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RESEARCH ARTICLE

EARLY SEEDLING GROWTH AND DEVELOPMENT RESPONSE OF ZEA MAYS L. TO EXTRACT FROM PALM BUNCH ASH (PBAE) OF ELAEIS GUINEENSIS JACQ

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ABSTRACT

A liquid extract (PBAE) commonly used for domestic purposes in most part of Southern Nigeria was produced from palm bunch ash of Elaeis guineensis Jacq. The effect of this extract on early seedling growth and development of Zea mays L. was evaluated in the laboratory using the concentration levels of 25, 50, 75, and 100% , alongside a control (0%- distilled water).The palm bunch ash extract revealed the presence of potassium, calcium, magnesium, sodium, copper, iron, zinc, and total nitrogen in a decreasing order as mineral elements. Germination studies indicated that the germination percentage was significantly ($P < 0.05$) reduced with increase in concentration of the palm bunch ash extract, except at low level (25%) where there was an increase above the control. Growth parameters such as shoot length, root length, fresh weight, dry weight and moisture content were significantly ($P < 0.05$) reduced with increase in concentration of the extract, except at (25 and 50%) for shoot length and root length, and 25% for fresh weight and dry weight where there were slight increases above the control. The chlorophyll contents were significantly ($P < 0.05$) reduced with increase in concentration of the extract, except at low levels (25 and 50%) where there were increases above the control. This study suggests that palm bunch ash extract at lower concentration could be utilized as organic fertilizer, however at higher concentration may inhibit germination and early seedling growth of Zea mays L.

INTRODUCTION

Organic materials contain nutrients needed for crop growth and also to improve soil conditions, increase water holding capacity, reduce water erosion, improve aeration and promote soil biological activity (Etukudo *et al*., 2011). Application of organic waste materials to soils must, however take into account crop needs, pH interaction with the soil medium and the potential for environmental contamination. In recent times, environmental concern has been geared towards the use of organic fertilizer for crop improvement without disrupting the balance of the soil medium and generating environmental problem. Improper use of nitrogen fertilizers such as urea in agriculture has been reported to create a global environmental issue such as ammonia volatilization upon surface application (Frency *et al*., 2001). Most organic materials also contain much more potassium than magnesium or calcium such that long term application of this material to soils may raise the ratio of potassium to magnesium and calcium sufficiently to retard crop growth (Doran *et al*., 1994).

Oil palm (*Elaeis guineensis* Jacq) is a major source of edible oil which is extracted from its fruits (Lua and Gua, 1998). In most part of Southern Nigeria, large quantities of oil palm bunch (solid wastes) accumulate from numerous palm oil producing localities. Oil palm empty fruit bunch is one of the by- products left in the palm oil mill. Oil palm empty fruit bunch is a lignocellulosic source which is available as a substrate in cellulose production (Rajoka and Malik, 1997). The empty fruit bunch can also be used as organic fertilizer. The ash produced from empty fruit bunches is sprayed on crops to prevent insects from destroying the crops, as well as useful in washing plates and pots (Udoetok, 2012). The filtrate (palm bunch ash extract- pbae) obtained from the filtration of the mixture of palm bunch ash and water has a brown colour and can emulsify oil. It is slippery to touch, giving an impression that it is alkali (Udoetok, 2012).

Zea mays L. belongs to the family Poaceae. It is an important annual crop utilized world wide for both industrial and food purposes (Udoh *et al*., 2005). This crop is utilized as a stable food and constitute a major component to many confectionery dishes, as well as a basal medium and raw material for industries in many region of the world (Udoh *et al*., 2005).

Palm bunch ash from which palm bunch ash extract (pbae) is produced, is one of the cheapest more available and sustainable sources of plant nutrient. It is a by product of oil palm growing wild and under cultivation in almost every locality in Nigeria (Offor *et al*., 2010). It is usually generated as solid waste, and despite the magnitude of this wastes generated daily with the possible effects on the environment, no serious attempts have been made either for their effective utilization or disposal (Akinmutimi *et al*., 2013). This research becomes greatly significant in view of the fact that most soils in Southern Nigeria are deficient in nutrients as well as acidic due to the nature of parent material, heavy leaching and weathering (Owolabi *et al*., 2003). It is therefore on this basis that this study was conducted to evaluate the potentials of palm bunch

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ash extract (PBAE) on the growth and chlorophyll contents of *Zea mays* L.

