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EVALUATION OF FOLIAR APPLICATION OF AQUEOUS *ASCOPHYLLUM NODOSUM* (L.) EXTRACT ON VEGETATIVE GROWTH OF SOME VEGETABLES IN KANO METROPOLIS

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ABSTRACT
Consumption of vegetables greatly enhances health and life quality and its production boosts economic and social status. This study was carried out at the Teaching and Research farm of Faculty of Agriculture, Bayero University, Kano in order to determine the effectiveness of foliar application of six selected concentrations (0, 0.5, 1.0, 1.5, 2.0 and 2.5 g/L) of aqueous extract of A. nodosum on growth of okra, watermelon and Amaranth. The experiment was laid out in Completely Randomized Block Design (CRBD) with six replications and data were collected on plant height, number of leaves and branches, leaf area, chlorophyll content and dry weight in all the three selected vegetables. Data collected were subjected to analysis of variance and the Fisher's least significant difference was used to separate the means. The analysis has indicated that the measured parameters were significantly (P>0.05) affected by the foliar application of the extract where substantial growth was observed in selected vegetables treated with 1.0, 1.5 and 2.0 g/L aqueous extract of *A. nodosum*. Therefore, at those concentrations the extract was found to be an effective growth promoting compound on the amaranth, okra and watermelon and extending this result on small and medium size farmlands could improve production and thus, benefit both local farmers and consumers in Kano and other places.

Keywords: Vegetables, Growth, *A. nodosum* extract, Metropolis, Foliar

INTRODUCTION

One of the important roles of vegetables is in provision of micronutrients which was found to prevent some ailments and hence production of micronutrient rich food such as vegetables are considered essential (Badifu and Ogunsua, 1991; Ifon and Bassir, 2001; Aletor *et al*., 2002). Production of vegetables, besides its contribution to better health and quality of life, enhance the economic and social status of a nation. For example, in 2021, vegetables primary production for Nigeria was 15.8 million tonnes. Between 1972 and 2021, vegetables primary production of Nigeria grew substantially from 2.99 million to 15.8 million tonnes rising at an increasing annual rate that reached a maximum of 20.77 % in 2014 and then decreased to -0.69 % in 2021. It is in this regard that fruiting and leafy vegetables such as Okra (*Abelmeschus esculentus* L.), Amaranth (*Amaranthus cruentus* L.) and watermelon (*Citrullus lanatus* L.) became highly valued crops, particularly in the Northern part of Nigeria. Production constraints have been reported previously in vegetable production systems in Cameroon, Benin, Nigeria, Senegal and South Africa (Ogunjimi and Adekalu, 2002; Temple and Moustier, 2004; Shackleton *et al*., 2010; Ngome and Foeken, 2012; Alao *et al*, 2014).

Nigeria and Benin Republic are reported to have least production figures of these vegetables, while South Africa is ranked the largest producer in the continent (FAO, 2008). In Nigeria, governmental and Non-governmental organizations have developed agricultural plans to promote and expand dry season agriculture so as to meet up with the food demands to feed the growing population and export to earn foreign exchange. World Health Organization (WHO) and Food and Agriculture Organization (FAO) recommended an intake of 400 g of vegetables per person per day or 150 kg per year. However, consumption of vegetables cannot be said to be adequate among the populace of Kano and Nigeria due to a number of factors including low production (Aliko *et al*., 2017). The study added that the demand for okra, amaranths and watermelon in urban Kano is relatively high and cannot be met by existing level of production from peri-urban vegetable farmers. Insufficient knowledge of improved practices and use of compounds from natural source, particularly plants which overcome constraints to poor growth by vegetable farmers in subsistent and commercial production cannot be overlooked.

