

EFFECT OF POULTRY MANURE RATES ON CHLOROPHYLL CONTENT AND YIELD ATTRIBUTES OF THREE AMARANTH VARIETIES IN KANO, NIGERIA

HARUNA, Y. R., SHEHU, A. M., AND IBRAHIM, A.

*Department of Agricultural Science Education, Federal College of Education,
Katsina, Katsina State, Nigeria*

Corresponding author: y.rawayau@fcekatsina.edu.ng (+2348065676266).

Abstract

A 4 x 3 factorial pot experiment arranged in a Completely Randomised Design (CRD) was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Bayero University, Kano to examine the effect of poultry manure at different rates (0, 10, 20 and 30 t/ha) and 3 varieties of Amaranth (Hemera, White and Black Amaranth), on the chlorophyll content and fresh weight of the plant. A chlorophyll content meter was used to measure the chlorophyll content of the Amaranth at different growth stages, which indicates photosynthetic activity relating to the nitrogen concentration of the leaf. The fresh weight of the leafy plant was also measured at harvest (7 WAS). Data collected were computed and analysed using Analysis of Variance (ANOVA) with Statistical Analysis Software (SAS) version 9.4. Means were compared using the Duncan Multiple Range Test (DMRT). There was no significant difference in poultry manure rates at any of the growth stages measured, and no significant interaction was observed for chlorophyll content. While the yield (fresh weight) shows a significant difference ($p < 0.05$) among the amaranth varieties, the Hemera variety has significantly more weight than the Black and White varieties, with no significant difference observed due to poultry manure rates. The Hemera variety, with no poultry manure application, can benefit vegetable farmers in the study area.

Keywords: *Poultry manure, Amaranth, hemera, chlorophyll content, fresh weight.*

Introduction

Amaranth is the common name for the domesticated species of *Amaranthus* (family *Amaranthaceae*). It is one of the oldest food crops in the world (Gigliola and Vera, 2012). *Amaranthus* is one of the most promising plant genera, comprising approximately 70 species, of which 40 are native to the Americas, 17 are primarily vegetable species, and three are grain species. In contrast, others are weedy (Andreas *et al.*, 2011). Amaranth is a multipurpose crop whose leaves and grains are tasty and of high nutritional value; additionally, it can be cultivated as an ornamental plant (Venskutonis and Kraujalis, 2013). The genus *Amaranthus* has received considerable attention in many countries due to the high nutritional value of some species, which serve as essential food sources, either as vegetables or grains (Srivastava, 2001).

Amaranthus (*Amaranthus cruentus*) is an important vegetable crop grown in Nigeria, mainly for its leafy material, which is used in preparing dishes such as soup, stew, salad, porridge, and as a garnish. It is an erect annual with a short life cycle of two to three months and is widespread in hot, semi-arid and equatorial climates. Its cultivation and consumption are becoming increasingly popular, with more than 60 species cultivated in Asia, Australia, North America, South America, Europe, and Africa (Spetter and Thompson, 2007).

Amaranthus cruentus is cultivated for its leaves and is among the highly prized vegetables in Nigeria, due to its high nutritional and commercial value. The fresh leaves are an excellent source of plant protein, iron, calcium, fibre, beta-carotene and folate. Proximate analysis shows that 100 g of fresh leaves contain 80-89% water, 3.6-4.6 g protein, 1.3-8 g cellulose, 154-410 mg calcium, 2.9-8.9 mg iron, 5.7-6.5 mg beta-carotene, 23-64 mg vitamin

C and an energy value of 108 kg or 26 kcal/100 g (De Lannoy, 2000). Cooked leaves and young stems are highly valued among peasants and are utilised in various forms. They may be consumed as vegetables and eaten with boiled, roasted, or fried yams, cocoyams, sweet potatoes, or Irish potatoes. Raw or partially boiled leaves and shoots may be served in salad dishes and have been rated superior or equal in taste to spinach. It is considerably higher in calcium, iron and phosphorus than most other leaf vegetables (Markus and Davis, 1984; Markus, 1990). Amaranth, a type of vegetable, has been used in China for over 400 years. It is commonly found in the Caribbean and Africa. Grain amaranth was cultivated and revered by the Aztecs of Mexico, the Mayas of Central America and the Incas of South America (O'Brien and Price, 2008).

