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Effect of Plant Growth Regulators on the Performance of Vegetable Amaranth (*Amaranthus Caudatus* L.) in Mubi Northern Guinea Savannah Zone of Nigeria

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Abstract

Low crop productivity is a general problem facing most farming systems in Nigeria. Due to the increase in demand in urban areas where people are not involved in the primary production, the demand for vegetable amaranths has increased. Field trial was conducted during 2022 cropping season, under rain fed condition at Department of Crop Science Teaching and Research Farm, Food and Agricultural Organization/Tree Crop Program (FAO/TCP) farm, Adamawa State University, Mubi. The treatments consisted of four Plant Growth Regulators (Gibberellins, Cytokinins, Indole butyric acid and Water as the control). The treatments were laid in a Randomized Complete Block Design (RCBD) replicated three (3) times. Data were collected on plant height, number of leaves, fresh plant weight, leaf area index, absolute growth rate, relative growth rate and fresh vegetable yield. Data collected were subjected to Analysis of Variance (ANOVA), Least Significant Differences (LSD) was used to separate the means at 5 % level of probability. The result shows that foliar application of gibberellins recorded the highest mean values in all the growth parameters measured. Higher fresh vegetable yield (79.07 tones ha^{-1}) was also obtained in the application of gibberellins. For the best growth and yield of vegetable amaranth (Amaranthus caudatus L.), foliar application of gibberellins was found to be realistic and is hereby recommended for the farmers in the study area.

Keywords:
Amaranthus caudatus, Plant growth regulators, Growth and vegetable yield

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Background to the Study

Vegetables are essential in the diet for humans as they provide plant fibre, mineral elements, vitamins, carbohydrates and proteins, (Hollingsworth, 2017). *Amaranthus caudatus* L. is a leafy vegetable commonly cultivated in Nigeria and other West African countries (Olorode, 2015). Aphane *et al.* (2016) reported that foods of animal origin which are known was the major source of vitamins and proteins are very expensive for poor households. Fruits and vegetables could alternatively play a major role in alleviating problems associated with malnutrition due to their ability to supply proteins, vitamins, calories and other nutrients needed in a balanced diet (Wehmeyer and Rose, 2018). Laker (2007) observed that of more than 100 different indigenous leafy vegetable species in Africa, amaranth is the most widely consumed. Amaranth, a C4 plant, is one of a few dicots in which the first product of photosynthesis is a four-carbon compound. Mabulu and Chalamila (2005) reported that the average leaf yields of amaranths in Sub-Saharan Africa are less than 1.2 t ha_{1-}, against the potential yield of 32-40 t ha_{1-}. Most of existing cultivars of amaranth in Africa are generally much smaller, up to 50 cm, strongly branched and prostrate with many flowers and small leaves which creates difficulties during harvest particulary *A. blitum* and *A. graecizans* (Mabulu Chalamila, 2005). Amaranth requires 40-50% less moisture than maize and survives better than most crops under dry and hot conditions because of its extensive root system and use of C4 photosynthesis mechanism (Stallknecht *et al.,* 2018).

African indigenous vegetables play significant role in the food security of the under-privileged in both urban and rural settings (Schippers, 1997). Many communities used vegetables as source of energy and micro nutrients in their diets. Vegetables are usually picked fresh, used as greens in salads or blanched, steamed, boiled, fried in oil, and mixed with meat, fish, cucurbit seeds, groundnut or palm oil. Cooked greens can be used as a side dish, in soups or as an ingredient in sauce and baby food etc. (Grubben and Denton, 2004). Improved vegetable productivity and resources use efficiency could only be achieved, when appropriate planting technique and seed density, adequate application of fertilize and use of Plant Growth Regulators (PGRs) are available.

For sustainable food production to meet the increasing population in Nigeria, the production of vegetable amaranths needs to be increase through proper application of plant growth regulators that can give maximum output because most vegetable amaranth growers in Nigeria do not apply PGRs. Vegetables can be grown all year round and can be produced even on marginal soils. Most of the important indigenous vegetables including amaranth have been identified as having potential for commercial exploitation and production for human consumption (Taylor and Moss, 2020). Most indigenous plants are adapted to the prevailing conditions and require few agricultural inputs and perform well in areas unsuitable to introduced vegetables (Aphane *et al.*, 2016).

