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EFFECT OF INDOLE-3-ACETIC ACID AND COCONUT MILK ON VEGETATIVE GROWTH OF *AMARANTHUS HYBRIDUS* LINN

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ABSTRACT
Studies were carried out on the effect of Indole-3-acetic acid (IAA) and coconut milk on the vegetative growth and chlorophyll contents of Amaranthus hybridus Linn. Subsp. Cruentus (L.) Thell. The various treatments of IAA and coconut milk considerably enhanced plant height, stem circumference, number of leaves, shoot dry weight, root dry weight, leaf area and chlorophyll contents. Of all the IAA and coconut milk treatments, 15% coconut milk was the most effective. As the concentration of IAA was increased from 50ppm to 200ppm, corresponding increases were observed in plant height, stem circumference, number of leaves, chlorophyll content, shoot and root dry weights and leaf content. As for coconut milk, there were increases in these parameters with increase in concentration from 5% to 15% but a decrease at 25%.

Keywords: Indole-3-acetic acid, coconut milk, vegetative growth, Amaranthus hybridus.

INTRODUCTION

Amaranthus hybridus belongs to the family Amaranthaceae (Anonymous, 1984) and it is cultivated as a leafy vegetable in Nigeria (Omidiji, 1978). *Amaranthus hybridus* has a high dietary value with high levels of nutritionally important lysine, methionine, mineral elements and vitamins A, B and C being present in the leaves (Kock *et al.,* 1965; Oyenuga, 1968; Faboya, 1983).

A lot of work has been done on the effects of plant hormones on the growth and yield of many plants. Singh et al. (1984) observed that spraying of rice plants at anthesis with Kinetin and IAA significantly increased the number of grains per panicle, percentage of filled spikelets, 1000-filled grain weight and yield, gibberellic acid and ethrel had no effect. Mohammed *et al.* (1984) detected that spraying of 1½ years old guava plants with ethephon increased flower and fruit production, naphthalene acetic acid and diaminozide were not effective. A similar result of increased flower and fruit production in apple plants sprayed with indole-3-acetic acid was reported by Lukwill and Child (1973). Acceleration of flowering in apple plants on ethephon and naphthalene acetic acid application was reported by Swart and Schipper (1982). Moreover, Abdel Rahman and Abd El-Aziz (1983) observed that spraying of datura plants with ethephon and Kinetin increased the sugar and alkaloid contents of the leaves. Foliar spraying of geranium (Pelargonium graveolens) and Pterocarpus santalinus L. with gibberellic acid (GA_3) was found to increase the plants' height, intermodal elongation, net assimilation rate and herbage production (Venkataramaiah and Swamy, 1981; Mohammed *et al.,* 1983).

Kadiri *et al.* (1997) observed that 100mg/L gibberellic acid (GA_3) and 15% coconut milk treatments on *Abelmoschus esculentus* and Solanum gilo enhanced the plant yield, chlorophyll and vitamin C contents. Mukhtar (2008) reported that similar treatments of Hibiscus sabdariffa with 100mg/L gibberellic acid and 15% coconut milk resulted in significantly increased plant height, stem girth, leaf development, chlorophyll, carbohydrates, vitamins A, B6 and C contents. The author also observed that phosphorus and potassium levels were higher in 15% coconut milk treated *H. sabdariffa* plants, whereas sodium, copper and zinc levels were greater in 100mg/L GA_3 treated plants. Kadiri (1999) had earlier obtained significantly increased shoot and root dry weights, leaf area and fruit yield for capsicum annuum (red pepper) treated with 100mg/L, 200mg/L indole-3-acetic acid and 15% coconut milk. Ebofin et al. (2003) likewise reported positive effects of some growth hormones on the seedling growth of some savannah tree legumes. Islam et al (2010) obtained changes in vegetative characters and enhanced yield following indole-3-acetic acid spraying of black gram (Vigna mungo) whereas Olaiya (2010) observed that application of auxins on tomato plants enhanced the nutritional quality of the fruit.

The present study was undertaken in order to assess the effects of indole-3-acetic acid (IAA) and coconut milk (a source of crude cytokinins) on the vegetative growth and chlorophyll contents of *Amaranthus hybridus* Linn. Subsp. Cruentus (L.) Thell.

