

## Responses of some Nigerian vegetables to plant growth regulator treatments

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(Rec. 4-XI-1994. Rev. 24-VIII-1995. Acep. 18-I-1996)

**Abstract:** The effects of single and combined growth regulator treatments of indole-3-acetic acid (IAA), gibberellic acid (GA<sub>3</sub>) and coconut milk on plant height, yield, chlorophyll and vitamin contents of *Abelmoschus esculentus* L. and *Solanum gilo* L. were investigated. The single growth regulator treatments consisted of 50mg/L, 100mg/L of IAA and GA<sub>3</sub> and 10%, 15% of coconut milk. In case of combined growth regulator treatments, the treatments were 100mg/L IAA + 100mg/L GA<sub>3</sub>, 100mg/L IAA + 15% coconut milk and 100mg/L GA<sub>3</sub> + 15% coconut milk. Control vegetable plants were sprayed with water. Single treatments of 100mg/L IAA, 100mg/L GA<sub>3</sub>, 10% and 15% coconut milk resulted in significantly increased plant height, chlorophyll contents and yield of *A. esculentus*, *H. sabdariffa* and *S. gilo* while only combined treatments of 100mg/L IAA + 10% coconut milk and 100mg/L GA<sub>3</sub> + 15% coconut milk had such an effect on *A. esculentus* and *S. gilo* but not on *H. sabdariffa*. Moreover, single treatments of 100mg/L GA<sub>3</sub> and 15% coconut milk caused significantly higher vitamins A, B<sub>6</sub> and C contents of treated plants whereas the combined treatments produced such an effect on only vitamin C contents of treated plants. Growth regulator treatments of 100mg/L GA<sub>3</sub> and 15% coconut milk were consistently the best out of the entire growth regulator treatments tried with the treated plants having the greatest plant height, yield, chlorophyll and vitamin C contents.

**Key words:** Nigerian vegetables, plant growth regulators, plant growth, chlorophyll and vitamin contents.

Plant growth regulators are known to influence growth and development at very low concentrations but inhibit plant growth and development at high concentrations (Jules *et al.* 1981).

Plant physiological processes are under the control of growth regulators. Examples of these are plant rooting and propagation, dormancy initiation and breaking, promotion of flowering, setting of fruit fall, regulation of plants' chemical composition and mineral uptake from soil and conferment of resistance on plants against pests and harsh environmental factors (Nickell 1978).

Recently, researches have shown the stimulatory effects of growth regulators in the vegetative growth and yield of vegetables.

Gibberellic acid has been used to stimulate stem and petiole extension in rhubarb, celery and water cress (Thomas 1976). Treatment of radish and onion seeds with auxin or a mixture of gibberellic acid (GA<sub>3</sub>) and kinetin have been found to increase the germination of the seeds (Thomas 1976). Monthly foliar spraying of geranium (*Pelargonium graveolens*) resulted in increased plant height and herb production (Mohammed *et al.* 1983). Spraying of datura plant (*Datura innoxia*) planted in different salinity concentrations with chlormequat, ethephon or kinetin was found to enhance plant growth alkaloidal and soluble sugar contents of leave and reduce the harmful effect of salinity on the plant (Abdel-Rahman & Abdel-Asiz 1983). Application of

gibberellic acid, 4-chloroindole and 6-benzyl aminopurine on to the standard petal and calyx of *Vicia faba* var. major before or after tripping was found to significantly enhance pod set (Rylott and Smith 1990). Likewise, spraying of *Vicia faba* cv. Troy reproductive structure with indole-3-acetic acid, gibberellic acid or 6-benzylaminopurine resulted in increased pod number (Clifford *et al.* 1992).

