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GROWTH AND PRODUCTION OF CORN COMPOSITE (ZEA MAYS L.) UNDER APPLICATION OF BOKASHI KALAKAI FORMULATION AND P FERTILIZER ON INTERNAL PEATLAND

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ABSTRACT
The purpose of this study was to determine the formulation of bokashi kalakai and P fertilizer on the growth and yield of composite maize (*Zea mays* L.) on inland peatlands. The study used a non-factorial randomized block design (RAK) with 5 treatment levels, namely, F1 = No Treatment. , F2= Bokashi Kalakai (15 $\mathrm{t\,ha^{-1}}$), F3 = Bokashi Kalakai (15 $\mathrm{t\,ha^{-1}}$) + P (150 kg $\mathrm{ha^{-1}}$), F4 = Bokashi Kalakai (15 $\mathrm{t\,ha^{-1}}$) + P (300 kg $\mathrm{ha^{-1}}$), F5 = Bokashi Kalakai (15 $\mathrm{t\,ha^{-1}}$) + P (450 kg $\mathrm{ha^{-1}}$). The results showed that the application of bokashi kalakai and P fertilizer on inland peatlands affected the growth and yield of composite maize. Kalakai bokashi treatment 15 ton ha^{-1} + fertilizer P 450 kg ha^{-1} on inland peatland had a significant effect on plant growth of plant height by 201.11 (8 WAP), number of leaves 14.65 strands (8 WAP), leaf area 4295.99 g, total plant dry weight 147.27 g, seed weight/ plant 185.41 g, weight of 100 seeds 30.85 g, weight of cob cobs 259.32 g, weight of cob without hulls 232.67 g, plant growth rate 7.5 (6-8 WAP), leaf area index 2.84 (8 WAP), the yield of harvested plots was 1107.62 g and the yield of dry shelled corn was 3.12 tons ha^{-1}.

KEY WORDS
Composite corn, inland peatlands, bokashi kalakai, P fertilizer.

Corn is the most important food commodity after rice. As the population increases, the demand for corn increases. Apart from being a food ingredient, corn is also widely used as a main source of animal feed (feed) and as an energy raw material (biofuel). The development of the food industry that processes corn into various processed forms, and along with the growth of the Indonesian economy, has caused domestic demand to increase.

National corn production and productivity is still relatively low. One of the factors causing the low national average production is that some farmers are still planting local varieties with low yields.

A strategy to overcome the problem of low corn production, which is recommended by the government to farmers in their farming activities to use corn seeds from improved varieties, both hybrid and non-hybrid varieties. One type of free-pollinated maize is known as a composite variety and is generally referred to as local maize or composite maize. Seed-free varieties of maize can be taken from the previous crop. And can be planted repeatedly so that it does not cause dependence on farmers. Corn has the ability to adapt well to various environments.

Central Kalimantan is one of the provinces that has various typologies of land and diverse agro-ecosystems and has the potential for maize development. Corn planting can be done on several types of soil, one of which is inland peatland.

Inland peatland is often referred to as marginal land and is fragile because it has many limiting factors and needs to be used carefully. Some experts state that peat soil fertility is very low, due to low availability of macro and micro nutrients, low pH (acidic), high cation exchange capacity (CEC) but low base saturation (KB). This situation causes the availability of nutrients for cultivated plants to be relatively low.

Efforts that can be made to increase the productivity of peatlands which at the same time increase plant growth and yield can be done by amelioration. One of the indigenous peatland plants which is directly present in abundance in Central Kalimantan is kalakai (Stenochlaena palustris). Based on the results of observations and research, kalakai has the potential as one of the raw materials for ameliorants (Wahyuningtyas, 2013; Maftu'ah and Nursyamsi. 2015; Elia et al., 2021).