MATERIALS AND METHODS

Planting and hormonal treatments:

Seeds of *A. hybridus* were sprinkled on vegetable farmland that was demarcated into seven beds. Each bed had 3M x 3M dimensions and there were 1M spacings in-between beds.

The beds were watered daily, and at one week after sowing, 50ppm, 100ppm and 200ppm of IAA and 5%, 15% and 25% of coconut milk were sprayed separately on *A. hybridus* seedlings sown on six beds at one concentration per bed. The *A. hybridus* seedlings on the seventh bed sprayed with distilled water were employed as control plants. All the spraying types were repeated at 2 week intervals. The beds were kept weed-free throughout the duration of the study.

Effect of IAA and coconut milk on the vegetative growth of *A. hybridus*

At 1 week after each spraying of batches of A. hybridus plants with IAA, coconut milk and water, number of leaves, leaf area, plant height, stem circumference and the shoot and root dry weight were determined. Three plants were uprooted from each treatment and control beds and the number of leaves on each plant counted. The leaves were then detached from each plant, their outline traced on a graph paper and the leaf area determined. Another set of three plants were uprooted from each treatment bed and the control. The height of each plant was measured from the soil level up to the top of the terminal bud using a metre rule. The circumferences of each plant were measured at the top, middle and bottom portions of the stem by tying threads around the stem at these portions and measuring the lengths of the 3 threads against a metre rule. The average of the 3 lengths was taken as stem circumference. The shoot and root dry weights were determined by dividing each of the uprooted treatment and control plants into shoot and root, drying them separately in the oven at 80^{o}C for 48 hours and the dry weights recorded.

Effect of IAA and Coconut Milk on the Chlorophyll contents of A. hybridus: Chlorophyll contents of treated plants and controls were determined using the method described by Witham, et al. (1971) and Fasidi (1981). One gram (1g)of fresh leaf from each treated and control plant was ground in a mortar with 40ml of 80% acetone. The extract was filtered through a Buchner funnel and the residue re-extracted twice with 30ml aliquots of 80% acetone. The final volume of the combined filtrates was topped up to 100ml with 80% acetone and the optical densities of the chlorophyll extracts measured spectrophotometrically at 645nm and 663nm. The amount of chlorophyll in each acetone extract was calculated using the equation of Ziegler and Egle (1965).

Statistical Analysis

Values given in the tables are the means of 3 replicates. The statistical significance of the differences among the means were determined by analysis of variance using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Treatments of *A. hybridus* with 50ppm, 100ppm, 200ppm of IAA and 5%, 15%, 25% of coconut milk resulted in considerable increases in the height, stem circumference, number of leaves, chlorophyll content, shoot dry weight and root dry weight (Tables 1 and 2). The enhancement of vegetative growth and chlorophyll content by IAA and coconut milk treatments are due to physiological effects of IAA and cytokinin-like characteristic of coconut milk. Indole-3-acetic acid is known to induce cell elongation while cytokinin causes cell division as well as increase in number and size of metabolic sinks (Pandey and Sinha, 1981). Similar observations of IAA and cytokinin enhancement of grain yield had been reported for rice (Singh et al., 1984) and wheat (Holmes, 1974). Mukhtar (2008) obtained a similar result of increased growth of *H. sabdariffa* or spraying with IAA and gibberellic acid.

Out of the various treatments of IAA and coconut milk employed on A. hybridus, 15% coconut milk treatment consistently produced plants with the greatest plant height, stem circumference, number of leaves, chlorophyll content, shoot dry weight and root dry weight (Tables 1 and 2). Ebofin et al. (2003) observed 15% coconut milk as the best growth regulator for enhancing seedling growth of some savannah tree legumes. This finding is also comparable to that of Singh et al. (1984) who observed that cytokinin treatment of rice causes greater increase in the number of grains per panicle than IAA treatment. Olaiya et al. 2010 likewise obtained an enhanced nutritional quality of tomato on spraying with auxins.

Significant increase in stem circumference, chlorophyll content, shoot dry weight, and root dry weight occurred at 50ppm, 100ppm and 200ppm IAA treatments of *A. hybridus* (P = 0.01). Similarly, 5, 10 and 25% coconut milk significantly increased stem circumference, number of leaves, chlorophyll content, shoot dry weight and root dry weight (Tables 1 and 2). As the concentration of IAA treatment increased from 50ppm to 200ppm, there were corresponding increases in plant height, stem circumference, number of leaves, chlorophyll content, shoot and dry weights. As for coconut milk, there were increases in these parameters from 5% to 15% concentration and decreases at 25% concentration (Tables 1 and 2). These results are in line with the physiological behavior of phytohormones which are effective in promoting physiological functions at very low concentration but become inhibitory or ineffective at high concentration (Kadiri et al., 1997; Kadiri, 1999).

