Kencur(*Kaempferiagalanga*L.) is a plant inthe Zingiberaceae family that commonly lives under trees,and it does not require a lot of high light intensity. Plants, in general, need light for photosynthesis with the aim of growing and producing productivity through metabolic processes in plant cells. According to [1], light is a source of energy through photosynthesis to produce new cells, increase the biomass of plants, and multiply the leaves in each tiller.Kencur plants still need light in the process of photosynthesis and carbohydrate synthesis, so if the kencur lacks light, it will disrupt the metabolic processes in the plant cells so that the plants try to keep the photosynthesis going [2].

K.galanga L. is a wild ginger plant that lives under trees or does not require a lot of highlight intensity, plants generally need light for photosynthetic in order to grow and produce throughmetabolic processes in plant cells[3]. Efforts to improve production and quality ofkencur is needed, and there are several aspects that need to be considered such as the intensity of lightreceived [4]. Kencur requires to grow with shaded light intensity with a percentage of 25-30% until the plant is six months old. Plants need light for the purposes of photosynthesis with the aim of vegetative and generative phases. The shading on kencur plants can be done by utilizing land with teak tree stands. According to [5],kencur can also be used as an intercrop between coconut tree stands or forestry plants such as sengon and teak trees. Light intensity plays a vital role in plant growth and development. High light intensity will accelerate the rate of photosynthesis because more energy is available. Meanwhile, if the light intensity is low, it will disrupt the photosynthesis process and slow down plant metabolism. The light intensity factor is one of the conditions for plant growth that must be considered to get optimal results and growth [6].

The production, quality and content of the active ingredients ingalanga rhizome are determined by the variety used, cultivation method and the environment in which it isgrown[7].The treatment of shade will affect the growth of plants underneath. Several growth

parameters that are affected by shadingare the plant height and the formation of plant biomass, especially if the plant will be developed with an integrated system with plantations or forestry. In Zingiberaceaeplants, the shade tends to increase several traits, such as plant height, pseudostem diameter, leaf length, leaf width, number of leaves, number and length of rhizomes, canopy dry weight, and number of buds on primary rhizomes [8]. East Java is one of the potential places for kencur cultivation. Thus it is necessary to analyze the effect of shade and no shade from each kencur sample existing districts in East Java. Everykencur from various regions has different characteristics, depending on theagronomic character and environment [9].This study aims to determine the influence of shade in response of several accessions of kencur in East Java. This could be a solution for the good and optimal growth of kencur and kencur planting source material in certain environments.

Materials and Methods

This research was carried out from November 2022 to May 2023 at the AgrotechnoparkUniversitasBrawijaya, Jatikerto Village, which was a continuation of previous research [9].This study using a split-plot design with the main plots were the shade ofteak and open land (no shade). The age of the teak plant was ten years. The kencur accessions were designated as a subplot.Accessions of kencurwere collected from 12 regencies in East Java including Pacitan (PCT), Ponorogo (PNR), Banyuwangi (BWI), Blitar (BLT), Lumajang, (LMG), Madura (MDR), Mojokerto (MJK), Gresik (GRS), Kediri (KDR), Malang (MLG), Nganjuk (NGK), and Trenggalek (TRG). The number of the experimental unit was 72 plots which were divided by 24 treatments with three replications. The size of the plot was 1.5 x 1.5 m with a plant spacing of 15 x 15 cm. The number of plants in each plot was 100.

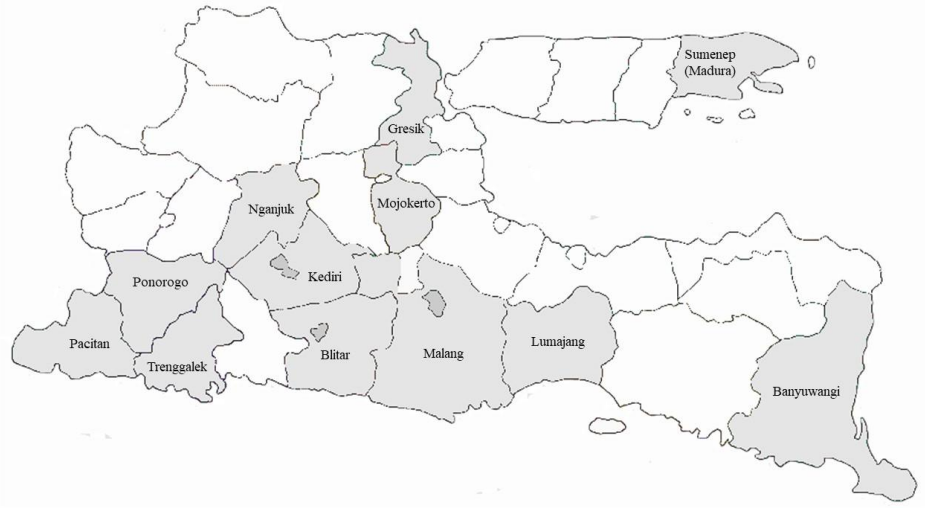

Figure 1. Location ofkencur accession [9].