The results of research by Lestari and Noor (2007), amelioration using purun rat compost, fern compost, weed ash, dolomite and natural phosphate in radish (Raphanus sativus) cultivation can increase soil pH, concentration of Ca-dd, Mg-dd, P -available, K-total and Fe. Research results Jakunda's *et al* (2020) giving bokashi kalakai affects the growth and yield of shallots on inland peat soil.

Apart from adding organic matter as an ameliorant, phosphorus (P) fertilizer is also needed. Compound P plays an important role in changes in carbohydrates and related compounds, glycolosis, metabolism of amino acids, fats and sulfur, biological oxidation and reactions with its main function as a chemical energy carrier. In addition, P also functions as a component of protein, ATP, RNA, DNA and fitin absorption enzymes, as an enzyme activator, seed and fruit formation (Hanafiah, 2005; Timperio et al., 2008; Eid et al., 2015; Pisoschi & Pop, 2015; Pandey, 2015; Uarrota et al., 2018).

The purpose of this study was to determine the formulation of bokashi kalakai and P fertilizer on the growth and yield of composite maize (*Zea mays* L.) on inland peatlands.

MATERIALS AND METHODS OF RESEARCH

The research was carried out from October 2020 to January 2021 on inland peatlands, Kalampangan Village, Sebangau District, Palangka Raya, Central Kalimantan Province, with coordinates.

The materials used are composite corn seeds, dolomite, urea fertilizer, TSP fertilizer, KCl fertilizer, bokashi kalakai (kalakai leaves, cow manure, fine bran, urea fertilizer, EM-4, molasses/brown sugar, and water), and chemical pesticides.

The study used a non-factorial Randomized Block Design (RAK) with 5 levels of treatment, namely: F1 = No Treatment, F2 = Bokashi Kalakai 15 $\mathrm{t\,ha^{-1}}$, F3 = Bokashi Kalakai 15 $\mathrm{t\,ha^{-1}}$ + P 150 kg $\mathrm{ha^{-1}}$, F4 = Bokashi Kalakai 15 $\mathrm{t\,ha^{-1}}$ + P 300 kg $\mathrm{ha^{-1}}$ and F5 = Bokashi Kalakai 15 $\mathrm{t\,ha^{-1}}$ + P 450 kg $\mathrm{ha^{-1}}$. Each treatment was repeated 3 times, so that 15 experimental units were obtained, each experimental unit consisted of 5 plants with destructive samples and 3 non-destructive samples. Each experiment measuring 3.5 m x 2.5 m with a spacing of 25 cm x 75 cm. The observed variables included: plant height, number of leaves, leaf area, total dry weight of plants, weight of dry shelled seeds in harvest plots, weight of dry shelled seeds cob, weight of 100 dry shelled seeds, dry weight of cob cobs, dry weight without husks, plant growth rate, leaf area index and corn production.

Data were analyzed using analysis of variance (F test) at levels = 5% and 1%. If there is a real or very real difference, then it is continued with the Honest Real Test (HSD) at the level of = 5%.

RESULTS AND DISCUSSION

The results of variance at the level of = 5% showed that bokashi kalakai and the application of P fertilizer had a significant effect on plant height from 2 to 8 WAP, while the number of leaves affected at 6 and 8 WAP. The average plant height and number of leaves from the HSD test at the 5% level are presented in Table 1.

Based on Table 1, it can be seen that bokashi kalakai with the addition of P fertilizer produced plant heights of 183.44 – 201.11 cm and 13.00 – 14.65 for the number of leaves. This indicates that the application of bokashi kalakai with the application of P fertilizer can increase the height of corn plants and the number of leaves. Increasing the dose of P fertilizer up to 450 kg $\mathrm{ha^{-1}}$ (F5) was able to increase the height of corn plants to an average of 201.11 cm (8 WAP), but was not significantly different from treatments F2, F3, and F4 and the number of leaves was 14.65 strands (8 WAP) only significantly different from F1 (without treatment).

