GROWTH RESPONSE AND YIELD OF *Celosia argentea* Linn. TO DIFFERENT LEVELS OF MAIZE RESIDUES AS SOIL AMENDMENTS IN A POT CULTURE

BY

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A THESIS SUBMITTED TO THE INSTITUTE OF ECOLOGY AND ENVIRONMENTAL STUDIES, OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIAIN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS OF SCIENCE IN ENVIRONMENTAL CONTROL AND MANAGEMENT

2015

CERTIFICATION

This is to certify that this research work was carried out by ADEKANMBI Adebisi Esther (Registration Number SCP12/13/H/0068)of the Institute of Ecology and Environmental Studies, Faculty of Science, in partial fulfillment of the requirements for the award of Master of Science (M.Sc.) in Environmental Control and Management, Obafemi Awolowo University, Ile-Ife, Nigeria.

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DEDICATION

To God be the glory!

ACKNOWLEDGEMENTS

I am grateful to the Almighty God for being my help in ages past and my hope for years to come. Thank you Jesus for being my Saviour. Thank you Holy Spirit for being there always. I sincerely appreciate my esteemed supervisor, Dr. M. B. Adewole for making this work come out well. God bless you, sir.I genuinely appreciate the Director, Institute of Ecology and Environmental Studies, Prof. O. O. Awotoye, and all members of staff of the Institute for making the Institute a pleasant place for all.

I am grateful to my ever-supportive parents, Prince and Olori A. A. Adekanmbi, for their immense contribution to my life and even this programme. God will continue to bless you and God be gracious unto you. I sincerely appreciate my siblings and cousins for their support in every way. God bless you all and take you places beyond your imagination.To my friends, I say thanks for making me better. To my mentors and role models, thanks for influencing my life, my life now has a meaning. To Junior Chamber International Nigeria,Obafemi Awolowo University (OAU), Ile-Ife, thanks for the love.

I appreciate the pastors and members of Abundant Life Chapel for the love. I pray God will show you love. Indeed, we are the righteous of the Lord, we flourish like a palm tree, and we grow like a cedar in Lebanon. I also appreciate the Postgraduate Christian Fellowship, OAU, Ile-Ife.

I am also grateful to the Space Applications and Environmental Science Laboratory (SPAEL), OAU,as well as the Presidential Afforestation Project, SPAEL, headed by Prof. A. T. Salami, for granting me the 2015 SPAEL Postgraduate Fellowship Award as a support for my M.Sc. programme.

To the one, Felix Ebosa, thanks for the love and support, God bless and increase you.

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ABSTRACT

This study determined the effects of raw maize cobs and maize stovers as organic materials on the growth performance of *Celosia argentea* and assessed the effects of these materials on the soil physical and chemical properties. The study also compared the efficiencies of maize cob and maize stover organic materials on the growth and yield of *C. argentea*. This was with a view to assessing the effect of these maize residues on the productivity and quality of *C. argentea*.

The experiment was conducted in the screenhouse of the Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife. There were five treatments (100% maize cob, 100% maize stover, 25% maize cob + 75% maize stover, 50% maize cob + 50% maize stover, and 75% maize cob + 25% maize stover) and five different fertility management levels (0, 3, 6, 9 and 12 t ha^{-1}) of the maize residues. The set-up was replicated three times to give a total of 75 pots, arranged in a completely randomised design; each pot contained three kilogrammes of exhaustively cropped and sieved top soil. The maize residues were applied and allowed to undergo incubation for a period of four weeks. Seeds of *C. argentea* obtained from National Horticultural Research Institute, Jericho, Ibadan were sown and thinned to three stands per pot at two weeks after sowing (WAS). The *C. argentea* plants were watered every two days till harvesting. The number of leaves, plant height, stem girth and leaf area were also measured weekly, till eight weeks after sowing when the vegetable stands were harvested. Fresh weight of the harvested vegetable per pot was determined using a top-loading weighing scale. A repeat experiment was carried out to determine the residual effects of the applied treatments. The pre- and post-cropping analyses of the soils were carried out to determine their physico-chemical properties using standard methods. The harvested *C. argentea* plants were oven-dried at 70°C to constant weights to

determine their proximate and nutrient compositions using standard methods. Results were analysed using GraphPad Prism 5.0 statistical software.