In this study, we also analyzed the chemical conditions of the soil before planting in the shaded and shaded locations. Soil samples were taken from five randomly selected plots at each sampling location at a depth of 0 to 30 cm, each weighing 200 g. Five soil samples were combined into one 1000 g composite sample. Composite samples for each location were analyzed at the Soil Laboratory, Assessment Institute for Agricultural Technology East Java. Moisture content of soil was determined by the gravimetric method, total nitrogen of soil was determined by the Kjeldahl method, available P2O5 of soil was determined by the Olsen method, cation exchange capacity (CEC) of soil was determined using atomic absorption spectrometry, and organic carbon of soil was determined by the Walkley and Black method.

The yield parameter was measured when plants reached six months with weighing fresh rhizome in every plot. This number was converted to ton/hectare. Statistical analysis of the yield data was done through one-way ANOVA with LSD at a 5% level using SPSS.The bioactive compounds of rhizome were determined using the GCMS (Gas Chromatography-Mass Spectroscopy) method and analyzed at the DKI Jakarta Regional Health Laboratory, Central Jakarta, Indonesia. Bioactive compounds from 24 samples of kencur derived from 12 samples of shaded and 12 that were not shaded were analyzed based on GC retention time.

Result and Discussions

As shown in **Figure 2**, the light intensity under teak shading was decreased by the reducing of the age of plants. It happens because at the time of planting, the leaves of the teak plant will still bloom, then at the end of planting the leaves of the plant will grow lusher.The age of the teak plant used is 12 years.

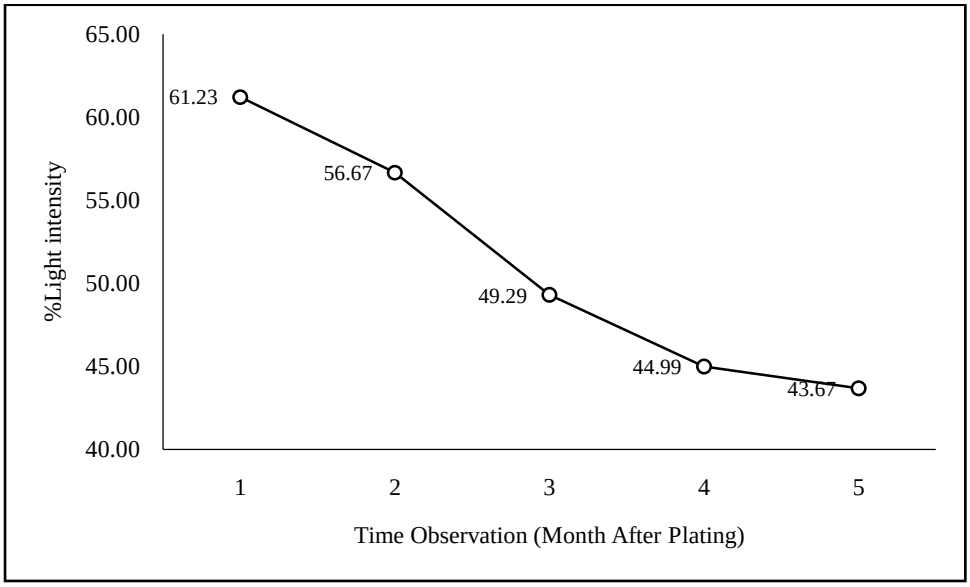

Figure 2. Light intensity under teak shading

The results of leaf morphology of 12 accessions of kencur are classified as narrow. leavesIn Indonesia, there are many types of kencur, based on the leaf type; there are 2 types of kencur,narrow and wide leaf. Commonly, kencur with a type of wide leaf is mainly cultivated in West Java whilethe narrow leaf is mainly cultivated in East and Central Java[10].

Tabel 1. Analysis of soil in open land (no shading) and under teak shading

No.	**Treatment**	**Water content (%)**	**Total N (%)**	**Available P_2O_5 (ppm)**	**CEC (me/100 g)**	**Organic C (%)**
1	No shading	6.86	0.15	176	1.35	0.45
2	Under teak shading	23.15	0.36	677	3.56	1.56

Based on soil analysis in **Table 1**, the soil under the shade of teak was better than the open land (no shade). The nutrient of teak was also determined by the potential and capacity of organic matter from teak plant litter to be decomposed. [11] stated that the quality of the soil in the teak land was classified as arable land due to the litter produced by the teak plant.