Table 1 – Average plant height and number of leaves given bokashi kalakai mixed with P fertilizer aged 2, 4, 6 and 8 WAP

Treatment	Age (WAP)							
	Plant Height (cm)				Number of Leaves (strand)			
	2	4	6	8	2	4	6	8
F1	22,54 a	43,58 a	69,97 a	81,13 a	3,11	6,11	8,67 a	10,44 a
F2	32,38 b	90,66 b	156,11 b	181,44 b	3,78	8,22	10,56 ab	12,66 ab
F3	31,57 b	91,06 b	162,58 b	183,22 b	4	8,22	11,00 ab	13,00 ab
F4	32,16 b	91,17 b	159,82 b	196,78 b	4,11	8,33	13,33 b	13,89 b
F5	32,50 b	95,11 b	162,84 b	201,11 b	4,11	8,67	14,33 b	14,65 b

Note: Numbers followed by the same letter in the same column are not significantly different according to the 5% HSD test.

The results of variance showed that bokashi kalakai with P fertilizer had a significant effect on leaf area at the age of 6 and 8 WAP, but did not affect the age of 2 and 4 WAP, while the total dry weight of the plant had an effect on the age of 8 WAP. The average leaf area and total dry weight of plants from the HSD test at the 5% level are presented in Table 2.

Table 2 – Average leaf area and total dry weight of plants given bokashi kalakai mixed with P fertilizer at 2, 4, 6 and 8 WAP

Age (WAP)								
Treatment	Leaf Area (cm2)				Total Plant Dry Weight (g)			
F1	2	4	6	8	2	4	6	8
F2	50,97	165,01	265,53 a	2471,05 a	0,28	1,06	3,7	35,55 a
F3	51,01	342,28	1349,45 ab	3400,54ab	0,42	1,54	19,88	61,19 a
F4	65,56	669,91	3558,45 b	4921,99ab	0,54	2,79	45,62	129,05 b
F5	73,89	2060,83	14018,04 c	5183,95b	0,64	4,71	50,38	137,12 b

Note: Numbers followed by the same letter in the same column are not significantly different according to HSD test 5%.

Table 2 shows that bokashi kalakai with the addition of P fertilizer produced leaf area of 4921.99 -5327.09 (cm^2) and 129.05 - 147.27 g of total plant dry weight. This shows that the application of bokashi kalakai with P fertilizer was able to increase leaf area and total dry weight of the plant. Increasing the dose of P fertilizer to 450 kg ha-1 (F5) was able to increase the leaf area of corn plants to an average of 5327.09 cm^2, but not significantly different from treatments F2, F3, and F4, and 147 g total dry weight of plants but not significantly different from F3 and F4, but significantly different from F1 and F2.

The results of variance showed that bokashi kalakai mixed with P fertilizer had a significant effect on the growth rate of plants aged 2-4, 4-6 and 6-8 WAP, as well as the leaf area index observed at 4, 6 and 8 WAP. The average plant growth rate and leaf area index from the HSD test at the 5% level are presented in Table 3.

Table 3 – Average Plant Growth Rate and Leaf Area Index

Treatment	Plant Growth Rate ($g.day^{-1}$)			Leaf Area Index			
	2-4 (WAP)	4-6 (WAP)	6-8 (WAP)	2 (WAP)	4 (WAP)	6 (WAP)	8 (WAP)
F1	0,06 a	0,19 a	2,27 a	0,03	0,09 a	0,14 a	1,32 a
F2	0,08 a	1,31 a	2,95 ab	0,03	0,18 a	0,17 a	1,81 ab
F3	0,16 ab	3,06 ab	5,95 bc	0,03	0,36 a	1,90 b	2,63 bc
F4	0,29 b	3,26 b	6,20 c	0,04	1,10 b	2,14 b	2,76 c
F5	0,47 c	2,45 c	7,55 c	0,05	1,12 b	2,29 b	2,84 c

Note: Numbers followed by the same letter in the same column are not significantly different according to HSD test 5%.