Amaranth is considered as underutilized crop (NRC, 1984) and has, until recently, received little research attention. Low crop productivity is a general problem facing most

farming systems in Nigeria. Due to the increase in demand in urban areas where people are not involved in the primary production, the demand for this vegetable crop has increased (Schippers, 1997); this has made the vegetable amaranths to become an important commodity in the market and its production an important economic activity for the rural people. However, yield per hectare of this crop is low (7.6 t/ha^{-1}) when compared to that of United States of America (77.6 t/ha^{-1}) and world average (14.27 t/ha^{-1}) (FAO, 2014). This may be due to poor cultural practices such as fertilizer application, timely planting, pests and disease control and non-use of plant growth regulators that can give maximum growth and yield. Even though much work has been done on the performance of vegetable amaranth, but at the moment not much work has been done on the effect of plant growth regulators on the performance of vegetable Amaranth in Mubi environment. Therefore, the right plant growth regulators that can give maximum growth and vegetable yield of amaranths needed to be identified, and this could be achieved through the use of different plant growth regulators.

The objectives of this study are to evaluate the effect of plant growth regulators on the performance of vegetable amaranth and to identify the best plant growth regulators that can give maximum yield of vegetable amaranth in the study Area. This research will facilitate understanding of the plant growth regulators and its effect on vegetable amaranths. The finding of this study will also be of great importance to researchers, farmers and policy makers as a guide to help in solving the issue of low yield among vegetable farmers in Nigeria.

Materials and Methods

Experimental Site

Field experiment was conducted at the Department of Crop Science, Food and Agricultural Organization/Tree Crop Program (FAO/TCP) Teaching and Research farm, Adamawa State University, Mubi, under rain fed condition in 2022 cropping season. Mubi is located in the Northern Guinea Savannah zone of Nigeria, situated between latitude 10°11" and 10°30" North of the equator and between longitude 13^{0}10" and 13°30" East of the Greenwich meridian and at altitude of 969 m above mean sea level (MSL). The mean rainfall of Mubi is 969 mm and a minimum temperature of 18°C during harmattan period and 40°C as maximum in April (Adebayo, 2020).

Treatments and Experimental Design

The treatments consisted four (4) different plant growth regulators viz: Gibberellins, Cytokinins, Indole butyric acid (IBA) and Water. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. The gross plot size was 2 m × 2 m (4 m2) and the net plot size 1.5 m x 1 m (1.5 m^{2}), 2 meters was left between replicates and 1 m between plots to check the effects of one treatment on the other.

Application of Plant Growth Regulators (PGRs)

The plant growth regulators were foliage applied at 20 and 30 days after sowing. Gibberellins (5 %) was sprayed at the rate of 600 ml per ha (60 ml was diluted in clean

water per knapsack), Cytokinins (0.4 %) was sprayed at the rate of 300 ml per ha (30 ml was diluted in clean water per knapsack), Indole butyric acid (IBA 0.6 %) was sprayed at the rate of 300 ml per ha (30 ml was diluted in clean water per knapsack). The clean water used in the dilution of the PGRs was sprayed to the control plots.

Harvesting

Vegetable amaranth was harvested at 6 weeks after sowing when all the vegetative parts have reached their maximum. The *Amaranthus caudatus* L. was harvested just before flowering in order to maintain quality.

Data Collection

Ten (10) plants were tagged in each plot and data were collected on the following parameters at 3 and 6 WAS: Plant height (cm), Number of leaves, Fresh plant weight (g), Leaf area index (cm), Absolute growth rate (g/d), Relative growth rate (RGR) (g/day), and Fresh vegetable yield (kg ha^{-1}) at harvest.

Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) appropriate to RCBD, least significance difference (LSD) was used to separate the means at 5 % level of probability using SAS, version 9.2 (2008).