There are concerns for contamination with carcinogenic compounds as well as other factors like cost and handling and this necessitated the search for biostimulant from natural source that could promote hormone activity on growth and yield of vegetable species. In this regard, the extract of some plant species including Moringa (*Moringa oleifera*), Tomato (*Solanum lycopersicon*), Carrot (*Daucus carota*), Coconut (*Cocos nucifera*) and Cucumber (*Cucumis sativus*) have been used as growth regulators (Phiri, 2010; Sandoval *et al*., 2014; Beata and Elżbieta, 2016). Exploration in this regard will complement the role of synthetic growth hormones which are expensive for ordinary vegetable growers. *Ascophyllum nodosum* is widely used in agriculture due to their good biostimulant activity (Matysiak *et al*., 2010). This study would therefore, determine the effectiveness of seaweed-based growth promoting compound in order to provide opportunity for subsequent development by farmers of vegetables to boost production.

MATERIALS AND METHODS

Study area

The research work was conducted in 2017 at the University Research Farms, Faculty of Agriculture, Bayero University, Kano on latitude 11°58"50' and 11°98"18', longitude 8°28"46'E and 8°48"01' and altitude 486.5 m. The study involved four major activities, namely; pre and post planting activities, preparation and application of test materials, management of experimental plots and measurement of selected parameters.

Sowing of Experimental Plants

Sowing of okra variety (NHB-AI-13) and watermelon (Kaolack) on the prepared pots was done by direct seeding at the rate of 3 and 1 seed per hole respectively. A local vegetable amaranth that was obtained from the farmers was also sown by direct seeding of mixture of sand and the amaranth seeds, with 10 g of seeds per 1 kg of fine river sand.

Treatments

Six different concentrations (0, 0.5, 1.0, 1.5, 2.0 and 2.5 g/L) of the aqueous extracted of *A. nodosum* were prepared and applied on the watermelon, amaranth and okra plants by foliar spray as described by Aliko *et al.* (2017).

Data Collection

The following parameters after observing all the agronomic practices were measured at seventh and ninth week after sowing.

Plant height (cm): height of plants was determined from each pot and plot by measuring with a meter rule from the ground level to the tip of stem or terminal bud. The data was recorded and the average determined.

Number of leaves: This was obtained by counting number of leaves and mean recorded.
Total area of leaf: This was measured using leaf area meter L1 – 3100 and the mean recorded.
Number of branches: Number of primary branches was counted and the average recorded.
Chlorophyll contents: This was measured using the model Minolta spad 502 plus meter produced by Spectrum Technologies of USA.

Experimental design and data analysis

The experimental units were arranged in Complete Randomized Block Design (RRBD). Data collected were subjected to analysis of variance and significant difference within the means were separated using Fisher's least significant difference test at $p \leq 0.05$.

RESULTS AND DISCUSSION

Results obtained on the effect of various concentrations of *A. nodosum* extract on vegetative growth parameters showed that plant height of amaranth, okra and watermelon was significantly P>0.05 found to be influenced by the application of aqueous *A. nodosum* extract at seven and nine weeks after planting while amaranth and watermelon recorded greater effect at 1.0, 1.5 and 2.0 g/L (Table 1). Results on number of branches and chlorophyll content showed significant difference (P>0.05) (Table 2) at different concentrations. Number of branches at 7 WAP was found to be greater in amaranth and okra treated with 1.0, 1.5 and 2.0 g/L when compared with what other concentrations produced. At 9 WAP, all the three vegetables sprayed with 1.5 and 2.0 g/L produced more branches compared with 0.5, 1.0 and 2.5 g/L while the control (0 g/L) treatment had significantly few numbers of branches in amaranth. Chlorophyll content was only affected by the extract in amaranth at 9 weeks after planting (9 WAP) where amaranth plants treated with 1.5, 2.0 and 2.5 g/L of *A. nodosum* extract produced more chlorophyll.

Table 3 showed results of leaf area and dry shoot weight as affected by the various concentrations of aqueous *A. nodosum* extract. Leaf area was also significantly affected in watermelon at both samplings, where *A. nodosum* concentrations at 0.5, 1.0, 1.5, 2.0 and 2.5 produced significantly higher leaf area than in the control. The increase in most of the measured parameters of vegetables by the application of three best performed concentrations (1.0, 1.5 and 2.0 g/L) of *A. nodosum* extracts coincided with earlier studies (Pise and Sabale, 2010; Kocira *et al*., 2013; Papenfus *et al*., 2013) and it could be attributed to the rich zeatin, a purine adenine derivative of plant hormone (cytokinin) (Makkar *et al*., 2007; Rady *et al*., 2013) which was found to enhance the antioxidant properties of many enzymes and protect plant cells from senescence (Zhang and Ervin, 2004) and also responsible for mitotic induction, stimulation of chloroplast maturation, growth of shoot and lateral buds (Chouliaras *et al.* 2009; Matysiak *et al*., 2010).