Table 3 can be seen that bokashi kalakai mixed with P fertilizer resulted in a plant growth rate of 5.95-7.55 (g day-1) and a leaf area index of 2.76-2.84. P fertilizer was able to increase plant growth rate and leaf area index. Increasing the dose of P fertilizer to 450 kg ha^{-1} (F5) was able to increase plant growth rate to an average of 7.55 (g day-1), at 6-8 observations. WAP was significantly different from F1 and F2, but not significantly different from F3 and F4 treatments, while the leaf area index yielded 2.84 (8 WAP) significantly different from F1 and F2.

The results of the variance showed that bokashi kalakai with P fertilizer had a significant effect on the weight of shelled seeds per ear, weight of 100 seeds, weight of cob cobs and weight of cobs without cob (Table 4).

Table 4 – Average weight of shelled seeds / cobs, weight of 100 seeds, weight of cobs and cobs without corn husks given bokashi kalakai mixed with P fertilizer

Treatment	Pipilan Seed Weight Per Cob (g)	Weight 100 Seeds (g)	Cob weight cornhusk (g)	Cob weight without knuckle (g)
F1	105,87c	23,05 b	132,93 c	122,88 c
F2	121,74 bc	24,06b	153,91 bc	142,36 bc
F3	126,39 bc	25,27b	161,40 bc	147,84 bc
F4	139,84 b	25,91b	178,41 b	163,19 b
F5	185,41a	30,85a	259,32 a	232,67 a

Note: Numbers followed by the same letter in the same column are not significantly different according to HSD test 5%.

Table 4 can be seen that the provision of bokashi kalakai with P fertilizer was able to increase the dry weight of shelled seeds per cob, dry weight of 100 seeds by weight of cob and cob weight without corn kernels. Increasing the dose of P fertilizer to 450 kg ha^{-1} (F5) was able to increased weight of dry shelled seeds per cob to an average of 185.41 g, weight of 100 seeds (30.85 g), weight of cob cob (259.32 g) without cob (232.67 g) and significantly different from other treatments.

The results of variance showed that bokashi kalakai with P fertilizer had a significant effect on dry weight of seeds per harvest plot of tons ha^{-1} corn production. The average dry weight of seeds per harvest plot and corn production from the HSD test at the level of 5% is presented in Table 5.

Table 5 – Average Seed Weight Per Plot Harvest and Corn Production

Bokashi Kalakai Treatment + P Fertilizer	Pipilan Seed Weight Per Harvest Plot (g)	Corn Production (t ha^{-1})
F1 (No Treatment)	382,40a	1,02a
F2 (Bokashi Kalakai15 t ha^{-1}+ without P. fertilizer)	398,99a	1,06a
F3 (Bokashi Kalakai 15 t ha^{-1}+ P 150 kg ha^{-1})	806,14ab	2,14ab
F4 (Bokashi Kalakai 15 t ha^{-1}+ P 300 kg ha^{-1})	871,5 ab	2,35ab
F5 (Bokashi Kalakai 15 t ha^{-1}+ P 450 kg ha^{-1})	1107,62b	3,12b

Note: Numbers followed by the same letter in the same column are not significantly different according to HSD test 5%.

Table 6 – Bokashi Kalakai Nutrient Content and Peat Soil Analysis

No.	Parameter	Analysis Early Land	Bokashi Kalakai	Final Soil Analysis				
				F1	F2	F3	F4	F5
1	N-Total (%)	0,31	2,69	0,37	0,53	0,45	0,36	0,66
2	C-org (%)	32,53	24,83	27,67	25,74	27,0	26,93	29,40
3	P2O5 (mg/100 g)	28,93	2,19%					
4	P2O5-tsd (ppm)	540,13	-	21,44	67,79	140,72	114,27	147,50
5	K2O (mg/100 g)	55,21	1,04%					
6	pH (H2O)	3,87	5,31	3,56	4,45	4,42	4,49	4,78
7	Ca-dd (me/100g)	3.30	17,96%					
8	Mg-dd (me/100 g)	0,22	0,10%					
9	Na-dd (me/100 g)	0,05						
10	k-dd (me/100 g)	0,17						
11	KTK (me/100g)	71,25						
12	KB (%)	5,25						