Results

Effect of Plant Growth Regulators on Plant Height $Plant^{-1}$ of Amaranth (*Amaranthus caudatus* L.) at 3 and 6 WAS in Mubi during 2022 Growing Season

The result of effect of plant growth regulators on plant height $Plant^{-1}$ of Amaranth (*Amaranthus caudatus* L.) at 3 and 6 WAS during 2022 growing season is presented in Table 1. The result showed a highly significant ($P<0.001$) difference between the treatments at both 3 and 6 weeks. At 3 weeks after sowing, foliar application of gibberellins recorded the highest value (31.23 cm), followed by cytokinins (24.20 cm) though statistically the same with Indole butyric acid (21.87 cm) and the shorted plants were recorded from the control (13.60 cm). Similarly, at 6 WAS, gibberellins recorded the tallest plant (105.07 cm), followed by cytokinins (90.57 cm) and the least value was recorded from control (50.93 cm).

Effect of Plant Growth Regulators on Number of leaves $Plant^{-1}$ of Amaranth (*Amaranthus caudatus* L.) at 3 and 6 WAS in Mubi during 2022 Growing Season

The result of effect of plant growth regulators on number of leaves per plant of amaranths (*Amaranthus caudatus* L.) at 3 and 6 WAS during 2022 growing season is presented in Table 1. The result showed a highly significant ($P<0.001$) difference between the treatments at both 3 and 6 WAS. At 3WAS, application of gibberellins recorded the highest value (12.67), followed by cytokinins (11.00) which is statistically similar with Indole butyric acid (10.67) and the least value was recorded from the control (8.00). Similarly, at 6WAS, gibberellins recorded the highest number of leaves (26.00), followed by cytokinins (21.67) also statistically the same with Indole butyric acid (21.67) and the least value was recorded from control (17.00)

Effect of Plant Growth Regulators on Fresh Plant Weight (g) of Vegetable Amaranths (*Amaranthus caudatus* L.) at 3 and 6 Weeks After Sowing in Mubi during 2022 Growing Season

The result of effect of plant growth regulators on fresh plant weight per plant of vegetable amaranth (*Amaranthus caudatus* L.) at 3 and 6 WAS during 2022 growing season is presented in Table 1. The result showed a highly significant (P<0.001) difference between the treatments at both 3 and 6 WAS. At 3 WAS, gibberellins recorded the highest value (43.83 g), followed by cytokinins (35.17 g) though statistically the same with Indole butyric acid (34.27 g) and the least value was recorded from control (18.40 g). Similarly, at 6 WAS, gibberellins recorded the highest value (89.50 g), followed by cytokinins (74.67 g) which is statistically the same with Indole butyric acid (74.200 g) and the least value was recorded from control (42.40 g).

Effect of Plant Growth Regulators on Leaf Area Index (cm^2) $Plant^{-1}$ of Vegetable Amaranths (*Amaranthus caudatus* L.) at 3 and 6 Weeks After Sowing in 2022 Growing Season

The result of effect of plant growth regulators on leaf area index of vegetable amaranth (*Amaranthus caudatus* L.) at 3 and 6 WAS during 2022 growing season is presented in Table 1. The result showed a highly significant (P<0.001) difference between the treatments at both 3 and 6 WAS. Application of gibberellins recorded the highest value (0.343 cm^2), followed by cytokinins (0.263 cm^2) though statistically the same with Indole butyric acid (0.233 cm^2) and the least value was recorded from control (0.1500 cm^2). Similarly, at 6 WAS, gibberellins recorded the highest value (2.270cm^2), followed by cytokinins with (1.563 cm^2), the least value was recorded from control (0.777 cm^2).

Effect of Plant Growth Regulators on Absolute Growth Rate Growth Rate (g/day) of **Vegetable Amaranth (*Amaranthus caudatus* L.)** at 6 Weeks After Sowing in Mubi during 2022 Growing Season

The result of effect of plant growth regulators on Absolute Growth Rate of vegetable amaranth (*Amaranthus caudatus* L.) at 6 WAS **during 2022 growing season** is presented in Table 1. The result shows that there was highly significant (P<0.001) difference between the treatments. Application of gibberellins recorded the highest value (1.05g/day), followed by cytokinins (0.697 g/day) though statistically the same with Indole butyric acid (0.6300 g/day) while control recorded the least (0.050 g/day).