Tabel 2. Effect of teak shading to yield in 12 kencur accession in East Java

Shading	Yield (t/ha)											
	TRG	**BWI**	**NGK**	**LMG**	**MJK**	**MDR**	**KDR**	**GRS**	**MLG**	**BLT**	**PNR**	**PCT**
No-Shading	14.16 bc	15.81 fg	18.15 j	14.86 cde	16.94 i	18.07 j	14.16 bc	16.77 gi	13.61 b	13.33 b	15.14 def	15.27 def
Under Teak Shading	13.34 bc	16.18 ghi	16.97 i	13.56 b	15.95 fgh	16.35 ghi	13.45 b	15.71 efg	13.50 b	11.92 a	14.11 bc	14.78 cd
LSD 5%	0.89											
CV (%)	9.01											

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

The study resulted that there arean interaction between the shade and the type of accession to yield of kencur rhizome (**Table 2**). The yield of teak shading in 12 accessions was 11.62-16,35 t ha^{-1}, and in no shading was 13,33-18,07 t ha^{-1}. [3] Accession responds to growth and yield components.Research conducted by [12], showed that shade influence the kencur yield, which was reached 15 t ha^{-1}.[13] showed that the kencur planted under shade improves the yield and chemical content. [14]concluded that the best shade intensity of ginger was 25% until 50%. The high shade level reduced the light intensity and reduced the temperature, thus inhibited the plant growth. On the other hand, no shade will increase the light intensity and temperature, thus inhibit the auxin, a growth hormone in the plant.

The effect of shading on bioactive concentration was shown in **Figure 3**. Ethyl p-methoxycinnamate (EPMC) was an active compound in kencur. The EPMC concentration of kencur accession was higher under the shade of teak than without shade (open land). The highest concentration of EPMC was found in Banyuwangi accession, followed by Blitar, Lumajang, and

Nganjuk. In general, other bioactive compoundswere also higher in kencur accession with shading.

Each plant species has an optimal range of light intensity for the optimum photosynthetic process to increase growth and production. Kencur plants require a light intensity of 70-100% for optimal growth [15]. Light energy will be converted into chemical energy in the form of ATP and NADPH, which are used to reduce CO_2 into carbohydrate compounds [16]. [17] explained that shading had a significant effect on the growth and rhizome weight of red ginger plants. [18], shade reduces the main light radiation that is active in photosynthesis, resulting in decreased plant assimilation yields so that shaded plants have low dry weight. The type and level of shade play a very important role in the distribution of light on shaded plants. Light as an energy source for the anabolic reactions of photosynthesis will increase the rate of photosynthesis at planting sites without shade, resulting in an increase in the rate of photosynthate translocation from leaves to storage organs that function as sinks, in this case, the rhizomes [19].

In addition to affecting plant performance, shade also affects the content of active ingredients contained in plants. The phenolic and antioxidant compounds contained in *K. parviflora* are affected by shade. The results of the study from [20] showed that *K. parviflora* grown at 60% shade level produced the highest phenolic compounds, and at 80% shade level produced the highest antioxidant compounds. In addition, the research results of [21] also showed that the lighting period tends to increase total flavonoids at 16 weeks after planting. The highest total flavonoid (11.92%) was produced at 50% shade for three months with one month of 100% light. The total flavonoids analyzed in each clone were the total of all flavonoid compounds, including anthocyanins.

