Early Growth of Zingiber zerumbet (L.) Smith as Affected by Different Organic Fertilizers and Harvesting Times

Nurhidah Munawer, Rozilawati Shahari

Abstract: ***Zingiber zerumbet (L.) Smith or lempoyang has various application especially in pharmacological field. This study investigated the effects of different organic fertilizers and harvesting times on the early growth of lempoyang grown at Pahang Matriculation College. The 9 treatment combinations were arranged in a randomized complete block design with five replications. Chemical analysis of soil and organic fertilizers were conducted. The morphological growth were regularly measured at 2 weeks interval. The interaction between organic fertilizers and harvesting times gave high significant (P≤0.001) effect to tiller and leaves number, plant height and pseudo-stem diameter. Different organic fertilizers showed significant differences (p<0.05). Quail litter significantly produced the highest mean on leaves number (14.94), tiller number (8.10), height (33.50) and pseudo-stem diameter (0.83). Most morphological attributes showed directly proportional to the time. The maximum height (34.62) recorded in 150 days after transplanting (DAT) followed by 120 DAT (30.02). Combination of goat manure with 150 DAT produced plants with the highest growth biometrics for leaves number, length of leaf 1, length of leaf blade 1-3, width of leaf blade 1 and 2. From the findings of this study, it can be concluded that application of quail litter and goat manure in combination with late harvest could enhanced the growth of lempoyang.***

Index Terms: Lempoyang, Zingiber zerumbet (L.) Smith, Organic Fertilizer, Quail Litter, Goat Manure, Harvesting Time.

I. INTRODUCTION

Medicinal herbal plants have been used for different purposes in many regions of the world and was pioneered over hundreds of centuries ago. Different countries popular with different type of their medicinal products[1][2]. In China, they are known for their ginseng-based products and their medicinal physician known as *sinseh* while Indonesian community is known *[3][4]*. In India, they practiced the herbs based medicinal system called *Ayurveda* while in Western cultures has its roots in the Hippocratic (Greek) elemental healing system, based on quaternary elemental healing metaphor (2).

In Malaysia, herbs are very prominent in Malay community and are frequently used as the main ingredient in daily dishes and consumed for health. One of the high value herbs is *Zingiber zerumbet* or formerly known as *lempoyang* among [5]. *Zingiber zerumbet* also commonly known as pinecone ginger or shampoo ginger [6]. It is a rhizomatous herbaceous perennial plant of the family Zingiberaceae with approximately 1-2 m tall. The leaves and inflorescence grow from a thick rhizome or underground stem. This species can be found naturally scattered in damp and shady area such as near rivers, waterfalls and other water sources (Chang et al., 2014) This herb species is widely used and popular for ornamental purposes due to its attractive appearance[7][8].

The rhizomes of *Zingiber zerumbet* is the part that is the most used for medicinal purposes (Yob et al., 2011; Koga et al., 2016). The rhizome serves as an appetizer and seasoning in foods (5) and has been extensively used with remarkable therapeutic effects for the treatment of inflammation, diarrhea, stomach cramps, bacterial infections, fever, allergies and poisoning (5). Powdered rhizome is used to treat ear infections, toothaches and can treat stomach disease if being consumed in form of tea [9][10]. The floral organ also contributes to the important and use of *Zingiber zerumbet* in which the floral buds are consumed as vegetable and the creamy substance present in the mature inflorescence serves as a natural hair shampoo and conditioner as it riches with surfactants (Yu et al., 2008; Yob et al., 2011). The leaves of *Zingiber zerumbet* are used in therapies for joint pain and consumed as *ulam*. Recently, the interest on *Zingiber zerumbet* became aroused as it has various application especially in ethnopharmacological field to serve the reference for developing the new drugs [11][12].

Zingiber zerumbet plant has been ranked 14th (MOA, 2014) under 18 identified herbs species proposed to be commercialized by Malaysian government due to its high value market [13][14][15]. By so many values exist in *Zingiber zerumbet,* this plant has big potential to be commercialized inside and outside the country. Therefore, community need to be conveyed to start cultivating this plant to ensure the survival of this plant and protect this species from become extinct due to continuous unattended harvesting from wild population. The Entry Point Project 1 (EPP 1) under National Key Economic Areas (NKEA) focuses in ensuring sufficient and continuous supply of raw herbs to fulfill the growing market demand in Malaysia due to the increasing of awareness on nutrition and health among Malaysian. From a commercial perspective, *Zingiber zerumbet* is a medicinal plant with great potential for cultivation that require low cost[16].

