JOURNAL OF WORLD SCIENCE
https://jws.rivierapublishing.id/index.php/jws
Volume 2 No. 4 April 2023
P-ISSN: 2828-8726
E-ISSN: 2828-9307

THE RELATIONSHIP BETWEEN THE GROWTH OF LEAVES, STEMS, AND ROOTS OF ELEPHANT FOOT YAM AT EACH APPLICATION OF BOKASHI AND NPK FERTILIZER

Yusuf L. Limbongan
Universitas Toraja, Sulawesi Selatan, Indonesia

yusuflimbongan@ukitoraja.ac.id

ABSTRACT
Research on the relationship between the growth of leaves, stems, and roots of elephantiasis plants in each application of bokashi fertilizer and NPK fertilizer was carried out from July to October 2022 in Rante Dengen, Lembang Karre Limbong, Nanggala District, North Toraja Regency. This study aimed to determine the relationship between the growth of leaves, stems, and roots of elephantiasis after each application of bokashi from chicken waste and NPK fertilizer. The experiment used a randomized group design (RB) with two treatment factors: liquid organic fertilizer from chicken waste and NPK. The results showed that giving bokashi at a dose of 400 g/plant gave the best results, and NPK fertilizer at a dose of 20 g/plant was also the treatment that gave the best results. The relationship pattern between leaf, stem and root growth variables is linear. The variables that most contribute to the dry weight gain of plants are stem diameter and akare's volume. Our sincere gratitude goes to DRPM, Directorate General of Higher Education, Ministry of Education and Culture (Kemendikbud Ristek DIKTI), Indonesia, as well as the Indonesian Christian University of Toraja, for their financial support throughout this study.

Keywords: bokashi, npk, elephant foot yam, liquid organic fertilizer.

Corresponding Author: Yusuf L Limbongan
E-mail: yusuflimbongan@ukitoraja.ac.id

INTRODUCTION

Elephant foot yam (Amorphophallus muelleri) is one of the root crops belonging to the Araceae (taro) family. This type of plant is found in tropical and subtropical regions. In Indonesia, many are growing wild in the forest (Sari & Suhartati, 2015).

As a country with a tropical climate, Indonesia has good opportunities for elephant foot yam cultivation. However, the elephant foot yam plant is relatively new among the public. Its popularity has only started in the last few years due to its high export value to several countries. In Toraja itself, it is still rare for farmers to cultivate it. This is due to a need for more information regarding the cultivation and benefits of the elephant foot yam plant. When viewed from its content, people have various benefits for humans and can also be an alternative food. The diversity of elephant food yam (Amorphophallus campanulate) in Indonesia is essential to be explored concerning its potential use for food and benefits for health (Utomo & Ginting, 2021), glucomannan level (Qur'ani et al., 2020); and farmers' profits (Indonesian Elephant foot yam Research and Development Center, 2013).

Elephant foot yam has a high nutritional content, containing 76.5% starch, 9.20% protein, 25% fibre and low fat, 0.20%. In addition to these several ingredients, elephant foot yam contains precious nutrients, namely glucomannan. Glucomannan can be used as a water-binding agent and gelling agent. Glucomannan contains high fibre, which can form and stabilize gel structures and be

used as a thickener in food products. The glucomannan content in elephant foot yam plants is as much as 60% (Fatoni & Bahri, 2018).

Elephant foot yam is a plant that grows in need of shade to be cultivated as an intercrop (Sari & Suhartati, 2015). In line with the custom of the Toraja people, most of their land is planted with trees to construct timber and for some plantation crops. Most farmers are only limited to waiting for the results of these plantation crops, most of which only produce once a year; even though farmers can take advantage of this long time to manage unproductive land to produce other agricultural products, such as elephant foot yam plants so that they can form an agroforestry system.

