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Effects of Indole-3-Acetic Acid on the Growth Parameters of *Citrullus lanatus* (Thunberg) Matsum and Nakai

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ABSTRACT

Effects of Indole-3-Acid (IAA) on *Citrullus lanatus* plant height, leaf number, branching and flower production were studied in order to evaluate the optimum concentrations required for growth and development. Foliar application using five different concentrations [1, 5, 10, 20 and 0 ppm IAA] was conducted twice at two weeks interval. The results suggest that as IAA concentration increases, plant height decreases with an optimum concentration of 5 ppm IAA. Mean plant height was also significantly different. More so, optimum concentration for leaf production and branching varied with varietal difference. Results obtained for number of branching suggest that 1 ppm IAA is optimum for variety A and 10 ppm is optimum for varieties B, C and D. Although flower production was poor during the study, high flower production is recorded for plants in 20 ppm IAA at 6 weeks after planting for all the varieties. This work establishes the inducing effects of different IAA concentration, which may be exploited for the commercial production of C. *lanatus.*

Keywords: Watermelon (*Citrullus lanatus*), Indole-3-Acetic acid, Growth parameters, Leaf production, Plant Physiology.

1. INTRODUCTION

In an era driven by mass extinctions of organic life worsened by food scarcity, humanity can only seek for a sustainable solution and through efficient utilization of natural resources. In spite of these extinctions, human population growth is not commensurate with improvement in agricultural performance. Plant genetic resources is the pillar upon which human existence hinges by fulfilling invaluable roles in the different facets of life regardless of their source and origin (Ogwu et al., 2014a; Osawaru and Ogwu, 2014a). According to Osawaru and Ogwu (2014a) watermelon is attracting the attention of researchers because of its potentials.

Watermelon [*Citrullus lanatus* (Thunberg) Matsum. and Nakai] belongs to the Cucurbitaceae (gourd) family, a monophyletic group recognized by Angiosperm Phylogeny Group (APG, 2009). The major cucurbit crops are taxonomically diverse but biologically similar. The members are distributed in the tropical regions of the old and new world. They are consumed

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almost worldwide. Watermelon originated in the tropics and subtropics; particularly in Africa south of the Sahara, where wild and cultivated varieties still exist with pronounced morphological differences (Ogwu et al., 2015). The plant is monoecious with pale yellow flowers, trailing hairy rough angular stem and dark-green alternate leaves carried on fairly long petioles. It is a creeping, short-lived annual herb, slender, hairy and spreading with lobed leaves. When the fruit is ripe, the spot on which it rests changes color. The fruits require careful handling as they are easily damaged and cannot be stored for more than 2 - 3 weeks (Remison, 2005).

Watermelon contains about 6 % sugar and 92 % water and is not a significant source of vitamins other than vitamin C. The flesh is sweet and juicy and is eaten raw. More so, it contains essential non-saturated fatty acids (a semi-drying oil). The oil can be extracted from the seeds and the seed cake can be used as livestock feed (Remison, 2005). The oil is used in cooking and is of interest to industrial biotechnological processes as well as cosmetic and pharmaceutical industries (Whitaker and Davis, 1962; Maynard, 2001; Schippers, 2002). It is cultivated in home gardens and outlying farms in the traditional mixed cropping systems that include maize, sorghum and yam. The different leaf types and growth cycles of the different crops provide ground cover, which prevents erosion, improves soil temperature and moisture condition as well as suppresses weed. There is a high potential in the use of the crop as a biological weed suppressant.

Plant hormones are vital to plant growth as in their absence plants would be a mass of undifferentiated cells (Davies, 1995). Auxins were the first class of growth regulators discovered and affect cell elongation by altering cell wall plasticity. Auxin stimulates cambial cells to divide and in stem; cause secondary xylem to differentiate.

