Comparative Effect of the Foliar Spray and Seed Soaking Application Method of Gibberellic Acid on the Growth of *Abelmoschus Esculentus* (Okra Dwarf)

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Abstract: This work was aimed at determining the effect of low concentrations (0,1,5,10,20 and 30 ppm) of gibberellic acid on the growth of *Abelmoschus esculentus* (dwarf) and also compared the efficacy of the spraying and seed soaking method of application of this acid. Several growth parameters were measured which include Number of internode, Length of Internode, Plant height, Number of leaves, Length of petiole, Number of flower buds and Number of fruits after the acid was applied exogenously using the two methods of application. The test of two population means analytical procedure adopted at 5% level of significance showed that gibberellic acid significantly stimulated internode elongation, Plant Height and Number of leaves and caused a reduction in the petiole length in both treatment methods. Gibberellic acid also stimulated earlier flowering , increased bud formation and fruit production. The foliar spray application was found to have a significant effect on the plant height when compared with the seed soaking application technique. Although GA_3 stimulated Internode elongation, it had no effect on the number of Internodes in both the treated plants and the control indicating that dwarfism of this variety of Okra may be due to the absence of adequate endogenous gibberellic acid. [Journal of American Science 2009;5(4):133-140]. (ISSN: 1545-1003).

Key words: Comparative effect, Foliar spray, Seed soaking, Application, Gibberellic acid, *Abelmoschus esculentus,*

1. Introduction

Plant regulators are organic compounds which, in small amounts, somehow modify a given physiological plant process and rarely act alone, as the action of two or more of these compounds is necessary to produce a physiological effect. Gibberellic acid is a simple gibberellin, promoting growth and elongation of cells. It affects decomposition of plants and helps plants grow if used in small amounts, but eventually plants grow a tolerance for it. Gibberellic acid stimulates the cells of germinating seeds to produce mRNA molecules that code for hydrolytic enzymes (Bidwell,1974).

Okra belongs to the family Malvaceae. It is a tropical and semi tropical plant with edible seed pods used as a vegetable. It is cultivated by means of seeds. Okra is an important vegetable crop plant in West Afric where the immature fruits which are good sources of vitamin C are used for the preparation of soup and sauces (Epenhuijsen, 1974). The immature leaves are used for soup preparation. Both the leaves and fruits may be conserved by drying. It can also be used for salad dressings, ice cream and its high protein content makes it a valuable food crop (Akinlade and Adesiyan, 1982).

Gibberellins stimulate extensive growth in intact plants. These enable them to overcome genetic dwarfness in some species if that dwarfness is because of a gene mutation, resulting into blocked gibberellin production.

This compound has now been applied to a large variety of plant organs in several ways and it has been found to greatly enhance stem elongation as its most striking effect. This was observed in many plants after treatment with minute amount of gibberellic acid (Brian and Hemming, 1955). An example of such a response was shown by (Bukovac and Wittwer, 1956) on dwarf bean which was induced to turn to a climbing bean. Gibberellins (GAs) play an essential role in many aspects of plant growth and development, such as seed germination (Haba et al., 1985, Khafagi et al., 1986, Kumar & Neelakandan, 1992; Maske et al., 1997), stem elongation and flower development (Yamaguchi & Kamiya, 2000). Wareing and Phillips (1976), recorded enhanced vegetative growth in plants sprayed with GA3. also when GA# was applied to plants there was similar increase in leaf area, leaf length and width. Also with respect to leaf growth, GA3 generally promoted elongation of graa leaves but had little or no effect on enlargement of broad leaves of dicotyledons.

Although there are many literatures on gibberellic acid, no attempt has been made to find out the most effective method of application. This work therefore investigated the effect of low exogenous foliar spray and seed soaking application of gibberellic acid on the morphology of dwarf cultivar of Okra and ascertain the method of application of gibberellic acid-Foliar spray and seed soaking that is most effective to use. It also assessed whether the observed dwarfness in the Okra plant is as a result of possible low endogenous content of gibberellic acid.

2. Materials and Methods

60 Dried viable seeds of *Abelmoschus esculentus* were extracted, soaked in distilled water for 24 hours after which they were spread on moist filter paper in Petri-dishes. The Petri-dishes were kept in dark cupboards at room temperature of 37^{O}c . Polybags were filled with sandy loam soil. All the polybags were perforated at the base to enhance effective drainage. 30 of the seeds tested for viability were divided into six groups and soaked in GA_3 concentrations of 0,1,5,10,20 and 30ppm respectively for 12 hours. These were planted in the polybags. The remaining half of the seeds were also divided into six groups and planted without soaking them nor applying any GA_3 concentration. Three seeds were planted in each polybags and later thinned down to one.