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Nurhidah Munawer, Unit of Biology, Department of Science, Kolej Matrikulasi Pahang, Malaysia, nurhidah@kmph.matrik.edu.my

Rozilawati Shahari, Department of Plant Science, Kulliyyah of Science, International Islamic University Malaysia, Pahang, Malaysia.

However, herbs cultivation is said to be considered as one of the most critical aspect in herbal planting to maximize the growth and development of the plant (2) in cases of poor agricultural practices. It is therefore, critical to have guideline on cultivation and requirements to optimize the maintenance of adequate levels of nutrients and organic matter in soils which is prerequisite for sustainable and high quality of plant production [17][18]. In general, the use of fertilizer strongly influences the plant growth and at the same time it may overcome the problem of nutrients deficiency in soil and further improve the plant performances. It is expected that the use of chemical fertilizers will continue to rise with the increasing of opening the new cultivated areas. Unfortunately, the excessive use of chemical fertilizer will lead to serious environmental and health problems, due to pollution of soil and water resources (11). Increasing awareness on environmental and food safety issues led to the growth and practice of organic agriculture. As a result, the market for organic products in Malaysia has been developing rapidly from few years back (Tiraieyari et al., 2017) and the purchase price for organic food is higher than conventionally grown products [23][24].

Nonetheless, Malaysia needs to import organic food production from other countries, especially from China, Australia, the United States of America and New Zealand due to the lack supply from within the country [28][29]. This factor contributes to the further developing of organic food industry to fulfill the increasing demand. Consequently, cultivation must be done with good agricultural practices as well as organic farming methods as herbal products are used for health and nutrition purposes. Thus, the farmers should be encouraged and explore the possibilities of producing organic crops [33][34]. All efforts should be made to develop consciousness of the farmers about organic farming.

Furthermore, the harvesting time also has been considered to significantly affect the level of growth performances in herbal plant. A research on the morphological variations of the plants until harvest stage is very crucial to investigate the plant responses towards different harvesting times to determine which planting period would give better growth. To ensure the quality of the plant from cultivating farm, number of factors such as the fertilizer supply which provide macro and micronutrients to plant (Sabri, 2009; Triticum et al., 2015) and harvesting time should be carefully planned to gain optimum growth of plant. Therefore, this work was undertaken to examine the effect of different type of organic fertilizers and harvesting times for the better of early growth and performances of *Zingiber zerumbet* (L.) Smith and this study is primarily beneficial to community, society, environmental and scientific field.

II. LITERATURE REVIEW

A. Fertilizer

Fertilizer is a natural or chemical substance that is spread on the land or given to plants, to make plants grow well. Fertilizer do not only assist in increasing yields and promoting healthy growth of plant but also in their development. In other words, the applied fertilizer to soils or to plant tissues is to supply one or more plant nutrients essential to the growth of plants. There are 17 elements that are known to be essential for plant growth and development [19][20][21]. Fertilizers, also called plant food elements are materials produced to supply those elements in a readily available form for plant use. Out of 17, there are three main macronutrients provided by the fertilizers; Nitrogen (N), Phosphorus (P) and Potassium (K) (Becky et al., 2015). In addition to primary nutrients, micronutrients and secondary nutrients are elements which are also essential for plant growth but are required in much smaller amounts than those of the primary nutrients. Secondary nutrients can include, for example, Calcium (Ca), Sulphur (S), and Magnesium (Mg). Micronutrients can include, for example, Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Zinc (Zn), Chlorine (Cl), Nickel (Ni), Carbon (C), Hydrogen (H) and Oxygen (O) [25][26][27].

For the smallholders, they are usually preferred to use fertilizers if they are easily accessible and most importantly, if they are affordable and their use is profitable. The prices of chemical fertilizers have been rising in line with international prices and that led to the granting of subsidies for fertilizers to the small farmers by Malaysian government (21). Inspired to reduce the dependence of small farmers on chemical fertilizers, the government is promoting programs that encourage the recycling and use of agricultural waste which includes animal droppings and other materials [30][31]. Environmental issues such as soil degradation and chemical pollution caused by the chemical fertilizer and the demand for safe food forced farmers to seek for other alternatives to move towards more natural and healthier methods of food production. Malaysia has an abundance of agricultural wastes that can be turned into composts and use as fertilizer for the crops on one main purpose, namely for the sustainable use and management of natural resources.