Bokashi kalakai with P fertilizer resulted in dry weight of seeds per harvest plot between 806.14 – 1107.62 g and 3.12 tons ha^{-1} maize production. Increasing the dose of P fertilizer to 450 kg ha^{-1} (F5) was able to increase the dry weight of seeds per harvest plot up to an average of 1107.62 g and significantly different from F1 and F2 treatments, but not significantly different from F3 and F4 treatments. Also on maize production F5 treatment (Bokashi Kalakai 15 tons ha^{-1}+P 450 kg ha^{-1}) gave the highest yield of 3.12 tons.ha^{-1}, but not significantly different from F3 and F4 treatments.

DISCUSSION OF RESULTS

The effect of giving bokashi kalakai mixed with P fertilizer on the growth of maize with an increase in the dose of P fertilizer to 450 kg ha^{-1} P (F5) was able to increase the growth of corn plants best as indicated by an increase in plant height, number of leaves, leaf area, and dry weight. The largest total plant compared to other treatments (Tables 1, and 2). It is suspected that the provision of bokashi kalakai 15 t ha^{-1} + P 450 kg ha^{-1} is able to meet the needs of plants in increasing plant growth, plus the nutrient content of P and the results of the analysis of peat soil in the research used as a medium for plant growth, namely N 0.31-0.66%, and P potential of 147.50 m/g .mg/100 g (Table 6). From the results of the analysis, it can be seen that the nutrients available through the provision of bokashi kalakai mixed with P have fulfilled the nutrient requirements for the growth of corn plants.

An increase in the dose of P fertilizer causes an increase in the concentration of available P in the soil so that it becomes easier for plants to absorb P from the peat soil to support their growth (Table 6). In inland peat soil the availability of P nutrients is very low. Radjagukguk (2000); Medina et al (2010); Andersen et al (2013); Macrae et al (2013); Maynard et al (2014); Geurts et al (2020); Choo et al (2020), suggests that natural peat soil have low availability of N, P, and K nutrients. This is the main reason why the need for inorganic P fertilizers such as phosphorus (TSP fertilizer) is applied to peat soils. Syahrudin, at al., (2009); Sojka et al., (2007); Revell, (2011); Devkota et al., (2013); Kuppusamy et al., (2016); Okaron, 2017; Adisa et al., (2019); Eslamian, (2020), added the application of P fertilizer to 450 kg ha^{-1} there was an increase in plant growth and yield, it is suspected that the addition of a dose of phosphorus can increase the availability of inorganic phosphorus that is soluble and ready to be absorbed by plants on peat soil.

Uchida, (2000); Rosmarkam and Yuwono (2002); Khan et al., (2010); da Silva et al (2011); O’Hara et al., (2013); Kathpalia & Bhatla, (2018) stated that phosphorus (P) plays a role in the formation of certain proteins, plays a role in photosynthesis and respiration so it is very important for overall plant growth. Gardner *et al* (1991); Yuan & Liu, (2008); Tairo & Ndakidemi, (2013); Pandey, (2018); Karthika et al., (2018), added that phosphorus plays an important role as a constituent of ATP compounds which are needed as a source of high-energy compounds for all plant biochemical activities, including cell elongation for growth.

Analysis of plant growth is one approach to the analysis of factors that affect crop yields and analysis of plant development as a net accumulation of photosynthetic results in an integrated manner with time.

Giving bokashi kalakai mixed with P fertilizer affects plant growth rate and leaf area index (Table 3).

Increasing the dose of P fertilizer to 450 kg ha^{-1}(F5) plant growth rate and leaf area index also increased by 7.55 g.day^{-1} (6-8 WAP) and 2.84 (8 WAP) for the area index. leaf. It is known that plant growth speed and leaf area index are determined by many factors, including nutrients and light.