The aim of this study is to evaluate the effects of Indole-3-Acetic Acid (IAA) on the growth and development of *C. lanatus* varieties in order to determine the optimum concentration required for the growth and development. This data will enhance production of the crop while assessing the potentials of IAA in the commercial production of the plant. The importance of cucurbits in the vegetable industry is increasing; therefore, it is essential to determine if any of the reported growth regulating chemicals could be used to enhance economic or practical advantage, which may result in an increase in yield (Abdel-Rahman and Thompson, 1969; Cantliffe et al., 2007). The growth of plants is dynamic and complex yet a strictly controlled process. As a result of many studies spanning over many years, show that hormones play vital roles in the control of growth not only within as a whole but apparently also within individual plant tissues and organs (Ojukwu, 2007). Indole-3-acetic acid is believed to be the principal auxin in higher plants (Wareing and Phillip, 1990). Its effect on plants is concentration dependent. It can either stimulate growth or inhibit it. Several growth responses have been attributed to this hormone including cell enlargement and gene expression. Auxin function primarily by cell enlargement through the extension of the rigid cellulose framework of the cell wall by a combination of osmotic swelling and directing the formation and laying down of new cell wall materials (Taylor et al., 2007). Synthetic auxin is also important in regulating plant growth and development (Bendre and Pande, 2007). Elongation of stems and coleoptiles of the plant is stimulated by both applied IAA and exogenous auxin (Remison, 1997). Pence and Caruso (1988) working on wheat stated that optimum concentration for stem elongation is usually 2×10^{-5} M, hence, any concentration above this is regarded as supra-optimal and concentration lower than the above is regarded as suboptimal and reduces elongation of stem and coleoptile. Experiments show that the main endogenous auxin that retards leaf abscission is IAA. Applied auxin in the form of IAA retards the pre abscission of the leaf (Jain, 2000). Auxin can initiate flowering in certain fruits such as pineapple. It can induce fruit set and development in some plant species. More so, fruit set in plant species with many seeds such as watermelon and pepper may be increased by auxin. The application of auxin to young developing fruits will increase their sizes and hasten the maturation period (Remison, 1997; Davies, 1995; Moctezuma and Feldman, 1998).

2. MATERIALS AND METHODS

2.1. Study Area

The study was conducted at the experimental field of Plant Biology and Biotechnology Department, University of Benin, Nigeria. A detailed description of the climatic condition, vegetation pattern, cultural practices and soil physicochemical and microbial characteristics have been reported by Osawaru et al. (2013a; 2013b); Osawaru and Ogwu (2014b); Ogwu and Osawaru (2015).

2.2. Collection of *Citrullus lanatus* Varieties

Fresh fruits of *C. lanatus* were obtained from within Benin City, Edo state. Four varieties of *C. lanatus* were selected based on morphological differences and three replicates each. A detailed description of the morphological characteristics of these fruits is reported by Ogwu et al. (2016).

Seeds were immediately extracted, washed, sun dried and stored until required for use. Seed viability test was conducted and only viable seeds were used.

2.3. Plant Growth Regulator

The Indole-3-Acetic acid solution was prepared by dissolving 1 g of IAA crystals, using a mild solution of sodium hydroxide (0.1 g NaOH) in about 100 ml distilled water in a 1-litre standard flask. The solution was then made up to the 1000 ml mark with distilled water. This gave a stock solution of 1 g/l of IAA. This stock solution was then serially diluted to obtain five different concentrations of IAA;

1 ppm IAA, 5 ppm IAA, 10 ppm IAA, 20 ppm IAA and 0 ppm IAA control (no IAA). It should be noted that the stock solution of 1 g/l is equivalent to 1000 mg/l. why these concentrations

2.4. Land Preparation and Laying of Bags

The experimental plot was measured, cleared and fenced. Topsoil was used in oil palm nursery bags measuring 30 cm in height and 23 cm in diameter. The bags were perforated at the bottom with the aid of a nail. The average weight of the polybag after filling with sand was 5 kg. The bags were laid 30 cm between bags and 20 cm between rows.

2.5. Experimental Design

The experimental design was a completely randomized block. ANOVA was carried out to compare the means of the different treatments, where significant and non-significant F-values were obtained. The sample size was five seeds per bag per treatment at a depth of 2 cm with three replicates for the four varieties. A total of 60 bags were used for the experiment.

2.6. Sowing and Crop Husbandry

The bags were irrigated with a quarter of a litre of water 24 hours before sowing. On the day of sowing, irrigation was repeated in the morning, and then 4 seeds were sown per bag at a depth of 2 cm. After five days, thinning was done reducing the seeds to three seedlings per bag as well as the foliar application of the growth regulator using spray nozzle pump. The second application of the growth regulator was carried after 15 days. Weed control was done by as recommended by Remison (2005). Irrigation of plants with water was done every day except on days that it rained. This was done from seedling emergence to the end of the experiment using a watering can.

2.7. Parameters considered for measurement

A quantitative expression of the amount of growth accomplished by plants was taken during the period of the experiment. The methods used were both for vegetative and reproductive traits as outlined in Remison (2005). The parameters considered include: The parameters considered for measurement include: (i) Plant height, (ii) Number of primary shoot branches, (iii) Number of leaves, and (iv) Number of flowers.