Findings of the present study were also corroborated in the previous report by Shahbazi *et al.* (2015) who conducted research on the effect of seaweed liquid fertilizer (SLF) of *Ulva fasciata*, *Nizimuddinia zunardini* and *Gracilaria corticata* without chemical fertilizer on seed germination, growth parameter, pigment and carbohydrate content of Wheat var. (Chamran) where they concluded that, seeds soaked with aqueous extract of seaweeds performed better when compared to the seeds soaked in water. Thambiraj *et al.* (2012) reported increased content of total chlorophylls in *Cyamopsis tetragonoloba* (L.) with seaweed application.

Table 1: Effect of different Concentrations of Aqueous Extract of *A. nodosum* on Plant Height and Number of Leaves at 7 and 9 Weeks after Planting in Amaranth, Okra and Watermelon, 2017

A.nodosum concentrations (g/L)	Plant height (cm) 7 WAP	Plant height (cm) 9 WAP	Number of leaves 7 WAP	Number of leaves 9 WAP
		Amaranth		
0	21.47 ± 1.75^{d}	30.30 ± 2.05^{c}	35.33 ± 0.58^{b}	57.00 ±3.54^{c}
0.5	28.63 ± 4.50^{c}	37.63 ± 2.83^{b}	36.67 ± 2.79^{b}	56.33 ±1.43^{c}
1.0	33.80 ± 2.07^{ab}	38.77 ± 3.65^{ab}	37.33 ± 2.03^{b}	58.00 ± 2.72^{bc}
1.5	34.50 ± 1.76^{ab}	45.00 ± 0.98^{a}	43.67 ± 2.74^{a}	67.00 ± 4.58^{b}
2.0	36.43 ± 2.48^{a}	47.90 ± 2.69^{a}	43.00 ± 1.29^{a}	79.67 ± 3.51^{a}
2.5	30.33± 1.40^{bc}	37.67 ± 3.87^{b}	36.67± 2.14^{b}	67.33 ± 4.62^{b}
LSD (5%)	4.63	6.90	5.61	10.20
		Okra		
0	13.83 ± 1.99	23.50 ± 2.31^{ab}	8.33 ± 1.53^{a}	11.33 ± 1.53^{a}
0.5	14.30 ± 1.97	22.90 ± 1.52^{b}	8.00 ± 1.65^{a}	11.67 ± 1.53^{a}
1.0	15.97 ± 1.56	23.10 ± 1.95^{ab}	9.67 ± 0.58^{a}	10.67 ± 1.15^{a}
1.5	17.57 ± 1.87	26.27 ± 1.70^{a}	10.00 ± 1.00^{a}	12.33 ± 1.04^{a}
2.0	17.70 ± 0.53	27.00 ± 2.95^{a}	10.33 ± 0.58^{a}	12.33 ± 3.21^{a}
2.5	16.20 ± 0.72	23.97 ± 1.72^{ab}	8.67 ± 1.15^{a}	11.00 ± 1.73^{a}
LSD (5%)	NS	4.25	NS	NS
		Watermelon		
0	41.03 ± 1.55^{b}	61.47 ± 1.55^{c}	14.67 ± 1.08^{b}	27.67 ± 0.58^{a}
0.5	44.13 ± 1.61^{ab}	70.03 ± 1.41^{b}	15.00 ± 1.00^{b}	28.00 ± 1.73^{a}
1.0	44.70 ±1.59^{a}	73.67 ± 1.32^{ab}	17.00 ± 1.55^{b}	29.67 ± 1.51^{a}
1.5	45.67 ± 1.00^{a}	73.60 ± 1.10^{ab}	22.33 ± 1.29^{ab}	30.00 ± 1.58^{a}
2.0	46.60 ± 1.22^{a}	79.10 ± 0.89^{a}	27.33 ± 1.62^{a}	31.33 ± 1.93^{a}
2.5	43.10 ± 1.65^{ab}	68.27 ± 1.67^{b}	17.00 ± 2.20^{b}	27.33 ± 1.08^{a}
LSD (5%)	3.95	6.81	7.70	NS

