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COMPARATIVE EFFICACY OF NPK FERTILIZER AND POULTRY DROPPINGS ON THE GROWTH AND YIELD OF *AMARANTHUS HYBRIDUS* L.

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Abstract: The persistent reduction in soil fertility as a result of continuous cultivation of the soil has become a problem to vegetable farmers, both inorganic and organic fertilizers have been recommended as good sources of nutrients. This study sought to compare the performance of NPK (15:15:15) and poultry manure at different application rate on the growth and yield of *Amaranthus hybridus*. The experiment was done in duplicate and laid out using a Randomized Complete Block Design (RCBD) with each plot measuring 1.2 m by 1.2 m. The plant height (117 cm), leaf length (22.70 cm), leaf width (14.60 cm), leaf area index (12.10 cm^2), fresh weight (387.58 g) and dry weight (54.20 g) were significantly ($P<0.05$) higher in plant with application rate of 15 g poultry dropping compared to NPK fertilizer and the control. Poultry droppings (15 g) is more efficient to be used by farmers for optimum growth and yield of *A. hybridus*.

Keywords: leaf, inorganic, organic, plant, weight.

Introduction

Amaranthus hybridus L., commonly referred to as amaranth, is a member of the Amaranthaceae family, which includes over 60 species [ANJALI, 2013]. They are primarily monoecious but, few are dioecious. The high nutritional value of this crop has attracted the attention from various nations globally [SRIVASTAVA, 2011]. Its leaves constitute a cheaper and rich source of protein, carotenoids [SHUKLA & al. 2006] and minerals and vitamins [MUYONGA & al. 2008]. Due to farmers' desire to fulfill the rising demand for agricultural products, there has been a surge in the need for mineral fertilizers in emerging nations in order to raise crop production. The need to sustain and increase yields is one of the agricultural difficulties that are becoming more prominent due to the growing global population and changing eating preferences [ADEDEJI & al. 2019].

Inorganic fertilizers are produced using synthetic substances or extracted from mineral deposits and, are easily accessible nutrients to plants. They include: Nitrogen (N), Phosphorus (P) and Potassium (K) which are suitable for crop production in the tropics to improve the fertility of the soil. However, their use has not always been successful in the tropics due to increased soil acidity, easy nutrient leaching, low organic matter status, decreased crop yield, and degradation of soil physical properties. The ingredients of NPK fertilizer are important and necessary, for plant growth. The usage of NPK fertilizer is crucial to the agriculture sector's ability to feed the world's population and guarantee healthy crops but, because of its high cost

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and negative effects on the environment, impoverished farmers cannot afford it and, are therefore not a desired option [EKWEALOR & al. 2021].

Organic manure contains high amount of nitrogen, phosphorus, potassium and other essential nutrients which are essential for soil fertility [OYEWOLE & OYEWOLE, 2011]. In contrast to inorganic fertilizer, organic fertilizer adds organic matter to the soil which improves soil structure, nutrient retention, aeration, soil moisture-holding capacity and water infiltration [DEKISSA & ALLEN, 2008]. Organic manure such as cow dung and chicken manure help to improve the soil by providing nutrients for growing crops and it also improves the soil quality because of its high organic matter content with available nutrients for plant growth. Although organic manure exists in readily available forms, cheap and easy to access, they need to be applied in large amounts to meet the nutrient requirement of crops [PRABU & al. 2003].

The persistent reduction in soil fertility as a result of continuous cultivation on the soil is becoming a problem to vegetable farmers. Application of poultry droppings to crops have been found to be an effective and cheap source of nutrient for sustainable production of vegetable crops [SHAGUFTA, 2012]. Poultry droppings contain significant amount of the macro and micro nutrients as well as organic matter that is capable of improving the soil aeration capacity, microbial activities, texture, structure and porosity levels that are very crucial for growth and yields of vegetables [MUSA & al. 2020]. ANO & AGWU (2005) reported that vegetables cultivated using organic manures such as poultry droppings are gaining popularity because of less chemical residue and better taste. This research compared the performance of inorganic fertilizer (NPK 15:15:15) and organic fertilizer (poultry manure) at different application rate on the growth and yield of *Amaranthus hybridus*.