Data from the Ministry of Agriculture, Directorate General of Food Crops for 2020, exports of elephant foot yam plants reached 11,720 tons. They experienced an increase in January-July 2020, reaching 14,568 tons. The export destination countries are Japan, China, Hong Kong, Vietnam, and Thailand. However, the demand for exports to foreign countries must be fully met. Even though when talking about land, elephant foot yam cultivation does not require exceptional land and does not require complicated maintenance, the export value of elephant foot yam is also high. It can be sold as processed products (Saputra, 2021). Elephant foot yam preparations can be in the form of chips, flour, noodles, jelly, etc. Elephant foot yam plant tubers contain glucomannan which is in great demand by humans to be used as an industrial material, such as cosmetic and food ingredients, which have a high fibre and carbohydrate content.

Given the many benefits and opportunities for elephant foot yam cultivation, it is necessary to increase production. However, one of the obstacles farmers faces is nurseries that still need to be maximized. At the same time, they are supporting the success of elephant foot yam cultivation, namely nurseries. To obtain high-yielding plants, it is also necessary to support the condition of quality seeds. Adequate nutritional needs determine quality seeds during their growth through proper fertilization.

Generally, fertilizers consist of two types, namely organic fertilizers, and inorganic fertilizers. Applying organic fertilizers plays a role in improving the soil's physical, chemical, and biological properties. However, the macro and micronutrient content are relatively low, so it must be used in large quantities.

We can process organic fertilizer from animal waste. One of the most common wastes that can be used as organic material is chicken livestock waste, which has a very pungent odour. Even if appropriately processed, chicken livestock waste has a high nutrient content. Chicken livestock waste has a higher nutrient content than other types of livestock because the liquid and solid manure are mixed. Chicken livestock waste contains nutrients plants need for growth, such as N, P, K, Ca, Mg and S. This waste can be processed into bokashi with a mixture of EM4 as a fermentation material (Sahetapy, 2017).

In addition to organic materials, inorganic fertilizers can also be used to supplement plant nutrient needs. One that can be used is compound fertilizer, namely NPK Mutiara. Pearl NPK fertilizer is a compound fertilizer containing macro and micronutrients that plants need. With its content, NPK fertilizer can quickly respond to plant growth (Saputra, 2021).

Based on the description above, research was conducted on the relationship between the growth of elephant yam leaves, stems, and roots at each application of chicken manure liquid organic fertilizer and NPK fertilizer.

METHOD

The research was conducted from July to September 2022. The research was conducted in Rantedengen, Lembang Karre Limbong, Nanggala District, North Toraja Regency. The place of this research is at an altitude of 900 meters above sea level. This study used a factorial experiment with a randomized block design (RAK) with two factors: bokashi and NPK.

The first-factor bokashi, consists of 3 treatments, namely:

B0 = Control
B1 = 200 g/plant
B2 = 400 g/plant

The second factor of NPK fertilizer consists of 3 treatments, namely:

N0 = Control
N1 = 10 g/plant
N2 = 20 g/plant

From the two factors above, there are 16 treatment combinations, namely:

B0N0 B1N0 B2N0
B0N1 B1N1 B2N1
B0N2 B1N2 B2N2

From the two treatment factors used, there were nine treatment combinations which were repeated three times so that there were 27 treatments. Each treatment plot consisted of 8 plants, so there were 216 plants.

Research Procedures

Making bokashi from chicken livestock waste

The prepared materials are:

1. Chicken livestock waste = 50 kg
2. Effective Microorganism 4 = 200 ml,
3. Rice bran = 15 kg
4. Brown sugar = 1 kg
5. Water

Working procedure:

1. Prepared brown sugar and EM4 are dissolved in water first.
2. Chicken livestock waste is mixed with rice bran in a tarpaulin container and stirred until evenly distributed.
3. A mixture of EM4 and dissolved sugar is poured onto the mixture of chicken livestock waste and rice bran until evenly distributed.
4. The mixed material is formed into a 10-20 cm thick mound, then covered tightly with a tarpaulin and stored in a place out of direct sunlight.
5. The fermented material is turned every two days.