Organic matter can improve soil tilth, soil texture and water-holding abilities and provides a weak negative electrical charge. As organic matter decomposes, its negative ions help positively charged nutrients remain in the soil and available to plants. Many organic materials serve as both fertilizers and soil conditioners and they feed both soils and plants. This is one of the most important differences between a chemical approach and an organic approach toward soil care and fertilizing.

B. Organic Manure as Fertilizer

Organic manure is a product resulting from the controlled biological decomposition of organic matter, which can be used as organic fertilizer in agriculture (Chandra, 2005; Emillie et al., 2014). Manures contribute to the fertility of the soil by adding organic matter and nutrients, such as nitrogen that assists the growth of plants. It can improve the soil structure (aggregation) so that the soil holds more nutrients and water, and therefore becomes more fertile [36][37]. Animal manure consist of animal excreta and bedding material, and the nutrient composition of the manure varies with the animal type (John, 2003).

Bat guano contains all the major and minor nutrients and many trace elements. Bat guano starts out as bat manure, where the bat droppings fall to the floor of a cave and decomposed by insects, bacteria, and fungi which then make the bat guano odor free, free of pathogens and other toxins. Its finally turned into the wonderful fertilizer and full of beneficial microbes (Oregon Department of Agriculture, 2016).

Goat manure and quail litter also have received research attention in many Asian countries. Goat manure has been acknowledged as one of the best organic fertilizer in Pakistan, India and Bangladesh. In those countries, the prices of goat manure have been rising as it is an effective source of nutrient such as N, P, K, Ca and Mg and other organic matter. Quail litter which also contains high macro and micronutrient sources was believed to has positive effects on soil texture. Quail litter refers to the combination of accumulated manures, feathers and spilled feed will not only improves soil fertility and aeration but also increases water holding capacity of soil (Suppadit et. al, 2012).

C. Harvesting Times

The harvest time is also said to have a great influence on the growth and development of plants. Different harvesting would give different effect on growth performances of different plants. Many researchers have conducted the research on the effect of harvesting times with respect to plant growth and development (Kumar & Gill, 2009; Hossain, 2010; Turk et al., 2012; Melati et al., 2016; Vergara et al., 2016)

III. METHODOLOGY/MATERIALS

A. Experimental site and design

The field experiment was conducted in Pahang Matriculation College of Malaysia located at 3º 43' 17" N, latitude of 103º 4' 28" longitude (GPS, Garmin 12). The 9 treatments combination were laid out in a randomized complete block design with five replications. Each treatment is repeated once in each replicate. The different organic fertilizer treatments; F1 (bat guano), F2 (goat manure) and F3 (quail litter) were assigned at random in the main plots, while the split-plots are devoted to the different harvesting time treatments; T1 (90 DAT), T2 (120 DAT) and T3 (150 DAT).

B. Plant Material

In this study, the local *lempoyang* variety was collected from Glass House Nursery Complex (GNC), IIUM Kuantan Campus, Pahang. Rhizomes that have been taken are carefully inspected and examined to ensure they are free of any fungal, pests and seed borne diseases. The selected rhizomes were cut into fragments (3-5 cm) and planted 5cm deep in growing pots under shed and irrigated twice daily. Germinated plants were then being transplanted into polyethylene bags (20 cm x 20 cm) and filled with top and sandy soil in the ratio of 1:1. The plants were placed under shed in experimental field and irrigated according to the schedule. Organic fertilizers were regularly applied at two weeks interval starting on week 4. The cultural practices such as weeding, hoeing, earthing up and treatment against insects, pests and diseases were done uniformly in all treatments and regularly throughout the growing period.

C. Morphological Growth

The morphological parameters such as the plant height (cm), number of tiller, number of leaves, the length of the leaf (cm) (include the length of the sheath), the length and width of leaf blade (cm) and diameter of the pseudo-stem were regularly measured on each plant at 2 weeks interval. Plant height, length and width of leave was estimated with a tape measure, number of tiller per plant and number of leaves per plant was counted physically. Diameter of the pseudo-stem was measured using Vernier caliper.