MATERIALS AND METHODS

Preparation of Palm Bunch Ash*:* Palm bunch refuse obtained from local oil palm mills sites in Ukanafun, Akwa Ibom State, Nigeria, were sundried for one week before they were ashed in the oven at 100^0C. 100g of palm bunch ash was extracted with 250ml of distilled water, with continuous heating and stirring (30 mins) on a mechanical shaker. The resulting slurry was centrifuged (1000 r/min, 15 mins) filtered under vacuum (using Bunsen burner) and freeze dried to obtain aqueous extract. The palm bunch ash extract was adjusted to the concentration of 25, 50, 75, and 100% while 0% (distilled water) served as a control.

Germination Studies*:* Seeds of *Zea mays* obtained from Akwa Ibom Agricultural Development Programme (AKADEP), Uyo, Akwa Ibom State, Nigeria , were surface sterilized with 0.01% ethanol for 30 seconds, thoroughly washed several times with sterile distilled water and air dried. Ten (10) seeds of the crops were sown in sterilized petri dishes each containing two sterile What-Man's filter paper based on the treatment. The experimental set up was maintained for 20 days under light condition at 28 ± 1^0C for germination studies. Percentage germination and coefficient of velocity of germination counts were recorded at 24, 48, 72, and 96 hours after sowing all the seeds.

Growth studies*:* Growth parameters such as shoot length, root length, fresh weight, dry weight, moisture content, and chlorophyll content of the seedlings were measured as follows:

Determination of Germination Percentage and Coefficient of Velocity of Germination: Percentage germination and coefficient of velocity of germination counts were recorded at 24, 48, 72 and 96 hours after sowing all the seeds (Esenowo, 2001).

$$\text{Germination Percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times \frac{100}{1}$$

$$\text{Coefficient of Velocity of Germination} = \frac{\text{Total number of seedlings}}{A_1T_I + A_2T_2 \text{-----} A_XT_X}$$

Where A = the number of seedling emerging on a particular number of days- (T)

Determination of Shoot Length and Root Length*:* The shoot length and root length of the seedlings were measured with a meter rule and expressed in centimeters.

Determination of Fresh Weight, Dry Weight, and Moisture Content*:* Seedlings were harvested and repeatedly washed with sterile-distilled water using a sieve to avoid loss of plant parts. Before measuring the fresh weight, blotting papers were used to dry the seedlings and the fresh weight measured using mettler-p-165 weighing balance. The fresh seedlings were dried in a Gallen Kamp oven maintained at 65^oc for 2 days to a constant weight in order to determine the dry weight. The difference between the fresh weight and dry weight of the plantlets multiplied by 100 over the fresh weight was taken as the percentage moisture content of the seedlings (Pajevic *et al*., 2004).

Determination of Chlorophyll Content*:* Chlorophyll content in the leaves was determined by using the method of Lichtenthaler and Buschmann (2001). Leaf tissue weighing 2g was crushed in a mortar and 80% acetone was added to it, in sufficient quantities to allow the tissue to be thoroughly homogenized. The supernant was decanted through a filter paper into a 100ml volumetric flask. Acetone was again added to the residue in the mortar and the extraction procedure repeated. Additional acetone was used to wash off the chlorophyll until the 100ml mark was attained in the volumetric flask. The resulting solution was thoroughly mixed and 5ml pipette into a 50ml flask and made to volume with 80% acetone. The absorbance of the extract was measured at 645, 663, and 652nm wavelengths using model 690 spectrophotometer for chlorophyll a, b, and ab respectively, using 80% acetone as blank. Concentrations of chlorophyll (mg/g fresh leaf weight) were calculated.

Analysis of Palm Bunch Extract*:* The pH, and mineral element (calcium, magnesium, potassium, sodium, zinc, copper and iron) contents of palm bunch ash extract were examined using atomic absorption spectrophotometer (A. O. A. C., 1990).

Statistical Analysis

The data generated from the study were subjected to analysis of variance (ANOVA) where the differences in the means were tested using Least Significant Difference (LSD), according to the method of Obi (2002).

RESULT

The analysis of the palm bunch ash extract showed that it was basic with a pH of 9.30. Potassium had the highest content of mineral element with a value of 20.04mg/l. Other contents of mineral elements in the extract examined range from 12.34, 10.02, 9.07, 0.54, 0.47 to 0.27mg/l for calcium, magnesium, sodium, copper, iron and zinc, respectively. The total nitrogen content of the extract was 0.06% (Table 1).