Different species exhibit distinct physical appearances and characteristics, which is useful in determining the appropriate variety for a particular purpose, especially for local people who are unfamiliar with the scientific names of the various species.

Amaranthus cruentus is an annual herb that grows up to 2 m tall, often with a reddish tint throughout, and features stout, branched stems. The leaves are long with petioles arranged spirally without stipules; they are deeply lobed and oval-shaped with a sub-acute apex that ends abruptly in a sharp point. Seeds are egg-shaped, with a narrow end and a base, and are whitish to yellow or blackish (Grubben, 2004). The primary use of *Amaranthus cruentus* in the past was for its grain; however, currently, its leaves are consumed as a vegetable dish or used in sauces. The leaves and tender stems are cut and fried, and eaten with cereals and tubers (Grubben, 2004).

Amaranthus hypochondriacus L. It is an annual herb that grows up to 2 m tall, often with a reddish tint throughout; its stems are tufted, branched, and covered in multicellular hairs. Leaves are long but broader in the middle, very lobed, arranged spirally, simple, without stipules, with a blunt tip. It has thick, large, and complex branches with many lateral, perpendicular, thin branches. Seeds are the species' profound red, dark-seeded form (Jansen, 2004). Amaranth is the most robust and highest-yielding grain, rich in carbohydrates, plant protein, iron, and vitamins, especially A and C (Nee Repo, 2011). Although this species has been previously described as a grain type, it can also be grown as a leaf vegetable (O'Brien and Price, 2008).

Amaranthus albus is also known as tumbleweed or white Amaranth. It can be distinguished from Amaranth spp. by its white stems and small, light green leaves; the foliage has a pale overall appearance, characterised by light green leaves ("White Amaranth (*Amaranthus albus*)", 2014). It is an annual plant that grows up to 0.6-0.9 m high but sometimes as high as 1.8 m (Dibble, 2012).

Chemical fertilisers are frequently used to rejuvenate and maintain soil fertility, thereby boosting farm productivity. However, long-term reliance on synthetic fertilisers jeopardises the environment, leading to unsustainable crop production. Also, the extent to which chemical farming can be depended on to increase farm output is constrained by high cost and limited availability of the correct type of inorganic fertilisers, as well as lack of technical skills and limited financial capacity of traditional farmers who dominate crop agriculture in Nigeria for their livelihood to purchase the fertilisers.

Organic agriculture, which avoids or largely excludes the use of agrochemicals, offers a sustainable alternative to conventional farming systems, minimising the negative impacts of chemical farming. Organic soil fertility management utilises the application of compost, manure, green manure and other organic amendments to replenish soil nutrients and enhance crop performance.

Poultry manure, sometimes referred to as chicken manure, is an excellent soil amendment that provides essential nutrients for growing crops and enhances soil quality when applied wisely, due to its high organic matter content combined with readily available

nutrients for plant growth. The chemical composition of poultry manure varies with factors such as the source of the manure, the birds' feed, their age and condition, storage conditions, handling of the manure, and the type of litter used. Poultry waste consists of droppings, waste feed, broken eggs, feathers and sometimes sawdust from the poultry floor. It also includes the dead birds and hatchery waste, which are high in protein and contain a substantial amount of calcium and phosphorus due to a high level of mineral supplements in their diet. Poultry manure has been reported to contain more plant nutrients than all other organic manures (Ibrahim *et al.*, 2021). The soil's physical and chemical properties improve with the application of poultry manure. Poultry manure at 10-50 t/ha has a positive impact on soil physical attributes, such as soil temperature and water-holding capacity, and it improves the number of pores. Poultry manure contains nitrogen 1.0-1.8%, P 0.4-0.8% and K 0.5-1.9%. The concentration of N, P, K, Ca and Mg increased in sorghum leaves with the application of poultry manure (Haruna *et al.*, 2019).