D. Soil and Organic Fertilizer Analysis

Soil and organic fertilizer samples were air-drying, grounded and passed through 2-mm sieve. The samples were then used for the analysis of pH and water holding capacity (WHC). The elements of P, K, Na, Mg, Mn, Fe, Ca, Cu, Zn and Al were measured by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) replicated thrice. Total Nitrogen (N) content was determined by micro-kjeldahl digestion method and the Total Organic Carbon (TOC) was determined according to KMnO4 oxidation.

E. Statistical Analysis

The data obtained for different growth parameters were statistically analyzed using the Statistical Analysis System (SAS) 9.4 for Windows to find out the effect and influences of different organic fertilizers and harvesting times on the early growth of Zingiber zerumbet. The data for growth of Zingiber zerumbet were subjected to analysis of variance (ANOVA) and the means value were compared using Duncan New Multiple Range Tests at $P < 0.05$.

IV. RESULTS AND DISCUSSIONS

The result of physical and chemical analysis for soil, F1, F2 and F3 used in the experiment before planting *lempoyang* are presented in Table I. The pH of the experimental soil was found to be slightly acidic (5.17). FAO, (2000) reported that the preferable pH ranges for most crops and productive soils are 4 to 8. Thus, the pH of the experimental soil was within the range for productive soils. The pH of F1 and F2 was acidic and slightly acidic at 4.48, 6.91 compared to the value of F3 (8.42) which is more alkaline. The nutrients content of the soil and organic fertilizers; F1, F2 and F3 were 0.045, 0.327, 0.360; 0.267, 0.020, 0.967; 0.114, 0.687, 0.267 and 2.575, 2.790, 0.167 percent N, P and K, respectively. Bat guano has the highest percentage of Cu (0.092), Mg (0.213) and K (0.967) while goat manure has the highest percentage of Fe (1.929) and Ca (1.987). Quail litter contains the highest percentage in most elements such as Al (0.771), Mn (0118), Zn (0.993), P (2.790), Na (1.663), C (2.274) and N (2.575) compared to other organic fertilizers

Table I : Physicochemical properties of the experimental soil and organic fertilizers

	Soil	Bat guano	Goat manure	Quail litter
pH	5.17	4.48	6.91	8.42
Water holding capacity	5	NA	NA	NA
Al27	0.364	0.183	0.021	**0.771***
Fe57	1.389	1.888	**1.929***	0.926
Cu63	0.065	**0.092***	0.003	0.007
Mg24	0.295	**0.213***	0.065	0.201
Mn55	0.096	0.104	0.095	**0.118***
Zn66	0.844	0.911	0.761	**0.993***
Ca43	0.647	0.080	**1.987***	0.147
P31	0.327	0.020	0.687	**2.790***
K39	0.360	**0.967***	0.267	0.167
Na23	1.767	1.300	1.500	**1.663***
Total Organic Carbon	0.2666	1.599	0.9255	**2.274***
Total Nitrogen	0.045	0.267	0.114	**2.575***

The morphological growth; plant height, number of tiller plant^{-1}, number of leaves plant^{-1} and pseudo-stem diameter is highly significant (P≤0.001) affected by the main factor; organic fertilizers (275.42, 32.02, 34.40 and 0.10) and split-factor; harvesting times (322.77, 543.58, 51.14 and 0.04). Similar finding was obtained through a study conducted by Yunus et al., (2014) where various organic manure application significantly increases the height and number of tiller of *temulawak* plant. However, the application of different organic fertilizers gave no significant effect to the length of leaf blade 1, 2 and 3 while the different harvesting times showed no significant effect with respect to the length of leaf blade 2. The interaction between organic fertilizers and harvesting times showed the significant effect (P<0.05) for both plant height and leaf length and high significant effect (P≤0.001) to the number of tiller plant^{-1}.

A. Effect of Organic Fertilizer to Growth of Zingiber zerumbet

The recorded data on the effect of different organic fertilizers on growth is given in Table II. Results of analysis of variance showed that the use of different organic fertilizers gave significant differences (p<0.05) in growth attributes. Among the different organic fertilizers, F3 was found to be the most effective and best treatment which showed high significant differences with the highest mean on growth biometrics. The higher and available nutrient content in quail litter might be the reason for the contribution of highest growth performances in *Zingiber zerumbet* plant. Level of nitrogen availability of the quail litter can improve the physical and chemical properties of the soil for maximum plant growth (Majumdar et al., 2005; Suppadit et al., 2012; Yunus et al., 2014).