Table 1 pH and Mineral Element Content of Palm Bunch Ash Extract (PBAE)

Parameters	Content
pH	9.3
Calcium	12.34 mg/l
Magnesium	10.02 mg/l
Potassium	20.04 mg/l
Sodium	9.07 mg/l
Zinc	0.27 mg/l
Copper	0.54 mg/l
Iron	0.47 mg/l
Total nitrogen	0.06%

There were significant ($P<0.05$) differences in germination percentages of *Zea mays* grown in media with palm bunch ash extract. 25% level of palm bunch ash extract had the highest percentage germination of 93.25% above that of the control-0% with 90.43%. In addition, the percentage germination decreased from 84.18, 66.73 to 57.21% at 50, 75 and 100% level of palm bunch ash extract, respectively. The coefficient of velocity of germination ranges from 0.22, 0.22, 0.23, 0.18, to 0.18 at 0, 25, 50, 75 and 100% level of palm bunch ash extract, respectively (Table 2).

Table 3 shows the growth parameters of *Zea mays* as affected by palm bunch ash extract. There were significant ($P<0.05$) differences in shoot length, root length, fresh weight and dry weight of the crop grown under palm bunch ash extract. The shoot length of the crop increased from 17.40cm at the control

(0%) to 17.70cm at 50% level of palm bunch ash extract. The values of shoot length recorded at 25% (17.60cm) level of palm bunch ash extract was higher than that of the control (0%), while those recorded at 75% (14.30cm) and 100% (9.30cm) levels of palm bunch ash extract were lower than that of the control (0%). The root length of the crop was higher at 25% (7.50cm) and 50% (7.60cm) levels of palm bunch ash extract than the control- 0% (7.20cm). Lower values of root length were recorded at 75% (5.50cm) and 100% (3.80cm) levels of palm bunch ash extract relative to the control (0%). The fresh weight of the crop was slightly stimulated at 25% (2.62g) level of palm bunch ash extract above the control- 0% (2.44g). Lower values of 2.41, 1.47 and 1.26g for fresh weight of the crop were recorded at 50, 75 and 100% levels of palm bunch ash extract, respectively. The dry weight of the crop was higher at 25% (0.58g) level of palm bunch ash extract than that of the control- 0% (0.56g). The values of dry weight recorded at 75% (0.36g) and 100% (0.31g) levels of palm bunch ash extract were lower than that of the control-0% (0.54g). The moisture content of 77.86, 77.59, 75.51 and 75.40% were recorded at 25, 50, 75 and 100% levels of palm bunch ash extract, respectively relative to the control-0% with a value of 77.87% (Table 3).

Table 2 Effect of Palm Bunch Ash Extract (PBAE) on the Germination Percentage and Coefficient of Velocity of Germination of *Zea mays*

Concentration of PBAE (%)	0	25	50	75	100	Mean	LSD
Germination Percentage (%)	90.43 ± 0.27	93.25 ± 0.77	84.18 ± 0.16	66.93 ± 0.42	57.21 ± 0.35	78.40	2.62
Coefficient of Velocity Of Germination	0.22	0.22	0.23	0.18	0.18	0.20	0.2

Mean value ± Standard error of 5 replicates

Table 3 Effect of Palm Bunch Ash Extract (PBAE) on the Growth Parameters of *Zea mays*

Concentration of PBAE (%)	0	25	50	75	100	Mean	LSD
Shoot Length (cm)	17.40 ± 0.32	17.60 ± 0.36	17.70 ± 0.41	14.30 ± 0.56	9.30 ± 0.24	15.26	1.27
Root Length (cm)	7.20 ± 0. 47	7.50 ± 0.23	7.60 ± 0.67	5.50 ± 0.46	3.80 ± 0.18	6.32	1.19
Fresh Weight (g)	2.44 ± 0.10	2.62 ± 0.14	2.41 ± 0.21	1.47 ± 0.32	1.26 ± 0.20	1.96	1.07
Dry Weight (g)	0.54 ± 0.04	0.58 ± 0.07	0.54 ± 0.08	0.36 ± 0.03	0.31 ± 0.04	0.49	0.1
Moisture Content (%)	77.87 ± 0.46	77.86 ± 0.58	77.59 ± 0.32	75.51 ± 0.54	75.40 ± 0. 46	76.28	2. 64

Mean value ± Standard error of 5 replicates

The chlorophyll content of the crop was higher at 25% (1.400 mg/g) and 50% (1.722 mg/g) than that of the control- 0% (0.820 mg/g). The values of 0.644 and 0.323 mg/g for chlorophyll-a were recorded at 75 and 100% levels of palm bunch ash extract, respectively. The chlorophyll-b contents of the crop were 1.093, 1.650, 0.530 and 0.230 mg/g at 25, 50, 75 and 100% of palm bunch ash extract, respectively relative to the control (0%) with the value of 0.765 mg/g. The contents of chlorophyll-ab of the crop at 25, 50, 75 and 100% of palm bunch ash extract were 2.491, 3.370, 1.172 and 0.550 mg/g relative to the control (0%) with the value of 1.582 mg/g (Table 4).