6. Fermentation lasts 7-14 days.
7. The fermented material is ready to use.

Implementation method:

1. Preparation of NPK fertilizer
   NPK fertilizer prepared as much as 3 kg.
2. Nursery
   Before sowing, the elephant foot yam seeds are soaked for ± 5 hours. After the soaking process, the elephant foot yam seeds are put into several containers (baskets) and stored in a dark place away from light. During the seeding process, the seeds are watered every morning or evening. The nursery process lasts for two weeks until the shoots grow.
3. Making nursery cages
   The location for making nursery cages is first cleaned of weeds. Then the nursery cages are made using bamboo as poles; the size of the nursery cages is 2×13 m with a roof using parents and nets as walls to protect the seedlings from pests such as chickens.
4. Filling Polybags
   The planting medium used is loose soil. The soil that has been prepared is mixed with fermented bokashi fertilizer at the dosage according to the predetermined treatment. Mixed planting media was put into 20×25 cm polybags and arranged in nursery cages according to the treatment plot.
5. Planting
   Seeds that have been sown and sprouted are transferred to polybags filled with planting media.
6. Maintenance
   a) Watering
      Watering is done in the morning or evening if it is not raining.
   b) Fertilization
      The application of NPK fertilizer was carried out twice, namely at 14 days after sowing and 28 days after sowing.
   c) Weeding
      The nursery cages must be cleaned of weeds to prevent the seedlings from being attacked by pests and diseases. Weeding has been carried out routinely every two weeks since the elephant foot yam seeds were planted.

Observed variables:

1) Stem diameter (cm)
   The stem diameter was measured 2cm from the surface of the media using a calliper. Measurements were made at the age of 60 daps.
2) Leaf area (cm^2)
   Leaf area was measured at 60 daps using the millimetre block method.
3) Root volume (ml)
   Root volume was measured at the final stage of the study using a measuring cup.
4) Plant dry weight (g)
   The oven method measured plant dry weight at the final stage of the study.

RESULTS AND DISCUSSION

The analysis of variance (Table 1) showed that the bokashi treatment of chicken livestock waste, NPK and interactions had a very significant effect on all observed variables, namely leaf area, stem diameter, root volume, and dry seedling weight. This is in line with (Rismawati, 2018) on red dragon fruit; Okra (Hidayatullah et al., 2020); corn (Irawan et al., 2019); lowland rice (Kaya, 2018); and mung bean (Ramadhan et al., 2022).

Table 1. Analysis of Variance of Leaf Area, Stem Diameter, Root Volume and Plant Dry Weight.

Source of Variation	Leaf area		Stem diameter		Root volume		Dry weight	
Block	1.84	ns	1.97	ns	7.14	**	0.54	ns
Treatment	196.10	**	118.55	**	40549.23	**	1852.71	**
Bokashi	89.42	**	202.09	**	66399.27	**	3081.44	**
NPK	690.36	**	246.47	**	88281.45	**	3978.72	**
Interaction	2.30	*	12.83	**	3758.09	**	175.34	**

Description:
**= significant at F 1%
*= significant at F 5 %
ns: nosignificant

The LSD test results at level 0.05 (Table 2) showed that applying bokashi from chicken livestock waste at 400 g/plant and 20 g of NPK gave the best results, significantly different from all other treatment combinations. This is because the need for nutrients for the growth of elephant foot yam plant seeds can be fulfilled in these doses. The organic matter in bokashi from chicken livestock waste influences the planting medium used, namely soil. NPK treatment of 100:60:80 kg ha^{-1} produced more corm fresh mass than other treatments (Santosa et al., 2015); (Sahoo et al., 2019). Based on these results, the combination of these two ingredients makes the nutrients in them complement each other so that they have a good effect on the growth of elephant foot yam plant seeds. The same thing is found in kailan plants (Noura et al., 2022); cocoa seedlings (Setiadi et al., 2021); honey gourd (Robi Setiawan, 2021); and raddish plants (Sudinus & Santoso, 2021).

