INVESTIGATION OF RESPONSE OF AMARANTHS (Amaranthus hybridus) VARIETIES TO DIFFERENT RATES OF COCONUT MILK FOLIAR APPLICATION

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Abstract

The effect of coconut milk on the development of vegetable amaranths was tested at the college farm of the Federal College of Education (Technical), Bichi, during dry seasons. The research was aimed at harnessing the potentials of the coconut milk as a constituent of some phytohormones, such as; zeatin and cytokinin, required in identifying responsive growth rates and productivity of the vegetable amaranths. The treatments consisted of two varieties of amaranths (Improved and local), with five rates of coconut milk (0, 15, 30, 45 and 60%). These were factorially combined and laid out in a randomized complete block design with ten treatment combinations. This was replicated three times. Data was collected on the plant height, number of leaves per plant, number of branches per plant, total fresh weight, total dry matter and marketable yield. The data were subjected to analysis of variance. Significantly, different means were ranked using Duncan Multiple Range Test (DMRT). Results of the study showed that Coconut milk had significant influence on all the characters tested with 15% foliar application producing plants with more desirable traits. Similarly, the improved variety always surpassed the local variety in vegetable output and other desirable traits. In view of this therefore, the potentials of coconut milk application of 15% in amaranths for improved productivity. More research is thus advocated in more leafy vegetables with a view to optimize the usefulness of this important commodity in crop production.

Introduction

Amaranths is one of the most important vegetables consumed in Nigeria. It is usually cultivated by people in farms and gardens. Two classes of amaranths are common the grain and the vegetable amaranths. The vegetable type is clearly distinguished from the grain type. It has succulent leaves with high moisture content, small inflorescense, short stems with broad leaves. It produces less seeds as compared to the grain type (Bashir, 2004). Amaranths species are ancient, cultivated by the western agriculturalists. It originated from the tropical America and was later distributed to the Tropics, Mexico, India and China (Encarta, 2005). Amaranths leaves are rich in protein and are also very good source of carotene, vitamin C, folic acid, iron, calcium and many micro nutrients. The leaves also have nitrate and oxalate levels similar to other green leave vegetables (Norman, 1992). Coconut water contains a variety of nutrients. These include vitamins, minerals, antioxidants, amino acids, and other phytonutrients (Bruce, 2013). The organic compounds present in coconut milk makes it useful as physiologic buffer. Coconut milk has a high level of nitrogen in form of amino acids, phytohormones in adequate balance of plant requirements (Krikorian, 1991). These indicate the use of coconut water as a component of culture medium which can also be used as substitute to expensive organic compound, zeatin (Piexe, *etal*, 2007). Coconut water combined with BAP was reported to be used in the micro propagation protocols of many economically important crops. Foliar spray with 15% coconut milk was reported to significantly enhance the productivity of lettuce (Bashir, *et al*, 2004., Abba, 1991).

It is pertinent to say that increased human population demands a corresponding increase in food production. This is obvious as it relates to important vegetables like amaranths. In view of this, there is the need for an improved technology to enhance quality production of such food items. Amaranths is one of the important vegetables needed all year round, owing to its diverse way of utilization and their requirements in the diets of the populace. However, the current production practices limits its supply to some parts of the year thereby making it a scarce commodity. In view of the aforementioned, it is worthy to harness the potentials of coconut water as rich source of phytohormones, so that the growing season could be maximized to increase overturn in the harvest of the commodity with minimal input.

Objectives of the study

This research is aimed at:

1. Assessing the efficacy of coconut milk foliar application on the productivity of vegetable amaranths.
2. Comparing the two varieties among others in terms of marketable leafy yield.
3. Identifying the best rate of coconut milk that could be used to improve productivity of vegetable amaranths.

Origin and Distribution of Amaranths

Amaranths is distributed worldwide in warm and humid regions. It is also important in the culture, diet and agricultural economy of the people of mexico, central and south America, African and Northern india (Mcgraw, 1997) Amaranthus species originated from low land humid and at higher altitude of the world. However, there are some species of amaranths common to both regions (Rice et al, 1987). Amaranths are grown mainly in East-Asia, Caribbean and Africa like; *A. Caudatus*_2 and *A. Hypochandriacus*_L (Kochhar, 1981). Also, Amaranthus species are grown in Africa and in South East Asia for soup or boiled for salad. The crop is widely cultivated for its leaves in many parts of Nigeria (Omidiji, 1978).