Gupta *et al.* (2005) indicated that fresh poultry manure droppings contain 70% water, 1.4% N, 1.1% P₂O₅ and 0.5% K₂O. Poultry manure had the most concentrated nutrient content among the different sources of organic manure used in crop production (Shehu *et al.*, 2019). Adzemi *et al.* (2017) observed that applying poultry manure improved the availability of certain minerals in soil, particularly in transferring nutrients from rangeland to plants. Izunobi (2002) reported that poultry manure, especially which produced in deep litter or battery cage houses, is the richest known farmyard manure, supplying greater amounts of absorbable plant nutrients. Haruna (2018) noted that poultry droppings play a significant role in enhancing crop yields.

Amujoyegbe *et al.* (2007) reported that poultry manure increased the leaf area, total chlorophyll content and grain yield of maize and sorghum. Ibeawuchi *et al.* (2007) reported that 8 t/ha of poultry manure resulted in significantly higher grain yield, dry matter and increased leaf of maize. Fagimi and Odebode (2007) reported that poultry droppings applied at rates of 10 t/ha and 20 t/ha increased plant height, the number of leaves, and fruit yield of pepper, while reducing the incidence and severity of Pepper Veinal Mottle Virus (PVMV).

Despite the numerous advantages of Amaranths and the influence of fertiliser on their productivity and quality, there is a dearth of information on the chlorophyll content of the plant as affected by poultry manure rates.

The study was conducted to determine the fresh weight and chlorophyll content of Amaranth in different varieties as affected by varying poultry manure rates.

Methodology

A pot experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Bayero University, Kano (11°0' N; 80°25' E) in Nigeria's Sudan Savannah ecological zone.

The treatments consisted of three varieties of *Amaranthus* (Hemera, white Amaranth and black Amaranth) and four rates of poultry manure (0, 10, 20 and 30 t/ha). The treatments were randomised and repeated three times using a Completely Randomised Design (CRD).

The soil used for the experiment was obtained from a location within the faculty's research farm. The soil was mixed with different rates of poultry manure. The mixture was filled into 36 pots, each weighing 7.6 kg, and labelled. The pots were arranged inside the screen house. The mixture was irrigated to allow the decomposition of the poultry manure contained in the mix for about seven (7) days before sowing. Planting was done using a broadcasting method, where seeds were evenly spread across the prepared beds.

Data collected were computed and analysed using Analysis of Variance (ANOVA) with Statistical Analysis Software (SAS) version 9.4. Means were compared using the Duncan Multiple Range Test (DMRT).

The chlorophyll content of the amaranth leaf was measured using a chlorophyll content meter at 3, 5 and 7 WAS. It provides an indicator of photosynthetic activity relating to the nitrogen concentration of the leaf.

The fresh weight was measured at harvest (7 WAS) using a standard weighing scale according to different treatments.

Results and Discussion

Table 1 shows the effect of poultry manure rates on fresh weight per plant at harvest, and the chlorophyll content of amaranth varieties at 3, 5 and 7 WAS. The results show that the amaranth varieties significantly affected the fresh weight per plant at harvest (7 WAS). Black Amaranth and Hemera were at par, recording significantly ($P \leq 0.05$) more fresh weight, while White Amaranth recorded less weight. Also, poultry manure rates did not significantly ($P > 0.05$) affect fresh weight at any sampling period. The interaction between varieties and poultry manure on fresh weight was not significant.

The study showed that poultry manure has no significant effect ($P \leq 0.05$) on Amaranthus yield. However, no statistical difference was observed in either parameter assessed, which may be attributed to the short cropping period, which provided less time for the mineralisation of the nutrients present in the applied manure. The observed differences in values obtained in both parameters assessed could be attributed to the differences in nutrients contained in the rate of poultry manure applied. Asiegbu and Carol (2000), Nweke and Obasi (2013) observed that higher organic manure rates (15 t/ha and 20 t/ha) and pig manure rates (12 t/ha and 24 t/ha) yielded higher results than those without manure application.

Moreover, Ali *et al.* (2010) reported that Amaranthus requires soil with high organic content, and such soils favour the production of fresh leaves. The enhancement of the parameters studied by applying poultry manure may also be attributed to its high nitrogen and other plant nutrient content. Abou-Elmagd *et al.* (2006) reported that poultry manure is rich in nitrogen and other plant nutrients. As a result, it favours the growth and development of the root system, which reflects better growth and photosynthesis activity.