In Nigeria, spraying of vegetables with growth regulators to enhance their vegetative growth and yield is currently not being practiced. This is due to lack of information on the optimum concentrations of growth regulators that could be used to enhance vegetables' growth and yield. The present study aims at bridging up such an information gap with respect to three tropical vegetables; namely, *Abelmoschus esculentus* (Okra), *Hibiscus sabdariffa* (sorrel) and *Solanum gilo* (egg plant). *Abelmoschus esculentus* and *H. sabdariffa* are cultivated for their mucilaginous pods, young leaves and shoots which are eaten as cooked vegetables in soups and *H. sabdariffa* Calyx that is used in preparing a refreshing beverage (Tridall 1983, Ughorogho & Shofoyeke 1983). *Solanum gilo* is cultivated for its fruits and leaves which are eaten raw as vegetables and for the seasoning of other foods (Yoyock *et al.* 1988).

## MATERIALS AND METHODS

**Planting of seeds:** Seeds of *A. esculentus*, *H. sabdariffa* and *S. gilo* were sown on separate prepared beds at 4 seeds per hole. There were seven beds of 2 x 2m each per vegetable for the single hormonal treatments and 4 beds of 2 x 2m each per vegetable for the combined treatments with a distance of 0.5m in between beds. the number of beds were replicated thrice and weeding was carried out regularly. During the study period, the land area of the prepared beds had a mean temperature of  $30 \pm 3^\circ\text{C}$ , relative humidity of  $58 \pm 10\%$  and average day length of  $12.5 \pm 0.5\text{h}$ .

**Growth regulator treatments:** The growth regulator employed in the experiment were indole-3-acetic acid (IAA), gibberellic acid ( $\text{GA}_3$ ) and coconut milk. Two types of growth regulator treatments were given to the vegeta-

bles. These were single and combined growth regulator treatments. The single growth regulator treatments were IAA and  $\text{GA}_3$  (50mg/L and 100mg/L) and coconut milk (10% and 15%) while the combined growth regulator treatments were based on the best results obtained from promotional effect of single growth regulator treatments on the vegetables. For the three vegetable types, the combined growth regulator treatments given were: 100mg/L IAA + 100mg/L  $\text{GA}_3$ , 100mg/L IAA + 15% coconut milk and 100mg/L  $\text{GA}_3$  + 15% coconut milk. For both the single and combined growth regulator treatments, 30ml of the various concentrations were applied on the planted vegetables by foliar spraying of 4 doses at 2 week-intervals commencing from 2 weeks after sowing. The control vegetable plants were sprayed foliarly with 30ml water also applied in 4 doses at 2 week-intervals starting from 2 weeks after sowing.

### Effects of growth regulator treatments on plant height

**Chlorophyll content and yield:** Sampling of the treated vegetables and controls was carried out at 9 weeks after sowing. Plant heights were measured using a metre rule. Fresh weights of the fruits produced by the treated and control plants of *A. esculentus* and *S. gilo* were recorded in 3 replicates and the averages taken. Leaves of treated and control plants of *H. sabdariffa* were harvested and the chlorophyll extracted using 80% acetone. The chlorophyll contents were determined by following the method of witham *et al.* (1971).

**Effects of growth regulator treatments on vitamin contents:** Fruits of treated vegetables and controls were harvested at 9 weeks after sowing, dried in an oven at  $80^\circ\text{C}$  for 48h, ground into powders and the powders used for vitamins content determination. Vitamin A was analysed using the method of Beols and Troet (1959) by boiling 1g powder sample with a mixture of 30ml ethanol and 3ml 85%KOH for 30mins. Vitamin  $\text{B}_6$  analysis was carried out according to the method of Heochberg, Melnic and Oser (1944) in 1g powdered samples being hydrolysed with 4N HCL in a boiling-water bath for 1h. The colouring dye was 2,6-dichloroquinoquinoechloroimide reagent which

complexes with pyridoxine at pH 5.7 to form reddish brown chromophore that absorbs at 620nm. The determination of vitamin C was carried out using the method described by Lambert and Muir (1983) by 500mg of each powdered sample being completely homogenised in 10ml of 4% HCL in a blender. The colouring dye was 2,6-dichloroindophenol which on titration forms a pink colour with Vitamin C.