Plant height : The recorded data for plant height showed high significant differences between three different organic fertilizer treatments. The maximum plant height was obtained from the plants treated with F3 (34.62cm) followed by F2 (31.26cm). The minimum plant height was from F1 treatment (25.22cm).

Leaves and tiller number : Number of leaves and tiller showed high significant differences as affected by different organic fertilizers. The maximum leaves and tiller number was obtained from F3 (14.94 ; 8.10). The lowest number of leaves and tiller was from F1 treatment with 12.02 and 5.22 respectively.

Pseudo-stem diameter : Pseudo-stem diameter showed high significant differences between F1, F2 and F3 as the mean value for F3 was the highest (0.83cm) followed by F2 (0.74cm). However, the lowest pseudo-stem diameter was obtained from F1 with only 0.67cm.

Nevertheless, there was no significant differences between organic fertilizers with respect to the length of leaf 1 with the maximum value was recorded with 33.85cm by F2 application and length of leaf blade 1, 2 and 3 with the maximum value were recorded through the application of F3 with 15.31, 14.05 and 12.29 respectively. F3 and F2 showed no significant differences for width of leaf blade 1, 2 and 3 in comparable to F1. The application of bat guano significantly produced the lowest means throughout the planting periods for every observed and measured parameter. Kunz et al., (2011) predicted that the effectiveness of bat guano as fertilizer in agriculture is specific to certain plant communities. In placing more emphasis, Shetty et al., (2013) claimed that the effect of bat guano on plant growth was affected by different geographical location where the guano derived. This may be the one reason for the minimum growth achievement obtained from the application of bat guano to *Zingiber zerumbet*.

Table II : Effect of different organic fertilizers on growth parameter of *Zingiber zerumbet* (L.) Smith

Parameters	LNO	TNO	HEIGHT (cm)	PSDIA (cm)	LL1 (cm)	LLB1 (cm)	WLB1 (cm)	LL2 (cm)	LLB2 (cm)	WLB2 (cm)	LL3 (cm)	LLB3 (cm)	WLB3 (cm)
Bat Guano (F1)	12.02c	5.22c	25.22c	0.67c	31.91a	14.75a	4.82b	28.57b	13.38a	4.69b	24.77b	11.73a	4.62b
Goat Manure (F2)	14.18b	6.20b	31.26b	0.74b	33.85a	15.19a	**5.08a**	**30.06a**	13.89a	**5.06a**	**26.42a**	11.93a	**4.98a**
Quail Litter (F3)	**14.94a**	**8.10a**	**33.50a**	**0.83a**	33.61a	15.31a	**5.10a**	**31.01a**	14.05a	**5.12a**	**26.59a**	12.29a	**5.03a**

*Means followed by the same letter along the columns indicate no significant different at 5% probability level

B. Effect of Harvesting Time to Growth of Zingiber zerumbet

Growth performances of *Zingiber zerumbet* showed the significant differences (P<0.05) in almost all the observed parameters as affected by different harvesting times. This result excluded the attribute of the width of leaf blade 1 which showed no significant difference between three harvesting times as the mean obtained was 4.82, 5.07 and 5.11

respectively. The measured value for plant height, leaves number, tiller number and pseudo-stem diameter increase with time from 90 DAT to 150 DAT (Table III).

Plant height : The data of plant height was recorded for three harvesting times (Figure 1a) and reached maximum height (34.62) in 150 DAT followed by 120 DAT (30.02). As reported by Amin et al., (2013) the height of turmeric (*Curcuma longa* L.) continue increases throughout the growing cycle from 90 DAT up to 150 DAT.

Leaves and tiller number : Number of leaves and tiller showed high significant differences at different harvesting times. The maximum leaves (Figure 1b) and tiller number (Figure 1c) were obtained from 150 DAT (15.27 ; 13.44). Melati et al., (2016) reported that the number of leaves and tiller for ginger (*Zingiber officinale*) increased with times. The maximum uptake of nutrients occurs during the active growth phase attained during 4th and 5th month of Zingiberaceae plant (Behailu, 2017). This indicated why the number of tiller started increases tremendously from 120 DAT and peaked at 150 DAT. The lowest leaves and tiller number were obtained from 90 DAT with 11.67 and 2.69 respectively.