Mean ± Standard Deviation. Mean followed by different superscript along column for a plant are significantly different ($p \leq 0.05$) using Fisher's LSD (Least Significant Difference)

Table 2: Effect of different Concentrations of Aqueous Extract of *A. nodosum* on Number of Branches and Chlorophyll Content at 7 and 9 Weeks after Planting in Amaranth, Okra and Watermelon, 2017

A. nodosum concentrations (g/L)	Number of branches		Chlorophyll Content	
	7 WAP	9 WAP	7 WAP	9 WAP
		Amaranth		
0	1.33 ± 1.53^{b}	6.33 ± 0.58^{c}	71.53 ± 0.97^{a}	74.20 ± 2.95^{b}
0.5	1.67 ± 1.15^{b}	9.33 ± 0.58^{b}	72.77 ± 2.08^{a}	75.43 ± 2.25^{b}
1.0	2.00 ± 1.00^{ab}	8.67 ± 0.89^{b}	73.33 ± 1.26^{a}	77.97 ± 2.20^{b}
1.5	2.67 ± 0.58^{ab}	12.33 ± 0.58^{a}	73.70 ± 0.95^{a}	98.13 ± 2.99^{a}
2.0	3.00 ± 0.00^{a}	12.33 ± 1.53^{a}	73.30 ± 1.30^{a}	95.97 ± 1.34^{a}
2.5	1.67 ± 0.58^{b}	9.33 ± 0.58^{b}	73.53 ± 1.29^{a}	96.20 ± 2.09^{a}
LSD (5%)	1.00	2.40	NS	8.03
		Okra		
0	0.67 ± 0.10^{c}	0.33 ± 0.18^{b}	71.07 ± 1.29^{a}	73.27 ± 1.43^{a}
0.5	1.00 ± 0.00^{bc}	0.67 ± 0.18^{b}	67.60 ± 1.41^{a}	73.53 ± 1.45^{a}
1.0	1.67 ± 0.28^{ab}	0.67 ± 0.18^{b}	68.80 ± 1.26^{a}	74.50 ± 1.68^{a}
1.5	2.00 ± 0.00^{ab}	1.67 ± 0.15^{a}	67.27 ± 1.73^{a}	76.37 ± 1.28^{a}
2.0	2.67 ± 0.28^{a}	1.67 ± 0.18^{a}	67.83 ± 1.49^{a}	78.13 ± 1.50^{a}
2.5	1.33 ± 0.18^{b}	0.67 ± 0.18^{b}	66.40 ± 1.96^{a}	74.13 ± 1.11^{a}
LSD (5%)	1.02	0.90	NS	NS
		Watermelon		
0	2.00 ± 0.00	3.33 ± 0.15^{b}	70.30 ± 2.50^{a}	77.63 ± 1.59^{a}
0.5	2.00 ± 0.00	4.33 ± 0.53^{b}	74.33 ± 2.94^{a}	79.43 ± 2.69^{a}
1.0	2.33 ± 0.28	4.00 ± 0.73^{b}	72.30 ± 2.72^{a}	80.97 ± 0.59^{a}
1.5	2.67 ± 0.28	5.67 ± 0.53^{a}	72.10 ± 1.00^{a}	81.27 ± 0.91^{a}
2.0	3.00 ± 0.00	6.00 ± 0.00^{a}	74.50 ± 2.78^{a}	81.67 ± 1.07^{a}
2.5	2.67 ± 0.28	4.33 ± 0.53^{b}	72.73 ± 2.62^{a}	78.20 ± 1.78^{a}
LSD (5%)	NS	1.66	NS	NS