Seven (7) days after planting, the seedlings that were not soaked were sprayed with GA_3 concentration of 0,1,5,10,20 and 30ppm respectively using a hand pump. During the spraying, the leaves were completely wet or moistened until droplets of the chemicals started to form. In the control, the plants were soaked and sprayed with distilled water. Each seedling was moistened daily with water. Each treatment was replicated 5 times

Fourteen (14) days after planting, the growth and development of the plants were observed and recorded at weekly intervals for six (6) weeks until the plants started fruiting. The parameters measured were Number of Internode, Length of Internode, Plant Height, Number of Leaves, Length of Petiole, Number of flower buds, Number of fruits. On each sampling occasion, three replicate plants were selected randomly for the above measurements. The results obtained were subjected to statistical analysis using the test of two population mean.

3. Results

The results of this work which adopted two different methods of GA_3 application for its study (foliar and seed soaking) showed a significant increase in the plant's physiological growth after treatment with varying concentrations of the acid. (figs 1 & 2)

The foliar and seed soaking application methods did not have any effect on the number of internodes in the treated plants when compared to the control (Table 1 & 2). There was however an increase in plant height, Number of leaves and length of internode. This increase was continuous throughout the period the experiment was conducted. A decrease in the length of petiole was observed in both treatment methods when compared with the control though a more increase was observed in the soaked seeds. (Tables 3-10)

The foliar spray application technique was found to produce more increase in plant height when compared to the seeds soaked in the GA_3. (Table 5 & 6). It appeared that there were two (2) ranges of linearity (a low and high range) in the increase of the parameters measured in response to the applied Ga_3 in both the foliar and seed soaking application techniques. The low linearity was observed from 0-5 ppm whereas the high range was from 10-30 ppm with 20 ppm having a relatively lower or somewhat inhibitory effect compared to 10 and 30 ppm, although the effect of the concentration of 20 ppm were still stimulatory when compared with the control. The peak increase in the foliar spray was observed at a concentration of 10 ppm while 30 ppm were more effective in the soaked seeds. (fig 1 & 2).

This increase when reviewed statistically at 95% level of confidence that is at 5% level significance was found to be significant.

Table 1: The effect of foliar spray application of GA_3 on Number of Internode of *Abelmoschus esculentus.* cv dwarf

	GA_3 concentration (ppm)					
Plant Age (days)	**0**	**1**	**5**	**10**	**20**	**30**
14	2	2	2	2	2	2
21	3	3	3	3	3	3
28	5	5	5	5	5	5
35	6	6	6	6	6	6
42	7	7	7	7	7	7
49	8	8	8	8	8	8

ΣX	**31**	**31**	**31**	**31**	**31**	**31**
X	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**

Values are mean of three replicates

Table 2: The effect of seed soaking application of GA_3 on Number of Internode of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)	GA₃ concentration (ppm) 0	1	5	10	20	30
14	2	2	2	2	2	2
21	3	3	3	3	3	3
28	5	5	5	5	5	5
35	6	6	6	6	6	6
42	7	7	7	7	7	7
49	8	8	8	8	8	8
ΣX	**31**	**31**	**31**	**31**	**31**	**31**
X	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**

Values are mean of three replicates

Table 3: The effect of foliar spray application of GA_3 on Length of Internode (cm) of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)	GA_3 concentration (ppm) 0	1	5	10	20	30
14	0.9	1.0	0.9	0.9	0.8	0.9
21	1.3	1.33	1.4	1.43	1.2	1.3
28	2.2	2.6	2.6	3.4	3.0	2.9
35	2.6	3.2	3.3	4.3	3.8	4.0
42	3.1	3.7	3.8	4.3	4.2	4.5
49	4.0	4.4	4.5	4.9	4.7	5.1
ΣX	**14.1**	**16.2**	**16.5**	**19.2**	**17.7**	**18.7**
X	**2.4**	**2.7**	**2.8**	**3.2**	**3.0**	**3.1**

Values are mean of three replicates

Table 4: The effect of seed soaking application of GA_3 on Length of Internode (cm) of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)	GA_3 concentration (ppm) 0	1	5	10	20	30
14	0.8	1.0	0.9	0.9	0.8	0.9
21	1.2	1.3	1.4	1.4	1.3	1.4
28	2.2	2.5	2.6	3.1	3.0	3.3
35	2.6	3.2	3.2	3.9	3.7	4.2
42	3.1	3.7	3.8	4.3	4.2	4.5
49	4.0	4.4	4.5	4.9	4.7	5.1
ΣX	**13.9**	**16.1**	**16.4**	**18.5**	**17.7**	**19.4**
X	**2.3**	**2.7**	**2.7**	**3.1**	**2.95**	**3.2**