Pseudo-stem diameter : Pseudo-stem diameter showed no significant difference between 120 DAT and 150 DAT as the mean value for both were 0.77cm and 0.78cm respectively. However, the lowest pseudo-stem diameter was obtained from 90 DAT with only 0.68cm.

Table III : Effect of different harvesting time on growth parameter of *Zingiber zerumbet* (L.) Smith

Parameters	LNO	TNO	HEIGHT (cm)	PSDIA (cm)	LL1 (cm)	LLB1 (cm)	WLB1 (cm)	LL2 (cm)	LLB2 (cm)	WLB2 (cm)	LL3 (cm)	LLB3 (cm)	WLB3 (cm)
90 DAT (T1)	11.67 c	2.69b	25.34 c	0.68b	31.85 b	14.25b	4.82a	28.16 b	13.10 b	4.73b	24.80 b	11.20 b	4.68c
120 DAT (T2)	14.20 b	3.38b	30.02 b	**0.77a**	32.57 b	15.10ab	5.07a	29.08 b	13.64 b	**4.99a**	24.96 b	11.85 b	4.84b
150 DAT (T3)	**15.27 a**	**13.44 a**	**34.62 a**	**0.78a**	**34.96 a**	**15.90a**	5.11a	**32.39 a**	**14.58 a**	**5.16a**	**28.03 a**	**12.89 a**	**5.12a**

*Means followed by the same letter along the columns indicate no significant different

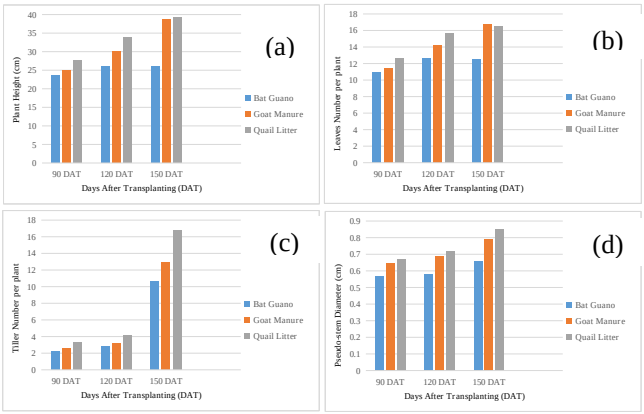

Fig. 1. (a) Plant height (b) Leaves number (c) Tiller number (d) Pseudo-stem diameter; as affected by different organic fertilizers at different harvesting times.

C. Combination Effect of Organic Fertilizers and Harvesting Times on Growth Parameters

The data revealed that the combination of different organic fertilizers and harvesting times and the interaction of the two factors gave effect to the early morphological growth of *Zingiber zerumbet* as shown in Table IV. Generally, the plant growth increases as it progresses to harvest and attains the maximum level at each harvesting time (90, 120 and 150 DAT). At 90 DAT, the differences between treatments as affected by different type of organic fertilizers were already noticed in all growth biometrics. Length of leaf 1, 2 and 3 at 90 DAT were 31.33, 32.47 and 31.74; 27.82, 27.88 and 28.78; 24.07, 25.71 and 24.61 for F1, F2 and F3 respectively.

Plant height : The plant height is a direct index to measure the growth and the height of *Zingiber zerumbet* was measured at 90, 120 and 150 DAT. At all these times, tallest plant was observed from F3 treatment with the mean value 27.55, 33.78 and 39.17 during each harvesting time respectively.

Leaves and tiller number : Among all treatments, combination of goat manure with 150 DAT produced plants with the highest number of leaves plant^{-1} (16.80). It was proven in a finding of Yunus et al., (2014) where goat manure has highly significant difference in the number of leaves of *temulawak* as compared to other manures. The increase in number of leaves per plant could be contributed by the availability of the growth limiting nutrient (nitrogen) in right amount that permit leaves to grow vigorously. Whereas, the minimum number of leaves was recorded from the F1 application (Figure 2b). The current result also revealed that, number of tillers per plant was significantly ($P<0.05$) affected by the main factor of organic fertilizer and split factor of harvesting times as well as by the interaction of the two factors. Varies number of tiller per plant obtained throughout the planting period and the maximum number of tiller was recorded from F3 organic fertilizer harvested during 150 DAT (16.80) which was closely followed by F2 organic fertilizer harvested during 150 DAT (Figure 2c). Again, the minimum number of tiller was derived from F1 (10.67). It was noted that with the increase of nutrient content and times, the number of tillers per plant would increase.