At 3 WAS, mean plant height ranged from 2.47 ± 0.84 cm to 5.73 ± 1.16 cm; mean stem girth from 0.33 ± 0.03 cm to 0.83 ± 0.10 cm; mean number of leaves from 2 ± 0 to 7 ± 1; and mean leaf area from 0.31 ± 0.11 cm^2 to 4.05 ± 1.74 cm^2 in the first sowing. This trend increased with the age of the plants. The highest mean yield of 27.81 gobtained with 6 t ha^{-1} of 25% maize coband 75% maize stover was not significantly ($F_{16, 74} = 15.78$; $p < 0.05$) different from 25.61 g obtained with 3 t ha^{-1} of 100% maize stover. All the soil properties such as organic carbon, total nitrogen, available P, potassium, exchangeable acidity, exchangeable bases, and soil micronutrients were enhanced by the various soil amendments. Proximate analysis showed that there were no significant differences in values obtained for crude fibre and carbohydrate when the treatments were compared. In the repeat experiment, the mean yield of *C. argentea* at 3 t ha^{-1} was significantly ($F_{16, 74} = 147.20$; $p < 0.05$) higher than all other levels of application. Also, maize stover was more efficient as soil amendment than maize cob.

The study concluded that the use of 100% maize stover at 3 t ha^{-1} as soil amendment had superior and positive influence on the soil physico-chemical properties and productivity of *C. argentea* than using either maize cob or maize cob and maize stover in equal proportion.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Celosia argentea L. is a leaf vegetable crop of the family Amaranthaceae. It is a versatile herbaceous plant characterized by its fast growth, its leaves and flowers are edible and are grown for such use in Africa and Southeast Asia (Grubben and Denton, 2004). *Celosia argentea* L. is also known as Lagos spinach (Badra, 1991). It is an important vegetable of Southwestern Nigeria, which is well known for its succulent leaves rich in protein, vitamins and minerals (Akanbi *et al*., 2007), popularly called "sokoyokoto" by the Yorubas of Southwest Nigeria(Schippers, 2000). The vegetable is accredited with possession of high nutritional values of essential nutrients like calcium, phosphorous, iron and other important components such as vitamins C, fiber, carbohydrate, fat and a high calorific value (Badra 1991). It is well distributed and consumed in Nigeria where it is regarded as a vegetable of national importance (NIHORT, 1986). Its leaves and young shoots are used in soup and stews; such leaves can be slightly mucilaginous. Moreso, *Celosia* leaves can be dried and preserved against the dry season in India (Aruna, 2009).

Celosia has a very high nutritive value, and both the grain and the leaf are widely used and processed into many food items, supplements and additives (NIHORT, 1986). In Nigeria, the resource-poor farmers intercrop *Celosia* with arable starchy staples to produce enough food to satisfy their dietary and cash requirements (Akinyemi and Tijani-Eniola, 1997), and to minimize the risk of crop failure. Its uses are beyond dietary and extend to medicinal purposes and treatment of ailments such as abscesses, cough, diabetes, diarrhea, dysentery, eczema, eye problems, gonorrhea, infected sores, liver ailments, menstruation problems, muscle troubles, skin eruptions, snakebites and wounds (Schippers, 2000).

The average yield (7.6 tha^{-1}) of this crop has been limited by obsolete cultural practices employed in its production, such as non-use of manure/fertilizer input among others (FAO, 2004). For commercial production, optimum performance of the crop must be obtained through changes in cultural practices (Sterrett and Savange, 1989) including the use of organic manure in soil to increase plant growth and crop yield.