Values are mean of three replicates

Table 5: The effect of foliar spray application of GA_3 on Plant Height (cm) of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)	GA₃ concentration (ppm) 0	1	5	10	20	30
14	6.0	6.4	6.7	7.3	6.7	7.2
21	7.8	9.4	9.8	11.2	10.8	11.2
28	8.7	10.5	10.9	12.8	12.0	12.7
35	10.2	12.5	13.0	14.9	13.7	14.1
42	12.7	15.5	16.0	20.1	16.3	18.9
49	14.6	17.7	18.1	22.4	19.3	21.0
ΣX	**60**	**72**	**74.5**	**88.7**	**78.8**	**85.0**
X	**10.0**	**12.0**	**12.4**	**14.8**	**13.1**	**14.2**

Values are mean of three replicates

Table 6: The effect of seed soaking application of GA_3 on Plant Height (cm) of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)	GA₃ concentration (ppm) 0	1	5	10	20	30
14	6.0	6.5	6.8	7.13	6.9	7.2
21	7.7	8.5	8.2	9.8	9.5	9.9
28	8.6	9.6	9.6	11.5	10.7	11.6
35	10.2	11.7	11.2	13.2	12.4	13.6
42	12.7	14.7	14.2	17.7	15.3	18.8
49	14.7	16.8	16.4	20.3	18.3	21.3
ΣX	**59.9**	**67.8**	**66.4**	**76.6**	**73.1**	**82.4**
X	**10.0**	**11.3**	**11.1**	**13.3**	**13.2**	**13.7**

Values are mean of three replicates

Table 7: The effect of foliar spray application of GA_3 on Number of Leaves of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)	GA₃ concentration (ppm) 0	1	5	10	20	30
14	4	4	4	4	4	4
21	5	5	5	5	5	5
28	6	7	7	8	7	7
35	7	8	8	9	8	9
42	8	9	9	10	9	10
49	9	10	10	11	10	11
ΣX	**39**	**43**	**43**	**47**	**43**	**46**

X	**6.50**	**7.20**	**7.20**	**7.80**	**7.20**	**7.70**

Values are mean of three replicates

Table 8: The effect of seed soaking application of GA_3 on Plant Height (cm) of *Abelmoschus esculentus.* cv dwarf

	GA$_3$ concentration (ppm)					
Plant Age (days)	**0**	**1**	**5**	**10**	**20**	**30**
14	4	4	4	4	4	4
21	5	5	5	5	5	5
28	6	7	7	8	7	8
35	7	8	8	9	8	9.3
42	8	9	9	10	9	10.2
49	9	10	10	11	10	11.3
ΣX	**39**	**43**	**43**	**47**	**43**	**47.9**
X	**6.5**	**7.2**	**7.2**	**7.83**	**7.2**	**8.0**

Values are mean of three replicates

Table 9: The effect of foliar spray application of GA_3 on Length of petiole (cm) of *Abelmoschus esculentus.* cv dwarf

	GA$_3$ concentration (ppm)					
Plant Age (days)	**0**	**1**	**5**	**10**	**20**	**30**
14	2.03	1.73	2.0	2.0	1.9	1.97
21	2.5	2.23	2.43	2.5	2.27	2.5
28	3.0	2.73	3.0	3.0	2.77	3.2
35	3.5	3.23	3.5	3.5	3.30	3.60
42	4.20	3.93	4.03	4.03	3.77	4.0
49	4.73	4.47	4.47	4.57	4.33	4.6
ΣX	**19.96**	**18.32**	**19.43**	**19.63**	**18.34**	**19.87**
X	**3.33**	**3.05**	**3.24**	**3.27**	**3.06**	**3.31**

Values are mean of three replicates

Table 10: The effect of seed soaking application of GA_3 on Length of Petiole (cm) of *Abelmoschus esculentus.* cv dwarf

	GA$_3$ concentration (ppm)					
Plant Age (days)	**0**	**1**	**5**	**10**	**20**	**30**
14	2.07	1.83	2.1	2.07	1.97	2.1
21	2.57	2.27	2.53	2.60	2.27	2.6
28	3.0	2.80	3.03	3.27	2.83	3.13
35	3.53	3.33	3.53	3.67	3.47	3.49
42	4.33	4.03	4.10	4.0	3.93	4.0
49	4.67	4.53	4.53	4.6	4.37	4.46
ΣX	**20.17**	**18.79**	**19.69**	**20.21**	**18.75**	**19.78**
X	**3.36**	**3.13**	**3.28**	**3.36**	**3.125**	**3.30**