The presence of N elements in these two treatment materials stimulates the formation of amino acids and chlorophyll which can increase the photosynthesis rate, producing energy for seedling growth. Element P plays a role in stimulating root multiplication so that the elements needed can be appropriately absorbed in sufficient quantities for the continuity of metabolism. While the element K plays a role in transporting photosynthetic results to all parts of the plant. These elements, if one of these is available in less proportion, will disrupt the metabolic process so that the growth of elephant foot yam plant seeds will be hampered. However, due to the availability of elements from the two treatments, which combined provide a balanced proportion and according to the needs of elephant foot yam plant seeds, the combination of bokashi chicken waste 400 g/plant and NPK fertilizer 20 g/plant is the best combination. A fertilizer schedule consisting of 175:125:175 NPK (kg/ha) may be recommended for obtaining a higher yield of elephant foot yam grown as

intercrop in the young areca nut plantation without hampering the growth of the main crop (Chattopadhyay et al., 2006).

Table 2. Test The Most Insignificant Differences in Leaf Area, Stem Diameter, Root Volume and Dry Weight of The Plant.

Interaction	Variables							
	Leaf area		Stem diameter		Root volume		Dry weight	
0;0 (Control)	143.90	*a*	4.00	*a*	23.33	*a*	1.50	*a*
0; 10 (B0N1)	341.33	*d*	5.67	*b*	42.17	*c*	4.50	*c*
0; 20 (B0N2)	628.17	*f*	6.67	*b*	93.50	*e*	7.50	*d*
200: 0 (B1N0)	260.10	*b*	5.33	*b*	35.17	*b*	3.25	*b*
200; 10(B1N1)	382.98	*d*	6.78	*b*	106.33	*f*	7.33	*d*
200; 20(B1N2)	706.60	*g*	10.00	*c*	129.50	*h*	14.58	*f*
400; 0(B2N0)	342.18	*c*	6.56	*b*	84.17	*d*	7.00	*d*
400; 10(B2N1)	466.74	*e*	9.33	*c*	124.50	*g*	13.25	*e*
400; 20(B2N2)	823.45	*h*	12.33	*d*	151.33	*i*	19.50	*g*

Information:

The mean value of each variable, followed by letters that are not the same, is significantly different at the 5% LSD test level.

B0= control, B1=200 g bokashi and B2 =400 g bokashi

N0 = control, N1 = 10 g NPK / plant; and N2 = 20 g per plant

The correlation analysis between each observed variable is shown in Table 3. The table shows that leaf area, stem diameter and root volume are positively and significantly correlated with elephant foot yam plant dry weight. This shows that the increase in leaf area, stem diameter and root volume align with the increase in plant dry weight.

This result is in line with the opinion of (Sahoo et al., 2019) that the integrated use of organic manures, bio-fertilizers and inorganic fertilizers is more efficient than the application of inorganic fertilizers alone concerning growth, yield and quality of elephant foot yam. An increase in P uptake was observed due to the addition of graded doses of NPK over control. Application of all the organic manures showed relatively higher P uptake over that of 100% NPK (Laxminarayana, 2021)

Table 3. Correlation Between Leaf Area, Stem Diameter, Root Volume and Plant Dry Weight

	X1	X2	X3	Y
X1	1			
X2	0.891**	1		
X3	0.865**	0.928**	1	
Y	0.896**	0.998**	0.941**	1

Description:

** = significant at r = 0.01,

X1 = leaf area, X2 = rod diameter

X3 = root volume, Y = plant dry weight.

The LSD test results at a level of 0.05 for all observation parameters showed that the interaction between bokashi chicken waste at a dose of 400 g/plant and NPK fertilizer at 20 g/plant was the best.

The results of multiple regression for the growth variables of elephant foot yam leaf stems and roots are presented in Tables 4 and 5. The table shows that the regression significantly affects the four variables tested. The relationship pattern between leaf, stem and root growth variables follows the multiple regression equation: Y = 7.37+0.0003X1+1.985X2+0.014X3.