## RESULTS AND DISCUSSION

Significant increases in plant height and yield were observed in *A. esculentus* and *S. gilo* given single treatments of 100mg/L IAA, 100mg/L GA<sub>3</sub>, coconut milk and combined treatments of 100mg/L IAA + 15% coconut milk and 100mg/L GA<sub>3</sub> + 15% coconut milk (Tables 1 and 2). Results of significantly increased plant height and chlorophyll content were also obtained for *H. sabdariffa* given single treatment of 100mg/L IAA, gibberellic acid and coconut milk (Table 1). Similar results of plant height stimulation were observed by Currah & Thomas (1979) upon application of 100mg/L GA<sub>3</sub> on carrot plant. Spraying of kinetin on *Datura innoxia* plant at 1mg/L, 5mg/L and 10mg/L was found to cause increased vegetative growth (Abdel-Rahman & Abdel-Aziz, 1983). Similarly, GA<sub>3</sub> spraying was found to stimulate production of flowers in lettuce (Metzger 1988). Biddington & Dearman (1987) also observed that GA<sub>3</sub> application increased the growth of bean and leaf length of lettuce. The auxin, naphthoacetic acid and the cytokinin, 6-benzyl-amino-purine when sprayed onto the open flowers *Solanum melongena* either singly or in combination were likewise observed to increase the number of fruit set as well as the total weights of the fruits (Olympios 1976). Spraying of kinetin on *Chlorella vulgaris* 157 was found to increase

chlorophylls a and b contents (Atanasiu *et al* 1983). Singh *et al* (1984) likewise obtained significant increase in the number of grains per panicle, % filled spikelets and yields of rice sprayed at anthesis with kinetin and IAA. Stuart and Cathey (1961) explained that increases in plant height by growth regulator treatments are due to the fact that they enhance stem elongation of plants.

Plants of *A. esculentus* and *H. sabdariffa* treated with 100mg/L GA<sub>3</sub> and 15% coconut milk had significantly higher vitamins A, B<sub>6</sub> and C contents than the control plants (Table 3). Similar result of increased total soluble sugar content in leaves of *Datura innoxia* treated with varied concentrations of chlormequat and ethephon was observed by Abdel-Rahman & Abdel-Aziz (1983). Dybing & Lay (1982) found that application of growth regulators on plants improves the plants' quality in terms of oil, latex, sucrose and protein contents, fruit colour and fatty acid composition.

The combined growth regulator treatments of the vegetables resulted in significant increases in only the vitamin C contents of the vegetables (Table 4). Of all the growth regulator treatments applied on *A. esculentus*, *H. sabdariffa* and *S. gilo*, 100mg/L GA<sub>3</sub> and 15% coconut milk treatments consistently produced plants with the greatest plant height, yield, chlorophyll and vitamins content (Tables 1,2,3 and 4). The possible reasons for this could be that GA<sub>3</sub> induces cell elongation and coconut milk is a crude source of cytokinin and therefore a cell division promoter. This is probably the first time that coconut milk is being reported to have a growth promotion effect when sprayed on plants. The significance of the present study is that single treatments of 100mg/L GA<sub>3</sub> and 15% coconut milk could be used to spray *A. esculentus*, *H. sabdariffa* and *S. gilo* in order to enhance their vegetative growth, vitamins content and yields.

TABLE 1

*Mean plant height (cm/plant), chlorophyll contents (mg/g fresh leaf) and yields (g fresh fruit/plant) of A. esculentus, H. sabdariffa and S. gilo given single treatments of various concentrations of IAA, GA, and coconut milk at 9 weeks after sowing*

Treatment (mg/L)	<i>A. esculentus</i>		<i>H. sabdariffa</i>		<i>S. gilo</i>	
	Plant height	Yield	Plant height	Chlorophyll content	Plant height	Yield
IAA (50)	15.8cd	14.0d	37.7c	0.61c	13.8d	8.8c
IAA (100)	18.3C	19.9b	38.3c	0.72b	22.6ab	11.4b
GA <sub>3</sub> (50)	24.2b	15.5cd	54.2b	0.76b	21.6b	9.8bc
GA <sub>3</sub> (100)	45.3a	17.0c	56.2ab	0.91a	17.7c	15.4a
10% Coconut milk	19.9bc	19.2b	55.8ab	0.91a	17.7c	15.4a
15% coconut milk	23.3b	26.4a	60.9a	1.08a	24.5a	17.3a
Control (water)	12.5d	7.6a	25.9a	0.60c	7.6e	6.4d

Means followed by the same letter(s) within any column are not significantly different at  $p=0.01$  by Duncan's Multiple Range Test.