Materials and methods

Study location

This study was carried out at the Botanical Garden (9°20'59"N, 12°29'7"E), of the Department of Plant Science, Modibbo Adama University, Yola. *Amaranthus hybridus* seeds and NPK (15:15:15) fertilizer were obtained from an agro-allied store while the poultry droppings used for the study was obtained from a poultry farm in Jimeta, Adamawa State Nigeria.

Sowing of seeds and experimental design

Seeds of *Amaranthus hybridus* were sown on a well-prepared nursery bed. The seedlings were transplanted one week after germination. Field experiment was done in duplicate and laid out using a Randomized Complete Block Design (RCBD) with a total of sixteen plots, each measuring 1.2 m by 1.2 m. Eight plots each were assigned to poultry and NPK treated seedlings.

Different mass of NPK fertilizer and poultry droppings (5, 10, 15 g) were applied to the soil beside each seedling on each plot except for the control (0 g) plots where neither NPK fertilizer nor poultry droppings was applied. The experiment was carried out for a total duration of seven weeks.

Data collection

Plant height: height (cm) of three randomly tagged amaranth plants was measured and recorded using a meter rule at five weeks after transplanting of the seedlings.

Number of leaves: number of leaves on three randomly tagged amaranth plants were counted and recorded at five weeks after transplanting of the seedlings.

Leaf length: leaf length (cm) of three randomly tagged amaranth plants was measured from the leaf apex to the leaf base using a meter rule at five weeks after transplanting of the seedlings.

Leaf width: leaf width (cm) of three randomly tagged amaranth plants was measured from the leaf apex to the leaf base using a meter rule at five weeks after transplanting of the seedlings.

Leaf area: leaf area was determined using a portable leaf area meter (AM 350 model).

Leaf area index: leaf area was calculated by dividing the leaf area (m^2) with the ground area (m^2) according to the method of AHMAD & al. (2015).

Fresh weight: whole plants were uprooted for each application rate in each replication and weighed using a digital weighing balance (Sartorius ED2245 model) to obtain the fresh weight in gram, five weeks after transplanting.

Dried weight: whole plant was oven dried at a temperature of 70°C for 55 minutes and weighed using a digital weighing balance (Sartorius ED2245 model) to obtain the dry weight in gram, five weeks after transplanting.

Data analysis

One-way analysis of variance was used to compare the growth performance of amaranth subjected to different application rate of NPK and poultry fertilizer using R software version 4.05, Tukey's Honest Significant Difference was used to separate means where significant. All tests were done at $P \leq 0.05$.

Results and discussion

The comparative effect of NPK fertilizer and poultry droppings on the growth and yield of *Amaranthus* is shown in Table 1.

Plant height of *Amaranthus* varied significantly across ($P<0.05$) the different treatments. The plant with the highest height (117 cm) were those on the soil that was treated with 15 g of poultry droppings while the lowest (68.80 cm) was in the control. The increase in height may be due to favourable nutrient mineralization. A similar report has been made by OLOWOAKE & OJO (2014) in *Amaranthus caudatus* where compost manure favoured plant height over NPK fertilizer. Number of leaves in each treatment did not vary significantly ($P>0.05$), however the highest number of leaves (36.80) was noted in plants treated with 15 g of poultry droppings and the lowest (24.20) was in the control treatment. Number of leaves in *Amaranthus* is an indication of the yield and the high number of leaves produced by 15 g of poultry droppings could be due to sustained release of nutrients in 15 g of poultry droppings over the other treatments. It depicts the efficiency of organic fertilizers in promoting the vegetative growth and yield of *Amaranthus*. This conforms to the report of YASSEN & al. (2009) that organic fertilizers (chicken manure and farm yard manure) improve the vegetative characters of spinach.