Table 4 Effect of Palm Bunch Ash Extract (PBAE) on the Chlorophyll Contents of *Zea mays*

Concentration of PBAE (%)	0	25	50	75	100	Mean	LSD
Chlorophyll a (Mg/g)	0.820 ± 0.01	1.400 ± 0.03	1.722 ± 0.02	0.644 ± 0.05	0.323 ± 0.03	0.982	0.2
Chlorophyll b (Mg/g)	0.765 ± 0.02	1.093 ± 0.21	1.650 ± 0.32	0.530 ± 0.03	0.230 ± 0.04	0.854	0.1
Chlorophyll ab (Mg/g)	1.582 ± 0.02	2.491 ± 0.17	3.370 ± 0.53	1.172 ± 0.37	0.550 ± 0.06	1.833	2.1

Mean value ± Standard error of 5 replicates

DISCUSSION

The promotory effects of palm bunch ash extract on germination percentage at lower concentration (25%) may be due to low osmotic pressure at lower concentration against the high osmotic pressure at higher concentration of the extract, which resulted in reduced germination percentage. This result collaborates the work of Ohwugbuta-Enyi and Offor (2010) that high osmotic pressure of palm bunch ash treated medium resulted in difficulty in imbibitions, thus, leading to low germination percentage and retardation of growth.

The high levels of mineral elements assayed in the palm bunch ash extract from this study imply that this extract has a high potential to enrich plant growth medium with nutrients, and therefore, can support plant growth and development. The slight variations in values of mineral elements composition obtained from this work and that of other studies may be attributed to the fact that palm bunch ash extract was used in this study rather than the ash itself. Again, variations may result depending on the methods of treatment of oil palm empty fruit bunch, such that elements such as Al, P, Cl, Fe, and Cu could be removed during washing, while Na, S and K decreased with the reduction of the ash content of the feedstock (Abdullah *et al*., 2011).

The growth parameters (shoot length, root length, fresh weight, dry weight and moisture content) of the crop tended to have declined at higher levels of the extract, however, the optimum level of palm bunch ash extract suitable for higher growth

This result agrees with the work of Owolabi *et al*. (2003) that increased levels of palm bunch ash above 4 tons/ha resulted in a reduction in the weight of saleable potato tubers, and this could be due to nutrient imbalance and negative interaction in plants as a result of excess supply of some nutrients such as potassium. Reduction in nutrient contents due to high pH in the growth media treated with palm bunch ash extract may also be the possible reason for growth reductions of *Zea mays* at higher levels of the extract. This agrees with the work of Brady and Weil (1999) that high pH values are not favourable for uptake of some essential nutrients such as Zn, B, Fe, Mn and

Although, high pH may be detrimental to nutrients availability, the rich calcium content of the palm bunch ash extract may easily interact with carbonates, thus may be utilized as liming material to reduce soil acidity as reported by, Awodun (2007), Manahan, (1997) and Udoetuk (2012).

Increase in plant growth parameters (shoot length, root length, fresh weight, dry weight and moisture content) were recorded at lower levels of palm bunch ash extract as shown in this study. Similar results were reported by Ezekiel *et al*. (2009) that oil palm bunch ash increased the fresh root yield of cassava in Umudike, Nigeria. Similarly, low levels of palm bunch ash were reported to increase fresh weight, grain number and whole length of maize than those with higher level of palm bunch ash relative to the control (Offor *et al.,* 2010). In addition, increase in soil nutrient in soils treated with palm bunch ash has been attributed to enhanced microbial activities in soils, production of organic matter and attendant increased availability of Nitrogen, Phosphorus, Potassium, Potassium, Calcium and Magnesium (Awodun *et al*., 2007).

Higher chlorophyll contents (chlorophyll a, b and ab) at lower concentration may be attributed to high nutrient uptake, synthesis and translocation probably facilitated by optimum availability of Iron and Magnesium in the medium treated with palm bunch ash extract as reported by Ohwugbuta-Enyi and Offor (2010). However, at higher concentrations the chlorophyll content may have been suppressed due to pH interaction with nutrient balance and uptake, thus leading to poor synthesis of chlorophyll.

CONCLUSION

Palm bunch ash extract could be utilized as effective source of available nutrients and liming material to increase soil fertility, and pH in acidic soil. Therefore, the extract can increase plant growth parameters of *Zea mays* if utilized at optimum level suitable for high growth performance.

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