Table 4. Analysis of Variance in The Growth of Elephant Foot Yam Stems and Roots

SV	df	SS	MS	F	Significance F
Regression	3	276.525195	92.17507	569.21	9.372E-07
Residual	5	0.80968154	0.161936		
Total	8	277.3348765			

Based on the equation above shows that the variables that give the most significant contribution to the increase in plant dry weight are stem diameter and root volume, which means that the larger the stem size and the higher the root volume, the greater the plant dry weight. Vegetative parameters were markedly influenced by different varieties and fertilizer levels (Choudhary et al., 2012).

Table 5. The Regression Coefficient of Growth of Stems, Leaves and Roots on The Dry Weight of Elephant Foot Yam Plants

Parameter	Coefficients	Standard Error	t Stat	P-value
Intercept	-7.369515599	0.50486827	-14.5969	2.725E-05
Leaf area	0.00033264	0.001450254	0.229367	0.8276712
Stem diameter	1.985317772	0.165029179	12.0301	7.004E-05
Root volume	0.013947927	0.008640832	1.614188	0.1674069

CONCLUSION

We sincerely thank DRPM, Directorate General of Higher Education, Ministry of Education and Culture (Kemendikbud Ristek DIKTI), Indonesia, and the Indonesian Christian University of Toraja, for their financial support throughout the course of this study.

REFERENCES

Chattopadhyay, N., Hore, J. K., Bandyopadhyay, A., & Ghosh, D. (2006). Response of varying levels of NPK fertilization on elephant foot yam grown as intercrop in areca nut plantation. *Agricultural Science Digest*, *26*(1), 23–26.

Choudhary, V. K., Kumar, P. S., Kanwat, M., & Sangeetha, A. (2012). *Influence of NPK Fertilization on Nutrient Uptake. Growth and Yield of Elephant Foot Yam in Laterite Soils of Arunachal Pradesh*.

Fatoni, K., & Bahri, S. (2018). Pertumbuhan Tanaman Porang (Amorphophallus Onchophillus) Akibat Perlakuan Macam Pupuk Kandang Dan Biotamax Growth of Porang plant (Amorphophallus Onchophillus) due to kind of fertilizers and biotamax. *Innofarm: Jurnal Inovasi Pertanian*, *19*(1). https://doi.org/10.33061/innofarm.v19i1.2129

Hidayatullah, W., Rosmawaty, T., & Nur, M. (2020). Pengaruh Pemberian Pupuk Kascing Dan Npk Mutiara 16: 16: 16 Terhadap Pertumbuhan dan Hasil Okra (Abelmoschus Esculentus (L.) Moenc.) Serta Bawang Merah (Allium Ascalonicum L.) dengan Sistem Tumpang Sari. *Dinamika Pertanian*, *36*(1), 11–20.

Irawan, S., Safruddin, S., & Mawarni, R. (2019). Pengaruh perlakuan jarak tanam dan pemberian pupuk npk terhadap pertumbuhan dan produksi tanaman jagung (Zea mays L.). *Bernas: Jurnal Penelitian Pertanian*, *15*(1), 174–184.

Kaya, E. (2018). Pengaruh kompos jerami dan pupuk NPK terhadap N-tersedia tanah, serapan-N, pertumbuhan, dan hasil padi sawah (Oryza Sativa L). *Agrologia*, *2*(1).

Laxminarayana, K. (2021). Effect of Lime, Inorganic and Organic Sources on Soil Quality and Yield and Proximate Composition of Elephant Foot Yam-Black Gram System in Alfisols. *Communications in Soil Science and Plant Analysis*, *52*(6), 635–650. https://doi.org/10.1080/00103624.2011.609259

Noura, A., Astuti, A., & Fikrinda, W. (2022). *Pengaruh Konsentrasi Em-4 Terhadap Kualitas Bokashi Kotoran Ayam Pada Pertumbuhan dan Hasil Tanaman Kailan (Barasica Oleraceae A)*. Fakultas Pertanian Unversitas Tribhuwana Tunggadewi Malang.