The diversity of growth speed and leaf area index is caused by varying soil fertility due to different treatments of bokashi kalakai and P fertilizer, resulting in different nutrient content obtained by plants for growth. The results of Wang et al., (2013); Darko et al., (2014); Maulana's (2018); Tränkner et al., (2018); Kour et al., (2020), nutrients in sufficient quantities cause metabolic activities of plants including the photosynthesis process to increase. Photosynthesis that takes place well, the plant can grow normally and is followed by an increase in dry weight.

In general, the increase in yield and yield of maize seeds was equivalent to the addition of P fertilizer which was applied up to 450 kg ha^{-1} compared to without P fertilizer. This was in line with the yield and yield component variables which had a positive correlation (Table 7). According to Sitompul and Guritno (1995); Fukai & Trenbath, (1993); Angelini et al., (2005); Luque et al., (2006) crop yields are largely determined by the production of biomass during the growth period (the distribution of biomass in the harvested portion).

At the time of growth and biomass production, giving bokashi kalakai 15 t ha^{-1}+ P 450 kg ha^{-1} was able to increase the ability of plant leaves to produce more photosynthetic products and this could be allocated to production organs (cobs) to develop more better with higher yields. According to Goldsworthy and Fisher (1996); Hodges, (2010); Lawlor et al., (2001); Ainsworth et al., (2007); Rouphael et al., (2012); Chen et al., (2019), nitrogen and phosphorus must be available in sufficient quantities to allow rapid weight gain and leaf development during the developmental period. Especially for phosphorus, its availability in the soil is closely related to the yield components and plant yields achieved. According to Indranada (1994) that phosphorus encourages flower formation and increases yield. Lack of phosphorus causes flower and fruit formation to be inhibited and production will decline. Rosmarkam and Yuwono (2002); Milla et al., (2005); Malhotra et al., (2018), added that phosphorus is needed for the formation of flowers and reproductive organs, therefore phosphorus is found in relatively higher amounts in fruit and plant seeds. According to Marschner (1986 in Rosmarkam and Yuwono, 2002); Šimková et al., (2013) phosphorus is also closely related to the formation of starch, especially in grains as in corn.

Table 7 – Test the correlation between variables

Variable	Heavy 100 seeds	seed weight / Harvest plot	Seed/cob weight	Weight without klobot	Weight	Corn production
Weight 100 seeds	1					
Seed weight/harvest plot	0,647**	1				
Seed/cob weight	0,652**	0,686**	1			
Weight without klobot	0,787**	0,600**	0,937**	1		
weight	0,799**	0,614**	0,936**	0,999**	1	
Corn production	0,657**	0,989**	0,786**	0,772**	0,770**	1

Based on Table 5, it shows that bokashi kalakai fertilizer was 15 tons ha^{-1} and the application of P (F5) fertilizer in general gave the highest yield of 3.12 tons ha^{-1}. In this case, bokashi kalakai fertilizer was able to increase the efficiency of photosynthate translocation into the seeds so that the yield of seeds obtained was much higher than the yield of corn plants without bokashi fertilizer. This result is supported by the research of Kadarwati and Riajaya (2009); Dou et al., (2012); Yuliana et al., (2015); Lasmini et al., (2018); Amalia et al., (2020) giving bokashi giving higher maize yields than the use of manure or without the use of bokashi fertilizer. Added by Jakunda, A et al (2020); Kharisma et al., (2021) giving bokashi kalakai 15 tons ha^{-1} was able to produce dry onion bulb weight of 61.30 g $clumps^{-1}$.

CONCLUSION

The application of bokashi kalakai and P fertilizer on inland peatlands affected the growth and yield of composite maize. The treatment of bokashi kalakai with a dose of 15 tons ha^{-1} + fertilizer P 450 kg ha-1 gave the highest corn yield in the form of dry shells of 3.12 tons ha^{-1}.

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