Effect of Plant Growth Regulators on Relative Growth Rate (g/day) $Plant^{-1}$ of Vegetable Amaranth (*Amaranthus caudatus* L.) at 6 WAS in Mubi during 2022 Growing Season

The result for effect of plant growth regulators on relative growth rate of vegetable amaranth (*Amaranthus caudatus* L.) at 6 WAS during 2022 growing season is presented in Table 1. The result shows a highly significant (P<0.001) difference between the treatments. Application of gibberellins recorded the highest mean value of (0.072g/day) though statistically the same with cytokinins (0.069g/day) and Indole butyric acid (0.068g/day), while control recorded the least (0.041g/day).

Effect of Plant Growth Regulators on Fresh Vegetable Yield (tons/ha) of Vegetable Amaranth (*Amaranthus caudatus* L.) at 6 WAS during 2022 Growing Season

The result of effect of plant growth regulators on fresh vegetable yield of amaranth (*Amaranthus caudatus* L.) at 6 WAS during 2022 growing season is presented in Table 1. The result shows a highly significant ($P<0.001$) difference between the treatments. Application of gibberellins recorded the highest value (79.07 tones ha^{-1}), followed by cytokinins (71.30 tons/ha) which is statistically the same with Indole butyric acid (70.87 tons/ha) and the least value was recorded from control (26.20 tones ha^{-1}).

Discussions

Effect of Plant Growth Regulators on Growth and Yield of Vegetable Amaranth (*Amaranthus caudatus* L.) at 3 and 6 WAS during 2022 Growing Season

The significant influenced of gibberellins in all the growth and yield parameters measured (plant height, number of leaves, fresh plant weight, leaf area index, absolute growth rate, relative growth rate and fresh vegetable yield) over the rest of the treatments may be due to the positive influence of gibberellins in cell division and elongation. This result is in line with the findings of Mc (2009) who reported that, application of gibberellins enhances the growth and yield of vegetable crops. Similarly, Mandava, (1979) reported that gibberellins are important in seed germination, affecting enzyme production that mobilizes food production, used for growth of new cells, they promote flowering and cellular division. This also agree with the findings of Surendra *et al*. (2006) who observed that application of gibberellins at different concentrations (25 and 50 ppm) significantly increases plant heights of amaranths. Singh *et al*. (2005) also reported that as gibberellins rates increased, the plant height, stem girth, leaf area, and yield per plant and yield per hectare increased in amaranthus. Medina (2005) reported that gibberellins has been used to increase leaf area, leaf area index, height of plants, increase the number of leaves and induced flowering in vegetables crops.

Conclusion and Recommendations

Based on the findings from this study, it is concluded that plant growth regulators significantly influenced vegetable amaranth (*Amaranthus caudatus* L.) and application of gibberellins produced the highest values in all the characters measured followed by cytokinins. From the forgoing, application of gibberellins on vegetable amaranth is hereby recommended for adoption by farmers in the study area in view of the highest growth and maximum yield of fresh vegetable recorded. This will increase farmers output and will go along to improve the standard living of farm families.

References

Adebayo, A. A. (2020). *Climate ii. rainfall in Adamawa State in maps. Adebayo, A.A and Tukur, A.L. (eds),* paraclete publishers Yola. Pp. 23-26.

Aphane, J., Chadha, M. L. & Oluoch, M. O. (2016). Increasing the consumption of micronutrient-rich foods through production of indigenous foods. In*: FAO/AVRDC International Workshop Proceedings, 5 - 8 March 2002, Arusha, Tanzania. AVRDC - The World Vegetable Centre Shanua, Taiwan: AVRDC Publication No.* 03 - 561: pp: 1-77.

F.A.O. (2014). *Traditional food plants. FAO food and nutrition paper* 42, Food and Agricultural Organization Statistical data of the United Nations, Available online: http://Faostat.fao.org(accessed 26 May, 2022.