Table 1. Effect of NPK and poultry droppings on the growth and yield of *Amaranthus hybridus*

App. rate		PH (cm)	NL	LL (cm)	LW (cm)	LA (cm^2)	LAI	FW (g)	DW (g)
NPK	0g	68.8±0.75^{b}	24.2±0.75^{a}	16.1±0.125^{c}	9.28±0.225^{b}	112±1.85^{a}	7.01±0.120^{b}	103±0.900^{c}	15.0±0.850^{e}
	5g	88.8±8.25^{ab}	47.2±19.2^{a}	20.8± 2.00^{abc}	12.9±1.07^{ab}	202±36.0^{a}	12.6±2.26^{ab}	256±10.2^{abc}	34.7±1.07^{c}
	10g	73.0±7.5^{b}	30±1.00^{a}	19.9±0.125^{abc}	12.2±0.25^{ab}	183±2.58^{a}	11.4± 0.160^{ab}	137±16.3^{bc}	21.3±0.890^{d}
	15g	90.8±7.75^{ab}	35.2±0.75^{a}	22.1±0.875^{a}	12.6±0.0250^{ab}	286±69.1^{a}	11.6±1.93^{ab}	246±44.3^{abc}	35.5±1.18^{c}
PD	5g	69.5±5.00^{b}	25.8±1.75^{a}	16.6±0.625^{bc}	9.38±0.125^{b}	117±5.95^{a}	7.31±0.370^{b}	127±16.2^{bc}	25.3±1.36^{d}
	10g	100±9.25^{ab}	31.2±1.25^{a}	21.4±0.625^{ab}	12.1±0.675^{ab}	194±16.5^{a}	12.1±1.03^{ab}	276±18.5^{ab}	46.5±1.15^{b}
	15g	117±5.50^{a}	36.8±3.25^{a}	22.7±0.190^{a}	14.6±1.88^{a}	249±29.8^{a}	15.5±1.86^{a}	387±58.8^{a}	54.2±1.20^{a}
	***P*-value**	0.0112 *	0.449	0.00634 **	0.0274 *	0.0591	0.031 *	0.00266 **	4.37e-07 ***

KEY: App.: application, PH – plant height, NL – number of leaves, LL – leaf length, LW – leaf width, LA – leaf area, LAI – leaf area index, FW – fresh weight, DW – dry weight, NPK: Nitrogen, Phosphorus, Potassium; PD: Poultry Droppings. Means with different superscript along each column are significantly different. * – significant, ** – highly significant, *** – very highly significant

Leaf length and width varied significantly across the different application rates of the fertilizer. The highest in leaf length (22.70 cm) and leaf width (14.60 cm) was recorded in plants treated with 15 g of poultry droppings and lowest in the control plant with values of 16.10 cm and 9.28 cm respectively. Leaf area did not vary significantly ($P>0.05$) in the accessions studied, the highest (286 cm^2) was recorded in 15 g of NPK treated plants and the lowest (112 cm^2) was in the control treatment. The increased leaf length and leaf width due to treatment with organic fertilizer could in turn lead to a large surface area of the plant which will affect the photosynthetic ability of the plant and in turn the general productivity of the plant. This is in conformity with the findings of EKWEALOR & al. (2021) which showed that application of organic fertilizer improved the leaf length, width and area of cabbage.

Leaf area index, fresh weight and dry weight was highest (15.5, 387 g and 54.2 g) in plant treated with 15 g poultry and lowest (7.01, 103 g and 15 g) in the control plant. This report indicates that poultry droppings increased the leaf production and as well as improved the biomass production of *Amaranthus*. The leaf area index (LAI) is an important variable used to evaluate many processes such as canopy, photosynthesis and evapotranspiration which play an important role in the transformation of energy and mass between the atmosphere and plant canopy [AHMAD & al. 2015]. The report of MUSA & al. (2020) that poultry manure significantly enhanced the growth and yield of okra is in conformity with this study.

Conclusion

Both NPK fertilizer and poultry dropping significantly improved the growth and yield of *Amaranthus*. However, 15 g application rate of poultry dropping was the best for most of the growth and yield parameters studied. It is recommended that 15 g of poultry droppings be used by farmers for each plant stand to obtain optimum growth and yield of *Amaranthus hybridus*.

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