Table 1: Effect of poultry manure rates on fresh weight and chlorophyll content of three amaranth varieties

Treatment	Fresh weight(kg/ha)	Chlorophyll Content (WAS)		
		3	5	7
Varieties (V)				
Black Amaranth	1472a	10.34b	19.0a	5.09a
Hemera	822ab	11.78a	18.8a	5.37a
White Amaranth	968b	10.62b	16.6b	5.40a
SE±	173.9	0.586	2.16	0.487
Poultry manure (t/h)				
0	850b	10.23b	18.9ab	4.75c
10	1294a	10.87b	17.4b	5.58b
20	1250a	10.83b	15.5b	4.65c
30	957b	11.73a	20.6a	6.17a
SE±	200.8	0.677	2.50	0.562
Interaction				
V× Pm	NS	NS	NS	NS

Means in the same column, having the same letter(s), are not significantly different at $P \leq 0.05$ Duncan Multiple Range Test (DMRT). WAS = Weeks after sowing, NS= not significant.

Conclusion and Recommendations

Based on the findings of this study, it is concluded that the variety Hemera should be adopted for higher fresh weight. Further research is needed to determine the optimal rate of poultry manure application to achieve better fresh weight and higher chlorophyll content in *Amaranthus*.

References

- Abou-El-Magd, M., El-Bassiony, A. M. and Fawzy, Z. F. (2006). Effect of organic manure with or without chemical fertilizers on growth yield and quality of some varieties of broccoli plants. *Applied Science*, 2, 791-798.
- Adzemi, M. A., Haruna, Y. R. and Wan Zaliha, W. S. (2017). Growth Performance and Yield of Sweet Corn Grown on Rasau Series Soil under Organic Amendments. *International Journal of Scientific Research in Science, Engineering and Technology* 3(6): 995-103.
- Ali, M., Khandaker, L. and Oba, S. (2010). Changes in pigments, total polyphenol, antioxidant activity and color parameters of red and green edible Amaranth leaves under different shade levels, 8:(3 and 4)(217-222). Retrieved from http://world-food.net/download/journals/2010-issue_3_4/37.pdf
- Amujoyegbe, B.A., Opabode, J. T. and Olayonka, A. (2007). Effect of organic and inorganic fertilizer on yield and chlorophyll content of maize (*Zea mays L*) and Sorghum (*Sorghum bicolor L Moench*). *African Journal of Biotechnical* 6 (16), 1869-1873.
- Andreas W. Ebert, Tien-hor-Wu, and San-Tai Wang. (2011). Vegetable amaranth (*Amaranthus L.*). AVRDC-WorldVegetableCenter.
- Asiegbu, J. C. and Carol, N. Okpara (2000). Effect of organic manure application on yield distribution over time in Truss position on the main stem in egg plants. *Agro. Science*, 74-81.
- De Lannoy, G. (2000). Vegetables. Pp 403-459. In: Raemaekers, R. B. (ed). Crop Production in Tropical Africa.
- Dibble, A. C. (2012). New England Wild Flower Society's Flora Novae Angliae: A Manual for the identification of Native and Naturalized Higher Vascular Plants of New England. Arthur Haines. 2011. Xxxiv + 973 pp. illus. 944 drawings. ISBN: 978-0-300-17154-9. New Haven, CT and London, UK. Yale University Press. Rhodora, 114(959), 337-340. doi: 10.3119/0035-4902-114.959.337
- Fagimi, A.A. and Odebode, C. A. (2007). Effect of Poultry Manure on Pepper Veinal Mottle Virus (PVMV), Yield, and Agronomic Parameters of Pepper (*CAPSICUM annum*) in Nigeria. *East Africa journal of science* 1(12), 104-111.
- Gigliola C., Vera A. (2012). Amaranthus: a crop to discover. forum ware international. Retrieved from <http://forumware.wuwien.ac.at/archiv/1364801634.pdf>.
- Grubben, G. J. (2004). *Amaranthus cruentus L.* PROTA.
- Gupta, S., Lakshmi, A. J., Manjunath, M. N., and Prakash, J. (2005). Analysis of nutrient and antinutrient content of underutilized green leafy vegetables. *Elsevier Ltd*, 339-345.
- Haruna, Y. R., Adzemi, M. A., & Wan Zaliha, W. S. (2019). *Influence of Poultry Manure Rates and Arbuscular Mycorrhizal fungi inoculation on Nutrients Uptake by Sweet Corn (Zea mays saccharata) Grown on Ultisol Soils*: Paper Presented at the Soil Science Conference of Malaysia, 16th – 18th April 2019.
- Haruna, Y. R. (2018). The Potentials of Organic Farming in Nigeria: A Review. *International Journal for Technical and Educational Research* 4(1): 131-140.
- Ibeawuchi, I. I., Opara, F. A., Tom, C. T. and Obiefuna, J. C. (2007). Graded Replacement of Inorganic with Organic Manure for Sustainable Maize Production in Owerri, Imo State, Nigeria. *Life Science Journal* 4 (2); 82-87 (ISBN: 1097-8135).