Importance of Amaranths

Chadha (2007) revealed that amaranths is very nutritive and that rapid growth as well as high yield of edible matter were valuable source for combating under-nutriton and malnutrition. Leaf amaranths are rich in provitamin A, vitamin C, iron, calcium and protein with lysine constituting as much as 5.9% of protein (equal to soyameal, and more than some of the best maize strains); glutomic acid constitutes as much as 10.8% of protein (Mcgraw, 1997).

There is an increasing awareness of the value of leafy vegetable in contributing to a balanced diet particularly in area where animal protein is deficient. Amaranths contribute significant amounts of vitamin C, protein, minerals (particularly calcium) and carbohydrate, (Rice et al, 1987).

Amaranth is also a useful as a forage crop for feeding livestock. Leaf protein concentrates can be extracted from amaranth and used for feeding young children and other persons with high protein, vitamin A and iron deficiencies (Carlsson, 1984). Nutritionally, amaranth is similar to other leaf vegetables. The dry matter content is often high (about 13%) and the nutritional value of its products are excellent because of its high content of mineral (calcium and iron) and vitamins (Oyenuga and Fetuga, 1975).

Ecological Requirements for Amaranthus Production

Amaranths can be grown on a wide variety of soil. However, sandy loam soil is best suited for its successful cultivation. It is also a C – 4 plant which can make efficient use of carbon II oxide (CO_2) and suppresses its photorespiratory loss (Chadha 2007). A C – 4 plant is any plant that possesses the C4 pathway of carbon dioxide fixation. In such plants, metabolic pathways concerned with photosynthesis are comparted between mesophyll cells and bundle sheath cell in the leaf. Soil with high organic content are required for optimum yields in amaranths production. Some species are tolerant of a wide range of soil conditions; optimum pit range is 5.5 – 7.5 seeds sown direct on raised beds or broadcast on seed beds and transplant to permanent beds, (Rice et al, 1987).

The crop is grown in areas with an annual rainfall of 3000mm. During the dry season, it can be grown under irrigation. It adapts to many environmental conditions and tolerate adversities such as low fertility, high temperature, bright sunlight and dry conditions (NRC, 1984). Amaranths require well moistened soil for proper growth and development. However, once seedling are established, grain amaranths do well with limited water, infact they are known to grow best under warm conditions (Cambell and Foy, 1984).

Plant Growth Substances/Regulators

Coconut (*Cocoss nucifera*) milk enhances growth and development in vegetable crops. It is one of the groups of hormones that influences the growth of plants. They greatly accelerate the development of plant embryos and promote the growth of isolated tissues and cells (Peter et al, 1992). Foliar spray with coconut milk on lettuce weekly at 15% dilution resulted in increased leaves number, plant height and yield (Bashir, 2004). Chawla (2005) revealed that hormones are organic compounds naturally synthesized in higher plants which influences growth and development. There are two main classes of growth regulators that are of special importance in plant tissue culture. These are the auxins and cytokinins, while others such as gibberellins, abscisic acid, ethylene etc. are of minor importance. Cytokinns induces or promotes the production of DNA, RNA protein synthesis cthiamine synthesis. They are involved in the stimulation of organ formation (e.g. formation of leaf, fruit, buds and branches) and are also useful in the preservation of flowers, fruits and leafy vegetables (Philip et al, 2006).

Cytokinins are also known as anti-aging hormones, regulates cell division and influences the rate at which plants age. Depending on the amount of cytokinins present, the aging process in plants can be either accelerated or retarded (Bruce, 2013).

Study Area

The study area for the research is the Federal College of Education (Technical), Bichi Kano State. This is located at 8^0 14^1 – 12^0 14^1E latitude and $12^0 14^1$ - 14^1 - 15^1N longitude and 570m above sea level. Bichi lies in the Sudan Savanna agro ecological zone of Nigeria. Soils of the experimental area are characterized by sandy loam texture. (Abdul'azeez, 2008)

Treatments and Experimental Design

The study is a two factor experiment (Coconut milk and Amaranths varieties). It consisted of two varieties of amaranths (improved and local), and five rates of coconut milk (0, 15, 30, 45, & 60%). These were factorially combined to have ten treatment combinations, and laid out in a randomized complete block design with three replications.