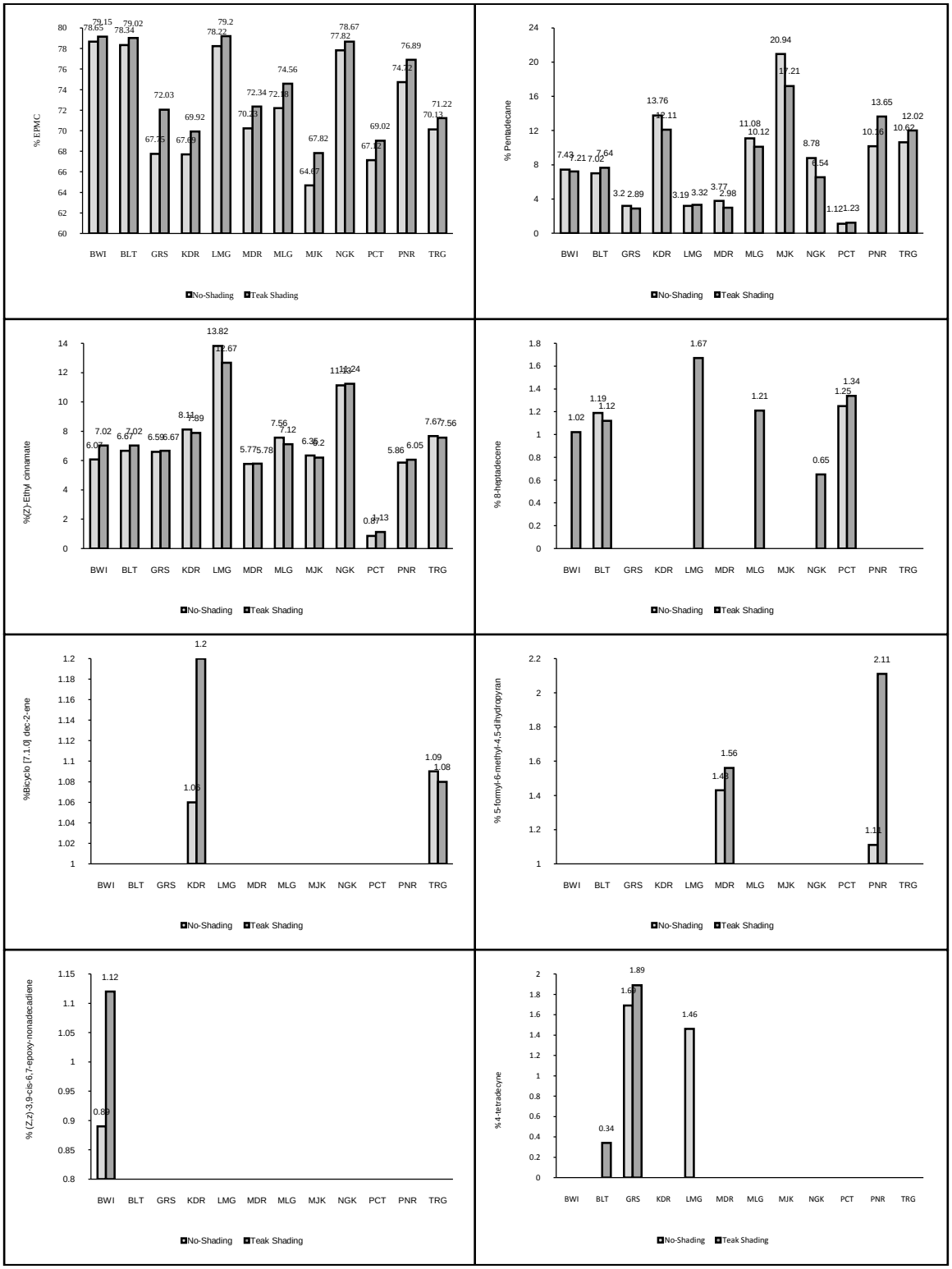

Figure 3. The comparison of bioactive compounds of 12 kencur accessions between no shading and teak shading

Conclusion

The results obtained suggest that the shade of teak improves the response of yield and bioactive compounds of 12 galangal accessions in different regions in East Java. In Yield only Banyuwangi accessions showed higher yields in teak shade while the other 11 accessions were higher without shade.The highest biocativecompounds present in the kencur rhizomes are ethyl p-methoxycinnamate (EPMC). Kencur plants will produce bioactives at higher rhizomes under the shade of teak.

References

1. ParsonsAJ. and Chapman DF. The Principles of Pasture Growth and Utilization. Grass its Production and Utilization. Ed 3rd. Blackwell Science Institure of Grassland and Environment Research. North Wyke. Okehampton Devon. 2002; 440 pp.
2. SopandieD, Chozin MA, Santrosumarjo S, Juhaeti T dan Sahardi. Toleran Padi Gogo terhadap Naungan. Hayati. 2003; 10(2): 71-75.
3. Setiawan WT, Widaryanto E, Saitama A dan Zaini AH. Uji PertumbuhanEnamAksesiKencur (*Kaempferiagalanga* L.) di BawahTegakanJati. Plantropica. 2020; 5 (2): 136-143
4. Zaini F, Friska AR, Mustika DM, Tyasmoro SY, Saitama A, Zaini AH and Widaryanto E.Enhancement of antioxidant activity of kencur rhizome in the shade by potassium fertilizer. IOP Conf. Ser.: Earth Environ. Sci. 2021; 913: 012006.
5. Rostiana O, Rosita SMD and Rahardjo M. StandarProsedurOperasionalBudidayaKencur. Circular. 2009; 16: 13-24.
6. Sukarjo EI. ToleransiBeberapa*Curcuma*SppterhadapIntensitasNaungan. J. IlmuPertanian. 2006; 6 (2): 97-103.