Qur'ani, N., Yuliani, Y., & Dewi, S. K. (2020). Respons Morfologi dan Kadar Glukomannan Tumbuhan Porang (Amorphophallus muelleri Blume) pada Lingkungan yang berbeda. *LenteraBio: Berkala Ilmiah Biologi*, *9*(1), 74–81. https://doi.org/10.26740/lenterabio.v9n1.p74-81

Ramadhan, A., Nurhayati, D. R., & Bahri, S. (2022). Pengaruh Pupuk Npk Mutiara (16-16-16) terhadap Pertumbuhan beberapa Varietas Kacang Hijau (Vigna Radiata L.). *Biofarm: Jurnal Ilmiah Pertanian*, *18*(1), 48–52. http://dx.doi.org/10.31941/biofarm.v18i1.1891

Rismawati, B. (2018). *Respon Pertumbuhan Setek Buah Naga Merah (Hylocereus costaricensis) terhadap PemberianAir Kelapa dan Bokashi Pupuk Kandang Ayam*.

Robi Setiawan, J. (2021). *Respon Pertumbuhan Dan Hasil Tanaman Labu Madu (Cucurbita Moschata) Akibat Pemberian Berbagai Takaran Pupuk Bokashi Kotoran Ayam*. 021008 Universitas Tridinanti.

Sahetapy, M. M. (2017). Analisis pengaruh beberapa dosis pupuk bokashi kotoran ayam terhadap pertumbuhan dan produksi tiga varietas tomat (Lycopersicum Esculentum Miil.) di Desa Airmadidi. *Agri-Sosioekonomi*, *13*(2A), 71–82. https://doi.org/10.35791/agrsosek.13.2A.2017.16607

Sahoo, B., Nedunchezhiyan, M., Acharyya, P., Munshi, R., Sahu, D., Toppo, M., Tripathy, S., & Sunita, K. (2019). Site-specific Nutrient Management in Elephant Foot Yam-A Review. *Int. J. Curr. Microbiol. App. Sci*, *8*(9), 1591–1596.

Santosa, E., Susila, A. D., Lontoh, A. P., Noguchi, A., Takahata, K., & Sugiyama, N. (2015). NPK fertilizers for elephant foot yam (Amorphophallus paeoniifolius (Dennst.) Nicolson) intercropped with coffee trees. *Jurnal Agronomi Indonesia (Indonesian Journal of Agronomy)*,

43(3), 257–263. https://doi.org/10.24831/jai.v43i3.11253

Saputra, R. H. (2021). *Karakterisasi Morfologi Tanaman Porang (Amorphophallus Muelleri Blume) Pada Tiga Daerah Dengan Zona Iklim Berbeda Di Sulawesi Selatan*. Universitas Hasanuddin.

Sari, R., & Suhartati, S. (2015). Porang Plants: Prospects of Cultivation as One of the Agroforestry Systems. *Ebony Bulletin*, *12*(2), 97–110.

Setiadi, H., Wahyudi, W., & Marlina, G. (2021). Pengaruh Pemberian Pupuk Kotoran Sapi Dan Pupuk Npk Mutiara (16: 16: 16) Terhadap Pertumbuhan Bibit Kakao (Thebroma Cacao L). *Green Swarnadwipa: Jurnal Pengembangan Ilmu Pertanian*, *10*(2), 185–198.

Sudinus, L., & Santoso, I. E. (2021). Respon Tanaman Lobak terhadap Kombinasi Pupuk NPK dan Pupuk Organik Cair Sabut Kelapa pada Tanah Gambut. *Jurnal Sains Mahasiswa Pertanian*, *10*(1). http://dx.doi.org/10.26418/jspe.v10i1.43830

Utomo, J. S., & Ginting, E. (2021). Physico-chemical characteristics of elephant foot yam (Amorphophallus campanulatus) germplasm. *IOP Conference Series: Earth and Environmental Science*, *803*(1), 12044.