Material and Method

Materials include: coconut, sprayers, water, measuring tapes, rulers, weighing scale, envelopes (bag), amaranthus seeds, cow dungs. The land was cleared from debris, wetted and ploughed using manual hoe. Ten plots of 3 x 3.6m = 10.8m^2 were ear-marked with pegs in each replicate. The plots were separated by 0.5m in between, while 1.0m border was earmarked to separate each replicate and the next. The total field size was 441.6m^2. Two amaranths varieties (improved and local) were raised in a nursery bed for two weeks. These were later transplanted to the prepared bed/plots at an intra row spacing of 30cm and inter row spacing of 60cm. Each plot comprises of ten stands per row and 6 rows per plot. This brings about a total of 60 stands per plot and 1358.69 stands per hectare as the plant population.

Plants were hoe weeded twice at two (2) and five (5) weeks after transplanting to keep it weed free. Ten tons/ha of cow dung manure was incorporated to the soil during land preparation as suggested by Norman (1992) as the standard practice in Amaranths production.

Preparation and Application of the Coconut Milk Rates

Code'ivore Coconut were procured from Yanlemo market, Kano. These were broken, split open to collect the milk. From the stock solution, 15, 30, 45 and 60% concentration were prepared by simple serial dilution technique using 100ml measuring cylinder. These were applied foliar applied (sprayed) to the designated amaranths plots at 3 weeks after planting (TWAT). Designated plants were however, sprayed with equivalent amount of ordinary water as control.

Sampling and Data Collection

Five randomly selected stands were tagged in each plot. Data on plant height, number of leaves per plant, leaf area/plant, total fresh weight and total dry matter were monitored and collected from the randomly tagged plants, across 1 – 4 weeks after transplanting.

Analysis of Data

Data collected on the above parameters were subjected to analysis of variance using (Snedecor and Cochran, 1967). Where significant difference was observed among the treatments, their means were ranked using Duncan multiple range test (DMRT) (Duncan, 1955).

Results and Discussion

Plant Height

Results of the plant height of amaranths sampled across 1- 4 weeks after transplanting as affected by variety and coconut milk foliar application is presented in Table 1. This showed a significant effect with the improved variety which presented significantly taller plants in all the samples. This might be due to genotype differences, as the improved variety had already been modified with potential traits for enhanced productivity. Significantly taller plants were recorded from the 15% and 20% coconut milk treated plants at 1, 2 and 3 weeks after transplanting. At the three weeks after transplanting (3 WAT), however, the 15 and 30% coconut milk treated plants were at par, while shortest plants were recorded from the control and 60% treated plants. Similar results were reported by Abba (1991) who suggested the 15% coconut milk foliar application enhanced amaranths productivity during rainy season.

Number of Leaves per Plant

The improved and local amaranths cultivars differed significantly in their number of leaves across 1 – 4 WAT (Table 2). The improved variety presented significantly higher number of leaves in all the sampling periods of the study. This is expected due to genotypic differences with the improved variety having genetic traits for enhanced productivity.

Plants with significantly higher number of leaves were also obtained from the 15% coconut milk treated plants. These were followed by the 30% with the control and 60% treatments having the least number of leaves all of which were not significantly different in all the sampling periods. The interactions of the varietal and coconut milk rates were however, not significant in all the samples.

Table 1: Plant height of Amaranths as affected by variety and coconut milk rates across 1 – 4 weeks after transplanting in 2013 dry season.

Treatment	Weeks after transplanting (WAT)			
	1	2	3	4
Variety				
Improved	29.00a	39.50a	63.20a	79.00a
Local	23.00b	35.20b	50.30b	72.30b
SE ±	0.03	0.09	0.11	0.14
Coconut milk rate (%)				
Control	26.5c	40.7c	49.1c	63.7b
15	31.00a	51.2a	63.7a	80.9a
30	30.71a	50.7a	61.2b	79.3a
45	28.0b	44.1b	49.0c	61.4c
60	24.1d	41.7c	43.1d	55.0d
SE ±	0.01	0.05	0.11	0.17
Interaction (v x r)	NS	NS	NS	NS

Means followed by the same letter (s) within columns are not significantly different 5 % level of probability (DMRT)

Key: SE ± = Standard Error; V = Variety, r = Replication

Table 2: Number of leaves per plant of Amaranths as affected by variety and coconut milk rates across 1 – 4 weeks after transplanting in 2013 dry season.