Mean ± Standard Deviation. Mean followed by different superscript along column for a plant are significantly different ($p \leq 0.05$) using Fisher's LSD (Least Significant Difference)

Table 3: Effect of different Concentrations of Aqueous Extract of *A. nodosum* on Leaf Area and Dry Shoot Weight at 7 and 9 Weeks after Planting in Amaranth, Okra and Watermelon,

A. nodosum concentrations (g/L)	Leaf area (mm^2)		Dry shoot weight (g)	
	7 WAP	9 WAP	7 WAP	9 WAP
		Amaranth		
0	38.93 ± 1.93	50.53 ± 1.45^{b}	8.70 ± 0.78^{b}	13.77 ± 1.04^{b}
0.5	39.03 ± 0.23	52.03 ± 2.67^{ab}	11.17 ± 0.55^{a}	20.97 ± 0.60^{a}
1.0	41.70 ± 1.46	51.90 ± 2.36^{ab}	11.70 ± 0.87^{a}	20.87 ± 0.46^{a}
1.5	42.60 ± 2.37	55.50 ± 2.43^{ab}	12.93 ± 1.01^{a}	22.10 ± 1.29^{a}
2.0	41.93 ± 1.91	56.17 ± 0.31a	13.07 ± 1.90^{a}	22.27 ± 1.53^{a}
2.5	40.10 ± 1.47	53.73 ± 2.95^{ab}	11.20 ± 0.89^{a}	21.77 ± 1.76^{a}
LSD (5%)	NS	5.40	2.28	3.01
		Okra		
0	43.67 ± 0.85^{b}	58.43 ± 2.08	10.17 ± 1.76^{b}	15.70 ± 0.31^{b}
0.5	43.63 ± 1.84^{b}	59.93 ± 1.09	13.67 ± 1.68^{a}	18.77 ± 1.26^{a}
1.0	45.20 ± 1.55^{b}	58.93 ± 2.27	13.97 ± 1.62^{a}	18.30 ± 0.95^{a}
1.5	51.63 ± 2.01^{a}	59.67 ± 1.96	13.43 ± 1.11^{a}	18.47 ± 0.70^{a}
2.0	53.00 ± 2.28^{a}	59.00 ± 2.52	13.63 ± 1.32^{a}	20.20 ± 1.05^{a}
2.5	43.20 ± 0.26^{b}	54.10 ± 1.91	13.80 ± 1.12^{a}	18.27 ± 1.01^{a}
LSD (5%)	3.33	NS	2.89	2.00
		Watermelon		
0	38.33 ± 1.00^{b}	52.57 ± 0.25^{b}	6.27 ± 0.42^{a}	9.80 ± 0.15^{a}
0.5	43.17 ± 0.50^{a}	57.83 ± 0.66^{a}	6.20 ± 0.25^{a}	9.87 ± 0.74^{a}
1.0	43.17 ± 1.96^{a}	59.67 ± 1.83^{a}	7.13 ± 0.99^{a}	10.17 ± 0.96^{a}
1.5	43.60 ± 0.78^{a}	60.63 ± 1.31^{a}	7.13 ± 0.42^{a}	11.23 ± 0.45^{a}
2.0	44.57 ± 1.73^{a}	59.90 ± 1.76^{a}	7.33 ± 0.20^{a}	11.33 ± 0.45^{a}
2.5	43.97 ± 1.40^{a}	58.03 ± 1.23^{a}	6.73 ± 0.84^{a}	10.53 ± 1.68^{a}
LSD (5%)	2.93	3.15	NS	NS

Mean ± Standard Deviation. Mean followed by different superscript along column for a plant are significantly different ($p \leq 0.05$) using Fisher's LSD (Least Significant Difference)

CONCLUSION

The study indicated that foliar application of 1.0, 1.5 and 2.0g/L aqueous extract of *Ascophyllum nodosum* enhanced plant growth, increasing number of leaves, primary branches, dry shoot weight, chlorophyll content as well as plant height of amaranth, okra, and watermelon. Thus, the *A. nodosum* extract has demonstrated its potentiality as growth promoting material.

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