In conclusion, IAA at 200ppm and coconut milk at 15% concentrations have been found to accelerate vegetative growth and enhanced the chlorophyll content of *A. hybridus*. Their usage as chemicals for spraying *A. hybridus* in order to increase its vegetative growth is therefore recommended.

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Table 1:Mean plant height, stem circumference and number of leaves of *A. hybridus* treated with IAA and coconut milk at varying number of weeks after sowing

Treatment type and concentration	Plant height (cm plant^{-1}) at different No. of weeks after sowing				Stem circumference (cm plant^{-1}) at different No. of weeks after sowing				Number of leaves plant^{-1} at different No. of weeks after sowing			
	3 wks	5 wks	7 wks	9 wks	3 wks	5 wks	7 wks	9 wks	3 wks	5 wks	7 wks	9 wks
50ppm IAA	58.3b	118.7a	156.7b	169.3b	3.2b	4.3c	5.9c	6.8c	33.7c	75.0cd	161.0c	169.7c
100ppm IAA	56.3b	118.9a	157.7b	169.3b	3.2b	4.4c	6.3bc	7.8b	41.0b	87.0c	171.3c	193.0bc
200ppm IAA	60.3b	120.7a	159.0b	171.7b	3.8a	5.3b	6.8ab	8.6a	42.0b	120.0b	175.3bc	221.0b
5% coconut milk	61.3b	115.7ab	145.3b	166.7b	3.4b	4.8bc	6.3bc	8.3a	32.0c	133.0b	199.0ab	298.0a
15% coconut milk	71.3a	127.2a	186.0a	191.3a	4.1a	6.8a	7.1a	9.3a	51.3a	198.0a	245.0a	313.7a
25% coconut milk	58.6bc	105.0b	144.0b	163.3b	3.2b	4.5c	6.3bc	8.0b	31.0c	86.7c	168.3c	174.7c
Control (Water)	54.6b	65.7c	78.3c	81.7c	2.4c	3.3d	4.2d	4.9d	24.7d	67.3d	71.0d	81.7d

Any two means on the same vertical line followed by different letters are significantly different at P = 0.01, wks = week

Table 2: Mean chlorophyll content, shoot and root dry weights of *A. hybridus* treated with IAA and coconut milk at varying number of weeks after sowing

Treatment type and concentration	Chlorophyl content (mg g^{-1} fresh wt.) at different No. of weeks after sowing				Shoot dry wt. (g plant^{-1}) at different No. of weeks after sowing				Root dry wt (g plant^{-1}) at different No. of weeks after sowing			
	3 wks	5 wks	7 wks	9 wks	3 wks	5 wks	7 wks	9 wks	3 wks	5 wks	7 wks	9 wks
50ppm IAA	6.5b	8.8b	10.1c	11.9b	5.9c	20.9c	32.9bc	50.8c	0.6de	2.3c	6.1cd	6.9d
100ppm IAA	7.0b	8.9b	11.1bc	12.6b	6.4bc	24.6b	37.7b	54.4bc	0.7cd	2.6c	6.8bc	7.4cd
200ppm IAA	7.2b	9.2b	12.5b	13.5b	7.0ab	29.5a	45.4a	60.4b	0.9ab	4.5ab	7.4b	9.0b
5% coconut milk	7.3b	9.4ab	12.6b	14.0b	6.9ab	26.2b	37.8b	54.7bc	0.8bc	4.1b	6.8bc	8.3bc
15% coconut milk	8.5a	10.3a	14.9a	16.8a	7.7a	32.3a	49.1a	79.1a	1.1a	5.1a	8.9a	11.5a
25% coconut milk	6.9b	9.8ab	11.2bc	12.1b	5.7c	18.2c	30.4c	50.6c	0.5e	2.3c	5.4d	6.5d
Control (Water)	4.9c	5.6c	6.8d	8.2c	4.3d	12.6d	17.2d	23.4d	0.3f	1.4d	2.0e	2.9e

Any two means on the same vertical line followed by different letters are significantly different at P = 0.01, wks = week