Treatment	Weeks After Transplanting (WAT)			
	1	2	3	4
Variety				
Improved	23.00a	29.50a	73.20a	77.00a
Local	20.00b	24.00b	50.00b	57.00b
SE ±	0.001	0.007	0.010	0.011
Coconut milk rate (%)				
Control	18.00c	21.00c	51.00c	57.00b
15	23.00a	28.00a	74.00a	81.00a
30	21.00b	28.00a	71.00b	80.00ab
45	18.00c	22.00b	53.00bc	71.00c
60	17.00cd	21.00c	50.00c	56.00d
SE ±	0.01	0.11	0.17	0.23
Interaction (v x r)	NS	NS	NS	NS

Means followed by the same letter (s) within columns are not significantly different 5 % level of probability (DMRT)

Key: SE ± = Standard Error; V = Variety; r = Replication

Leaf Area (Cm^2) per Plant (LApP)

Varietal difference had a significant effect on the leaf area of amaranths in this study (Table 3). Results showed that the improved variety manifested leafs with a wider surface area. However, coconut milk foliar application did not have any significant effect on the leaf area of the amaranths. This justified the role of genotype as controlling these traits.

Leaf Area Index (LAI)

The leaf area index of the amaranths tested as influenced by variety and coconut milk foliar application is presented in table 4. Results indicated that the improved variety also produced significantly higher leaf area index. There was however, conflicting results as opposed to the leaf area. This is because as the 15% and 30% treated plants produced significantly higher LAI at 1, 2 & 4 WAT, all of which were not significantly different. The 15 & 60% treated plants were however at par during the 1, 2 and 3 WAT.

Total Fresh Weight (g)

Varietal difference had a significant effect on the total fresh weight of the amaranths tested in this study (Table 5). Results of the study showed that the improved variety had plants with significantly higher total fresh weight in all the sampling periods. Similarly, the 15% coconut milk treated plants produced significantly higher total fresh weight in all the sampling periods. These were following by the 30% while the least total fresh weight was obtained from the control in all the samples. This signified the role of coconut milk as having some vital ingredients such as cytokinins that provide apical growth as reported by Bruce (2013).

Table 3: Leaf area per plant (cm^2) of Amaranths as affected by variety and coconut milk rates across 1 – 4 weeks after transplanting in 2013 dry season.

Treatment	Weeks After Transplanting (WAT)			
	1	2	3	4
Variety				
Improved	5.73a	32.33a	113.75a	233.23a
Local	4.57b	29.75b	101.23b	211.11b
SE ±	0.02	0.07	0.10	0.14
Coconut milk rate (%)				
Control	4.75	29.11	117.63	235.33
15	5.00	30.79	112.33	245.75
30	5.15	31.23	113.00	243.66
45	5.11	29.75	110.00	232.11
60	4.75	29.23	111.11	237.75
SE ±	0.11	0.17	0.21	0.32
Interaction (v x r)	NS	NS	NS	NS

Means followed by the same letter (s) within columns are not significantly different 5 % level of probability (DMRT)

Table 4: Leaf area index of Amaranths as affected by variety and coconut milk rates across 1 – 4 weeks after transplanting in 2013 dry season.

Treatment	**Weeks After Transplanting (WAT)**			
	1	2	3	4
Variety				
Improved	0.02a	0.07a	0.79a	0.98a
Local	0.01b	0.05b	0.66b	0.79b
SE ±	0.001	0.003	0.005	0.013
Coconut milk rate (%)				
Control	0.03b	0.05c	0.53c	0.61b

15	0.07a	0.10a	0.69a	0.92a
30	0.06a	0.09a	0.57b	0.91a
45	0.04ab	0.06b	0.49cd	0.57c
60	0.03b	0.05c	0.47d	0.55d
SE $\pm$	0.001	0.004cd	0.007	0.014
Interaction (v x r)	NS	NS	NS	NS

Means followed by the same letter (s) with in columns are not significantly different 5 % level of probability (DMRT)

Key: SE $\pm$ = Standard Error, V = Variety, r = Replication

Table 5: Total Fresh weight (g) of Amaranths as affected by variety and coconut milk rates across 1 – 4 weeks after transplanting in 2013 dry season.