7. Subaryanti, Sulistyaningsih YC, Iswantini D and Triadiati T. Essential Oil Components,Metabolite Profiles, and Idioblast Cell Densities in Galangal (*Kaempferia galanga* L.) atDifferent Agroecology AGRIVITA Journal of Agricultural Science. 2021; 43 245-261
8. ArchitaA. Pengaruh Intensitas Cahaya Rendah terhadap Keragamana Sifat Agronomis Tanaman Temu–temuan (*Curcuma* spp). Skripsi. Fakultas Pertanian. Institut Pertanian Bogor. Bogor. 2005; 76 hal.
9. AdianingsihOA, Widaryanto E, Saitama A and. Zaini AH. Analysis of bioactive compounds present in*Kaempferia galanga* rhizome collected fromdifferent regions of East Java, IndonesiaTo cite this article: IOP Conf. Ser.: Earth Environ. Sci. 2021; 913: 1-7
10. Kurniawan R, Dalilah AR, Ridwan MD, Saitama A, Zaini AH, Widaryanto E and Wicaksono KP. Analysis on rhizome shrinkage of two expected kencur (*Kaempferiagalanga*) accessions from east java using MgSO4 fertilizer under shading. IOP Conf. Ser.: Earth Environ. Sci. 2021; 913: 012007.
11. Mpapa BL. AnalisisKesuburan Tanah TempatTumbuhPohonJati (*Tectonagrandis* L.) pada Ketinggian yang Berbeda. J. Agrista. 2016; 20 (3): 135-149
12. Kumar BM, Kumar SS and Richard RR. Galangal Growth and Productivity Related to Light Transmission in Single-Strata, Multistrata and 'No-Over-Canopy' Systems. J. of New Seeds. 2005; 7(2) : 111-126.
13. Maheswarappa HP, Nanjappa HV, Hegde MR and Biddappa CC. NutrientContent and Uptake by Galangal (*Kaempferiagalanga*L.) as Influenced by AgronomicPractices as Intercrop in Coconut (*Cocos nucifera* L.) Garden. J. Spices Aromatic Crops. 2000; 9: 65-68.

14. Januwati M, Heryana N dan Luntungan HT. Pertumbuhan dan ProduksiJahe Gajah (*ZingiberOfficinale*Rosc.) sebagaiTanamanSela di Antara TegakanPohonKelapa (*Cocos Mucifera* L.). Habitat. 2000; 2(3): 65-70.
15. Rostiana, O. dan D.S. Effendi. 2007. TeknologiUnggulanKencur, Perbenihan dan BudidayaPendukungVarietasUnggul. Pusat Penelitian dan Perkembangan Perkebunan, Badan Penelitian dan PengembanganPertanian. Bogor. 21 hal
16. Ozalkan C, Sepetoglu HT, Daur I and Şen 0. Relationship Between Some Plant Growth Parameters and Grain Yield of Chickpea (*Cicer arietinum* L.) During Different Growth Stages. Turkish J. of Field Crops. 2010; 15(1): 79 – 83.
17. Wahyuni L, Barus a dan Sukri. ResponPertumbuhanJahe Merah terhadapPemberianNaungan dan Beberapa Teknik Bertanam. J. Online Agrotek. 2013; 1(4): 1171–1182.
18. Lambers H, Chapin III FS and Pons TL. Plant Physiological Ecology. Second Edi. Springer US, New York, USA. 2008; p. 11-15.
19. Kumar G, Karthik L, and Bhaskara Rao KV. A Review on Pharmacological and Phytochemical Properties of *Zingiberofficinale* Roscoe (*Zingiberaceae*). J. Pharm. Res. 2011; 4(9): 2963–2966.
20. ChansakaowS, Srigiofun Y, Chitarree L and Panyakard K. Effect of Light Intensity and Soil Amendments on Total Phenolics and Antioxidant Activity of *Kaempferiaparviflora*Wall. Ex. Bak. 31st Congress on Science and Technology of Thailand at Suranaree University of Technology. 2005; 12 pp.
21. GhulamahdM, Aziz SA, andNirwan. Peningkatanlajupertumbuhan dan kandungan flavonoid klondaundewa (*Gynurapseudochina* (L.) DC) melaluiperiodepencahayaan. Bul. Agron. 2008; 36:40-48.