Soil infertility is the result of a physical or chemical problem in the soil that inhibits the growth of plants. Soil depletion occurs when the components which contribute to fertility are removed and not replaced, and the conditions which support soil fertility are not maintained. This leads to poor crop yields. In agriculture, depletion can be due to excessively intense cultivation and inadequate soil management. Soil infertility could refer to the inability of a soil to supply plant nutrients. Soil nutrient depletion is an important concern directly linked to food insecurity in developing and least developed countries due to the intensification of land use for agricultural production without proper application of external inputs (Henao and Baanante, 1999a). The continued lack of required nutrient replenishment of nutrient depleted soils as well as nutrient losses through wind and water erosion are not only exacerbating soil degradation, but also jeopardizing agricultural sustainability in these regions (Ayoub, 1999; Sheldrick *et al*., 2002).

One of the major problems of agricultural soils in the tropical region of the Pacific is the low organic matter content. Organic manure is being applied on agricultural fields as an amendment to provide nutrients and also to enhance the organic matter content and improve the physical and chemical properties of the cultivated soils. Composted organic manure contains essential nutrients for plant growth, especially N and P (Beltran *et al*., 2002). Land application of composted manure as a fertilizer source not only provides essential nutrients to plants, it also improves soil quality and effectively disposes off wastes.

Organic farming relies heavily on the natural breakdown of organic matter, using techniques like green manure and composting, to replace nutrients taken from the soil by previous crops. This biological process, driven by microorganisms such as mycorrhiza, allows the natural production of nutrients in the soil throughout the growing season, and has been referred to as feeding the soil to feed the plant. Organic farming uses a variety of methods to improve soil fertility, including crop rotation, cover cropping, reduced tillage, and application of compost. By reducing tillage, soil is not inverted and exposed to air; less carbon is lost to the atmosphere resulting in more soil organic carbon. This has an added benefit of carbon sequestration which can reduce greenhouse gases and aid in reversing climate change (Wikipedia, 2014).

Agricultural waste, which includes maize residue, cassava shoot, banana peels and banana shoot, is a general term used to describe waste produced on a farm through various farming activities. It has variously been estimated that these wastes can account for over 30% of worldwide agricultural productivity (Ashworth and Azevedo, 2009). These wastes are widely available, renewable and virtually free (Sabiiti *et al*., 2005). They can be converted into heat, steam, charcoal, methanol, ethanol, bio diesel as well as raw materials (animal feed, composting, energy and biogas construction and so on). These wastes are known to contain high nutrient levels of Nitrogen, Potassium, Phosphorus that would improve soil fertility and increase crop yields such as vegetables, maize that fetch high prices and hence enhance food security. Agricultural wastes can be used to enhance food security mainly through their use as bio-fertilizer and soil amendment, use as animal feed, and energy production. They contain large amounts of organic matter, and many of them can be directly added to the soil without any risk (Sabiiti, 2011). Turning these agricultural wastes into organic fertilizers is one of the waste treatment technologies that make it possible to use organic waste as a fertilizer even in populated areas. Technology plays a key role in soil fertility improvement, and hence crop productivity (Amoding, 2007; Hargreaves *et al*., 2008). The use of organic fertilizers is particularly important in most parts of Africa, where low availability of nutrients is a serious constraint for food production (Brouwer and Powell, 1998).

The accumulation of agricultural wastes increases the organic carbon content of the soil. They exert positive influences on soil nitrogen which is an important source of nitrogen supply for crop production and could have a long term effect on the soil nitrogen (Anikwe and Nwobodo, 2002,; Eneje and Ukwuoma, 2005).

In Nigeria, maize (*Zea mays*) is one of the most important cereal crops grown mainly for human consumption. Maize residue consists of the stalk, leaf, husk and cob of a maize plant following the harvest of cereal grain. Maize residue is a very common agricultural product in areas of large amounts of maize production. Maize residues can be grazed as forage, feed, and biomass ethanol production (Wikipedia, 2013). Maize is an important cereal crop that readily provides staple food to a large percentage of human population in the world. In developing countries maize is a major source of income to many farmers (Tagne *et al*., 2008). Maize is usually extensively cropped during the rainy season in Nigeria and continues till the early dry season. The crop is harvested for its grain while the wastes (stalk, leaf, husk and cob) are either burnt, buried or thrown here and there, thereby constituting an environmental menace. Thus, this work focuses on the incorporation of maize residues as potential organic manure to increase soil fertility.