- Ibrahim, A., Auwalu, B. M., Haruna, Y. R., Abdullahi, R., Lawal, S. M. and Usman, A. (2021). Performance of Green Bean (*Phaseolus vulgaris* L.) Varieties in Response to Poultry Manure in Sudan Savanna of Nigeria. *International Journal for Research in Applied Science & Engineering Technology* 9(9): 763-769.
- Izunobi, N.D. (2002). Poultry husbandry: an integrated approach for tertiary students, extension agents, policy makers and farmers. NADS Publisher Inc., Ithala, Nigeria pp. 4-5, 192.
- Jansen, P. C. (2004). *Amaranthus hypochondriacus* L. PROTA.
- Khandaker, L., Ali, M. B., and Oba, S. (2008). Total polyphenol and Antioxidant Activity of Red Amaranth (*Amaranthus tricolor* L) as affected by Different Sunlight Levels. *Journal of the Japanese Society for Horticultural Science*, 77(4), 395-401. doi:10.2503/jjshs1.77.395
- Markus, D. J. (1990). Composition and nutritional value of vegetable Amaranth as affected by stage of growth, environment and method of preparation. Proceedings of the fourth Amaranth Symposium. Minnesota Extension Services, Minnesota Agriculture University St. Paul
- Markus, D. J. and Davis, D. R. (1984). A mid-summer crop for fresh green of canings: vegetable Amaranth. *Ark Farm Research*, 33:10.
- Nee Repo, R. (2011). *Andean indigenous food crops: nutritional value and bioactive compounds*. University of Turku.
- Nweke, I.A. and Obasi, M.N. (2013). Effect of different levels of pig manure on the growth and yield of Okra Proceedings of the 47th Annual Conference of the Agricultural Society of Nigeria, Ibadan, 2013, pp 23-26.
- O'Brien, G. K., and Price, M. L. (2008). Amaranth grain and vegetable types. ECHO Technical note.
- Shehu, A. M.; Bello, T. T.; Haruna, Y. R.; Abdullahi, R.; Ibrahim, A.; Lawal, S.M. (2019). Growth and Yield of Amaranth (*Amaranthus cruentus*) as Influenced by Poultry Manure Rates and Variety in Sudan Savanna, Nigeria. *International Journal of Agribusiness and Agricultural Sciences* 6(1): 01-07.
- Spetter, J. and Thompson, L. (2007). The revival of an ancient crop. *Low External Inputs AND Sustainable Agriculture*. September, 23 (3): 12-13.
- Srivastava, R. (2001). Nutritional quality of some cultivates and wild species of *Amaranthus* L. Retrieved from <http://ijpsr.com/V2I12/17%20Vol.%20Issue%2012,%20RA-934,%202011,%20Paper%2017.pdf>.
- Stevenson, D. E., and Hurst, R. D. (2007). Polyphenolic phytochemicals – just antioxidants or much more? *Cellular and Molecular Life Sciences*, 64(22), 2900-2916. doi: 10.2007/s00018-007-7237-1
- Venskutonis, P. R., and Kraujalis, P. (2013). Nutritional Components of Amaranth Seeds and Vegetables: A Review on Composition, Properties and Uses. *Comprehensive Reviews in Food Science and Food Safety*, 12(4), 381-412. doi:10.1111/1541-4337.12021
- White Amaranth (*Amaranthus albus*). (2014). Retrieved February 14, 2015, from http://www.illinoiswildflowers.info/weeds/plants/wh_amaranth.htm