TABLE 2

*Mean plant height (cm/plant), chlorophyll content (mg/g fresh leaf) and yield fruit/plant) of A. esculentus, H. sabdariffa and S. gilo given combined treatments IAA, GA<sub>3</sub> and coconut milk (CM) at 9 weeks after sowing*

Treatment (mg/L)	<i>A. esculentus</i>		<i>H. sabdariffa</i>		<i>S. gilo</i>	
	Plant height	Yield	Plant height	Chlorophyll content	Plant height	Yield
IAA (100) + GA <sub>3</sub> (100)	20.6b	9.5b	24.2a	0.86b	15.6b	8.9b
IAA (100) + 15% CM	21.1b	15.4a	25.3a	0.91ab	21.0a	10.8b
GA <sub>3</sub> (100) + 15% CM	25.7a	16.1a	26.6a	1.02a	23.7a	12.9a
Control (water)	12.2c	7.6c	24.4a	0.60c	8.0c	6.4c

Means followed by the same letter(s) within any column are not significantly different at  $P=0.01$  by Duncan's Multiple Range Test

TABLE 3

Mean vitamins A, B<sub>6</sub> and C contents (mg/100g dry matter) of fruits of *A. esculentus*, *H. sabdariffa* and *S. gilo* given single treatments of IAA, GA<sub>3</sub> and coconut milk at 9 weeks after sowing

Treatment (mg/L)	<i>A. esculentus</i>			<i>H. sabdariffa</i>			<i>S. gilo</i>		
	Vit.A	Vit.B <sub>6</sub>	Vit.C	Vit.A	Vit.B <sub>6</sub>	Vit.C	Vit.A	Vit.B <sub>6</sub>	Vit.C
IAA (100)	5.2b	13.9b	41.8c	21.6b3	6.1ab	52.8b	14.1a	38.8ab	37.4c
GA <sub>3</sub> (100)	5.8b	18.5a	53.6b	22.4ab	37.6a	59.1b	14.7a	39.4a	70.0b
15% Coconut milk	8.3a	18.6a	68.8a	25.1a	38.9a	74.2a	15.4a	43.9a	80.5a
Control (water)	5.0b	12.4b	31.5d	15.7c	33.7b	34.5c	14.0a	34.5b	35.8c

Means followed by the same letter (s) within any column are not significantly different at P = 0.01 by Duncan's Multiple Range Test.

TABLE 4

Mean vitamin A, B<sub>6</sub> and C contents (mg/100g dry matter) of fruits of *A. esculentus*, *H. sabdariffa* and *S. gilo* combined treatments of IAA, GA<sub>3</sub> and coconut milk (cm) at 9 weeks after sowing

Treatment (mg/L)	<i>A. esculentus</i>			<i>H. sabdariffa</i>			<i>S. gilo</i>		
	Vit.A	Vit.B <sub>6</sub>	Vit.C	Vit.A	Vit.B <sub>6</sub>	Vit.C	Vit.A	Vit.B <sub>6</sub>	Vit.C
IAA (100) + GA <sub>3</sub> (100)	5.0a	12.4c	40.2c	15.8a	33.8a	43.5b	14.0a	34.8b	36.9c
IAA (100) + 15% CM	5.2a	15.4b	50.4b	16.2a	34.9a	55.0a	14.8a	38.5a	60.4b
GA <sub>3</sub> (100) + 15% CM	5.4a	18.0a	62.5a	16.7a	35.5a	56.3a	15.0a	40.6a	75.6a
Control (water)	5.0a	12.4c	31.5d	15.7a	33.7a	34.5c	14.0a	34.5b	35.8c

Means followed by the same letter(s) within any column are not significantly different at P = 0.01 by Duncan's Multiple Range Test.

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