Pseudo-stem diameter : Application of F3 harvested during 150 DAT showed the highest reading for pseudo-stem diameter with 0.87cm followed by F2 harvested during the same period. However, the data from F1 showed the least diameter at all days after transplanting.

Table IV :Mean of morphological growth parameters of *Zingiber zerumbet (L.) Smith* as effected by different organic fertilizers and harvesting time

		Mean											
Level of Fertilizer	**Level of Time**	**LNO**	**TNO**	**HEIGHT (cm)**	**PSDIA (cm)**	**LL1 (cm)**	**LLB1 (cm)**	**WLB1 (cm)**	**LL2 (cm)**	**LLB2 (cm)**	**WLB2 (cm)**	**LL3 (cm)**	**LLB3 (cm)**	**WLB3 (cm)**

Bat Guano (F1)	**T1**	10.92	2.20	23.59	0.62	31.33	14.35	4.71	27.82	12.64	4.41	24.07	10.81	4.84
	T2	12.67	2.80	26.12	0.71	32.61	15.02	4.97	29.12	13.68	4.82	24.64	11.92	4.59
	T3	12.47	10.67	25.93	0.67	31.80	14.88	4.77	28.76	13.82	4.85	25.61	12.46	4.80
Goat Manure (F2)	**T1**	11.47	2.54	24.88	0.67	32.47	13.76	4.84	27.88	13.05	4.73	25.71	11.00	4.74
	T2	14.27	3.18	30.15	0.74	32.31	15.28	5.04	28.63	13.60	5.06	24.59	11.59	5.05
	T3	**16.80**	12.87	38.75	0.79	**36.75**	**16.54**	**5.37**	33.68	**15.04**	**5.40**	28.95	**13.21**	5.16
Quail Litter (F3)	**T1**	12.63	3.35	27.55	0.75	31.74	14.64	4.92	28.78	13.62	5.06	24.61	11.80	4.80
	T2	15.65	4.14	33.78	0.86	32.78	15.01	5.20	29.49	13.65	5.08	25.64	12.04	4.88
	T3	16.53	**16.80**	**39.17**	**0.87**	36.31	16.28	5.19	**34.75**	14.88	5.23	**29.53**	13.01	**5.41**

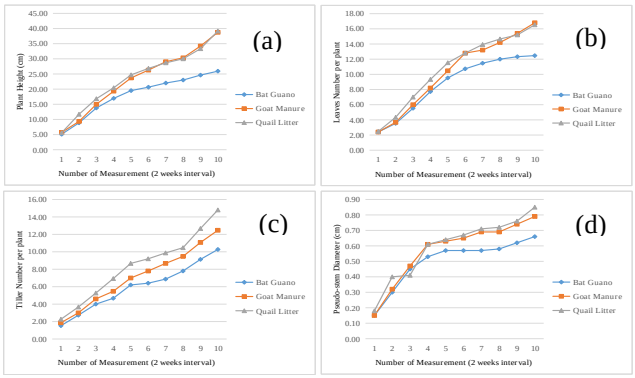

Fig. 2. (a) Plant height (b) Leaves number (c) Tiller number (d) Pseudo-stem diameter; as affected by different organic fertilizers as measured at 2 weeks interval.

V. CONCLUSION

The findings from this study seeks to educate the urban and rural farmers on the best type of organic fertilizer which requisite to ensure the early growth performance of the *Zingiber zerumbet* plants at their optimum level by avoiding the application of the inorganic or chemical fertilizer thereby minimising their cost of production. Unlike chemical fertilizer which are not affordable to farmers due to its high cost, organic fertilizers such as animal manures are easily available and accessible. Role of organic manure as fertilizers in maintaining and influencing the growth and development of *Zingiber zerumbet* plant has been proven through this study. The effect of different organic fertilizers and harvesting times shows different result in growth performances of *Zingiber zerumbet*. Quail litter and goat manure are suit and can be considered as best cost effective organic fertilizers recommended for *Zingiber zerumbet* cultivation due to high nutritional value and nutrients content such as N, P and K and their best effect with respect to plant growth. 150 DAT would be the best harvesting time as it promotes better growth and development for plant and give maximum value to farmers. Furthermore, the findings of this study are expected to open the eyes and provide space and great opportunity for farmers in implementing organic agriculture for the sake of universal well-being.

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