Grubben, G. J. H. & Denton, O. A. (2014). *Plant resources of tropical Africa,* Vegetable PROTA.

Hollingswortn, D. F. (2017). *The place of potatoes and other vegetables in the diet in vegetable production,* Spedding, C.R.W. (ed) Macmillan London. Pp 154.

Laer, M. C. (2007). Introduction to the special indigenous crops, water and human nutrition, *Water SA, 33* (3), 311-315.

Mbulu, R. B. & Chalamila, B. N. (2005). Organic vegetable production an alternative income generating activity to the disease effected coconut farming system in Mkuranga District in Tanzania, *African crop science conference proceedings, 7. Pp*, 1539-1544.

Mndava. N. B. (1979). *Natural products in plant growth regulators and plant growth substances, ACS symposium series 11*1, Washington (DC) *American Chemical Society, P*.137213

Mc. S. (2009). *Asymmetrical placement of cut tips on coleoptiles,* Gibberellins for treatment of Bakanae disease, Pp 89-93.

Medina, E. & Saavedra, R. (2005). *GA3 has been used to increase leaf area, leaf area index, and height of plants, increase the number of leaves and induced flowering in vegetables crops. Pp 34-89.*

NRC. (1984). *Amaranth: modern prospects for an ancient crop,* National Research Council. National Academy Press, Washington, D.C

Olorode, O. (2015). *Taxonomy of West African Flowing Plants,* Longman Group Ltd., London, UK, pp. 158.

SAS. (2008). *Statistical analysis software (SAS) system version 9.2*. User guides (2008).

Schippers, R. (1997). Domestication of indigenous vegetables for Sub-Saharan Africa: Strategy paper. African indigenous vegetables*, Workshop Proceedings, January 13-18, 1997, Limbe, Cameroon,* pp: 125-135.

Singh, U. O., Wadhwani, A. M. O. & Johri, B. M. (2005). Dictionary of economic plants of India, *Dictionary of economic plants in India(ed.2).*

Stallknecht, G. F., Gilberstone, K. M. & Ekohff, J. L. (2018) Food crop for people and animals, *New Crops. 1, 231-234.*

Surendra, W., Bin, A. & Petty, I. (2006). Natural products in plant growth regulation, Plant growth substances. ACS Symposium Series 111, Washington (DC), *American Chemical Society,* p. 137213.

Taylor, F. K. & Moss, H. (2020). *The potential for commercial utilization of veld products in Botswana.* Veld Products Institute, Gaborone.

Wehmeyer, A. S. & Rose, E. F. (2018). Important indigenous plants in the Transkei as food supplements. *Bothalia, 14, 613 - 615.*

Table 1: Effects of Plant Growth Regulators on the Growth and Vegetable Yield of Amaranth (*Amaranthus caudatus* L.) in Mubi during 2022 Growing Seasons

Treatments	Plant height (cm)		Number of leaves		Fresh plant weight (g)		Leave area index (cm^2)		AGR ($g/m^2/day$)	RGR g/day	FVY $t\ ha^{-1}$
	3 WAS	6 WAS	3 WAS	6 WAS	3 WAS	6 WAS	3 WAS	6 WAS	6 WAS	6 WAS	6 WAS
PGRs											
Gibberellins	31.23	105.07	12.67	26.00	48.83	89.30	0.3433	2.2700	1.050	0.072	79.07
Cytokinins	24.20	90.57	11.00	21.67	35.17	74.67	0.2633	1.5633	0.697	0.069	71.30
Indole butyric acid	21.87	79.70	10.67	21.67	34.27	74.20	0.2333	1.0767	0.630	0.068	70.87
Control	13,60	50.93	8.00	17.00	18.40	42.40	0.1500	0.7767	0.503	0.041	26.20
P of F	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
LSD	3.3479	6.8040	1.5737	2.0337	5.4416	7.9183	0.09780	0.2754	0.1237	0.0080	3.4419

AGR= Absolute growth rate, RGR= Relative growth rate, FVY= Fresh vegetable yield, PGRs= Plant growth regulators, WAS= Weeks after sowing