Treatment	**Weeks After Transplanting (WAT)**			
	1	2	3	4
Variety				
Improved	16.11a	36.22a	42.33a	107.11a
Local	12.67b	25.37b	38.21b	97.61b
SE $\pm$	0.10	0.17	0.19	0.21
Coconut milk rate (%)				
Control	11.17d	22.73d	36.21c	91.23d
15	17.11a	36.33a	47.23a	111.73a
30	15.23ab	35.12ab	46.19ab	99.23b
45	12.67b	29.12b	39.22b	77.11c
60	12.11bc	26.13c	38.77bc	76.77cd
SE $\pm$	0.11	0.17	0.23	0.37
Interaction (v x r)	NS	NS	NS	NS

Means followed by the same letter (s) within columns are not significantly different 5 % level of probability (DMRT)

Key: SE $\pm$ = Standard Error; V = Variety; r = Replication

Total Dry Matter (g)

The improved variety also produced significantly higher total dry matter (g) in all the sampling periods (Table 6). Similarly, the foliar application of coconut milk had significantly affected the total dry matter of the plants during the period under study. Results showed that 15% coconut milk treated plants produced significantly higher total dry matter in all the sampling periods. These were followed by the 30% treated plants all of which were at par, while the least plant dry matter was recorded from the control treatment. Similar findings was reported by Abba (1991) in which the 15% coconut milk treated plants surpassed the local variety in vegetable output and other desirable traits. This also emphasizes on the significance of coconut milk as a growth booster.

Marketable Yield (Tonne/ Ha)

Varietal difference also had significant effect on the marketable yield of amaranths in the period under study (Table 7). Results showed that the improved variety surpass the local variety. This is owing to the genotype differences as the improved variety has in it, inherent desirable traits for better yield. Similarly, the 15% coconut milk treated plants produced significantly higher marketable yields than all other treatment. These were followed by 30, and 45% treated plants, while the lowest marketable yield was obtained from the control and 60% treated plants, all of which were not significantly different. Abba (1991) reported similar observation.

Table 6: Total Dry Matter (g) of Amaranths as affected by variety and coconut milk rates across 1 – 4 weeks after transplanting in 2013 dry season.

Treatment	**Weeks After Transplanting (WAT)**			
	1	2	3	4
Variety				
Improved	7.13a	13.77a	37.23a	59.11a
Local	4.12b	10.11b	25.13b	47.77b
SE ±	0.01	0.05	0.09	0.12
Coconut milk rate (%)				
Control	4.55d	11.75c	27.11c	57.33c
15	8.19a	15.77a	51.23a	114.23a
30	7.23ab	15.21a	49.11ab	109.27ab
45	5.11b	12.67b	43.12b	100.11b
60	5.00c	11.07c	26.01c	49.37c
SE ±	0.11	0.17	0.23	0.37
Interaction (v x r)	NS	NS	NS	NS

Means followed by the same letter (s) within columns are not significantly different 5 % level of probability (DMRT)

Key: SE ± = Standard Error, V = Variety, r = Replication

Table 7: Marketable Yield (ton/ha)) of Amaranths as affected by variety and coconut milk rates across 1 – 4 weeks after transplanting in 2013 dry season.

Treatment	Leafy Marketable Yield
Variety	
Improved	30.13a
Local	21.41b
SE ±	0.17
Coconut milk rate (%)	
Control	22.13d
15	31.77a
30	29.91b
45	26.11c
60	22.77d
SE ±	0.71
Interaction (v x r)	NS

Mean followed by the same letter within column are not significantly different at 5 % level of probability (DMRT)

Key: SE ± = Standard Error; V= Variety; r = Replication

Conclusion and Recommendations

In conclusion treatment 15% concentration of coconut milk has the best effect on both growth and yield performances of amaranths. It is also more economical as higher concentrations produced reduced performance than the control. The study wish to recommend carrying out same research using other vegetable plants.

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