Values are mean of three replicates

Table 11: The effect of foliar spray application of GA_3 on Number of flower buds and number of fruits of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)		GA₃ concentration (ppm) 0	1	5	10	20	30
35	Number of flower buds	-	-	-	1	1	1
	Number of fruits	-	-	-	-	-	-
42	Number of flower buds	1	2	2	3	2	3
	Number of fruits	-	-	-	1	-	1
49	Number of flower buds	2	2	3	4	3	4
	Number of fruits	-	-	-	1	-	1

Table 12: The effect of seed soaking application of GA_3 on Number of flower buds and number of fruits of *Abelmoschus esculentus.* cv dwarf

Plant Age (days)		GA₃ concentration (ppm) 0	1	5	10	20	30
35	Number of flower buds	-	-	-	1	1	1
	Number of fruits	-	-	-	-	-	-
42	Number of flower buds	1	2	2	3	2	3
	Number of fruits	-	-	-	1	-	-
49	Number of flower buds	2	2	3	4	3	4
	Number of fruits	-	-	-	1	-	1

ANALYSIS OF DATA

H_0: There is no difference between the foliar spray application and seed soaking application of GA_3

H1: There is difference between the foliar spray application and seed soaking application of GA_3.

1.96 $t_{tab} = 1.96$

if $t_{cal} < 1.96$ (t_{tab}), we accept the null hypothesis and reject the alternative.

Comparism between the effect of foliar spray and seed soaking application of $GA_3$for Length of Internode

	N	Mean	Std. Dev.	T	D.F
S_S	30	2.95	1.46	0.02	8
F_S	30	2.94	1.44		

$t_{cal} < 1.96$ (t_{tab}), hence we accept the null hypothesis and reject H_1

Comparism of the effect of foliar spray and seed soaking application of GA_3 on Plant Height

	N	Mean	Std. Dev.	T	D.F
F_s	30	13.30	4.51	2.18	57
S_S	30	12.31	4.26		

$t_{cal} > 1.96$ (t_{tab}), we have therefore rejected H_O thus accepting H_1

Comparism of the effect of foliar spray and seed soaking application of GA_3 on Number of Leaves

	N	Mean	Std. Dev.	T	D.F
F_s	30	7.40	2.36	-0.10	57
S_S	30	7.46	2.39		

$t_{cal} > -1.96$ (t_{tab}), hence we accept the null hypothesis

Comparism of the effect of foliar spray and seed soaking application of GA_3. on Length of Petiole

	N	Mean	Std. Dev.	T	D.F
F_s	30	3.185	0.903	-2.06	57
S_S	30	3.248	0.881		

$t_{cal} < -1.96$ (t_{tab}), we accept the null hypothesis .

F_s = Foliar Spray
S_S = Seed Soaking

Effect of foliar spray application of GA3 on *A. esculentus*

Effect of foliar spray application of GA3 on *A. esculentus*

5. Discussion

From the observations one would deduce that more increase was observed in the sprayed plants. This is in agreement with the work of Bukovac and Wittwer (1956), when the acid was shown to have a vary remarkable effect on stem elongation of dwarf bean which was induced to turn to a climbing bean. Wareing and Phillips (1976) also recorded enhanced vegetative growth in plants sprayed with GA3. This hypothesis is also sustained by King et al. (2000), who reported greater stem growth in *Fuschia hibrida* and *Pharbitis nil*, resulting in the inhibition of flowering. Kumar & Neelakandan (1992) and Maske et al. (1997), using the same concentrations, and Haba et al. (1985) utilizing 0.1 mg L^{-1} GA_3 and imbibition for three hours, obtained an increase in germination. Since GA translocation occurs mainly through the symplast (Castro & Melotto, 1989), it could be the cause for the difference between responses, because when GA_3 is utilized via foliar application, an increase in hypocotyl length and in the length of the two nodes immediately above it can be verified and, consequently, affect the height of plants at that stage (Mislevy et al., 1989). Plant hormones will only take effect when and where specific receptors are located. Placing drops of the gibberellin solution on the leaves did not affect the leaves, but mainly caused elongation of the stem. This would tend to indicate that receptors for gibberellins are located in the cells of the stem as opposed to those of the leaf cells. However, application of the gibberellin solution to other locations may hasten it's absorption and travel to the location of activity. For example, if the the gibberellins were applied to the roots - perhaps included while watering - then the hormone may reach the site of action faster, with less being lost or metabolized elsewhere along the way. The roots have a reduced cuticle allowing easy entrance for water and dissolved material, plus little distance need be travelled through the interstitium before vascular tissue is reached. Once the gibberellins have reached the vascular tissue they can rapidly move up to the active region of the stem (Hilton, 1983).

From the above observations, it is inferred that the foliar spray application technique caused an increase in plant height than the seed soaking application. Also both application techniques are effective and can cause desirable effects.

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3/21/2009