2.8. Statistical Analysis

The effects of treatments on the measured variables were detected using means, standard error and single factor analysis of variance on Microsoft Excel 2013.

3. RESULTS

The effects of IAA on the plant height of *Citrullus lanatus* is presented in figure 1. For variety A, two weeks after planting, the control had a plant height value of 5.67 ± 0.88 cm; the 10 ppm had 7.70 ± 0.29 cm. At the fourth week, the control had 5.93 ± 0.78 cm and 5 ppm had 8.70 ± 0.74 cm. At the sixth, eighth, tenth and twelfth week, the control had 7.47 ± 0.55 cm, 9.47 ± 1.85 cm, 11.28 ± 1.55 cm and 12.65 ± 1.85 cm in that order while 1 ppm had 10.30 ± 1.55 cm at the sixth week, 13.20 ± 1.19 cm and 17.85 ± 1.68 cm and 18.57 ± 1.19 cm at the eighth, tenth and twelfth week in that order.

For *C. lanatus* variety B, at the second week after sowing, the control had a plant height (cm) value of 6.67 ± 1.20; the 20 ppm had 7.90 ± 0.56. At the fourth week, the control had 8.87 ± 0.50 and 5 ppm had 9.85 ± 0.82. At the sixth, eighth, tenth and twelfth week, the control had 7.17 ± 1.07, 15.20 ± 1.07, 16.03 ± 1.07 and 17.20 ± 0.61 in that order while 1 ppm had 10.10 ± 0.90 at the sixth week, 5 ppm had 17.17 ± 1.08, 18.87 ± 0.90 and 19.93 ± 0.84 at the eight week, tenth and twelfth-week in that order.

For *C. lanatus* variety C, at the second week after sowing, the control had a plant height (cm) value of 6.63 ± 1.77; the 5 ppm had 7.77 ± 1.25. At the fourth week, the control had 7.00 ± 1.15 and 5 ppm had 10.40 ± 0.87. At the sixth, eighth, tenth and twelfth week, the control had 7.38 ± 1.00, 11.93 ± 2.32, 13.80 ± 1.99 and 16.07 ± 1.83 respectively, while, 5 ppm had 10.60 ± 0.76, 18.58 ± 0.79, 19.62 ± 1.02 and 19.92 ± 0.84 at sixth, eighth, tenth and twelfth week in that order.

For *C. lanatus* variety D, at the second week after sowing, the control had a plant height (cm) value of 7.00 ± 1.15; the 5 ppm had 7.77 ± 1.25. At the fourth week, the control had 7.38 ± 0.84 and 1 ppm had 10.10 ± 0.45. At the sixth, eighth, tenth and twelfth week, the control had 9.47 ± 0.55, 14.37 ± 1.81, 14.95 ± 1.78 and 15.77 ± 1.46 respectively while 5 ppm had 10.87 ± 0.52 at the sixth week, 10 ppm had 15.73 ± 1.33 at the eighth week and 5 ppm had 19.05 ± 0.39 and 19.87 ± 1.07 at the tenth and twelfth week in that order.

The effect of different concentrations of IAA on the number of leaves of *C. lanatus* is presented in figure 2. For variety A, the second week after sowing, the control had a value of 5.00 ± 0.58; the 1 ppm had 5.67 ± 0.88. At the fourth week, the control had 13.30 ± 2.08 and 1 ppm had 31.67 ± 5.90. At the sixth, eighth, tenth and twelfth week, the control had 3.33 ± 1.76, 8.00 ± 4.36, 5.33 ± 2.91 and 3.67 ± 2.03 in that order while 5 ppm had 6.67 ± 0.88 at the sixth week, 1 ppm had 17.67 ± 6.94, 13.33 ± 5.21 and 11.33 ± 4.06 at the eighth, tenth and twelfth week in that order.

C. lanatus variety B, at the second week after sowing, the control had a value of 6.00 ± 0.58; the 1 ppm and 20 ppm had 4.67 ± 1.20 and 4.67 ± 0.67 respectively. At the fourth week, the control had 9.00 ± 2.08 and 10 ppm had 12.33 ± 3.76. At the sixth, eighth, tenth and twelfth week, the control had 7.33 ± 0.76, 7.33 ± 1.33, 3.33 ± 0.67 and 2.67 ± 0.67 respectively while 20 ppm had 12.67 ± 1.76 at the sixth week, 10 ppm had 10.00 ± 2.00 and 8.00 ±1.15 and 7.00 ± 1.53 at the eighth, tenth and twelfth week in that order.

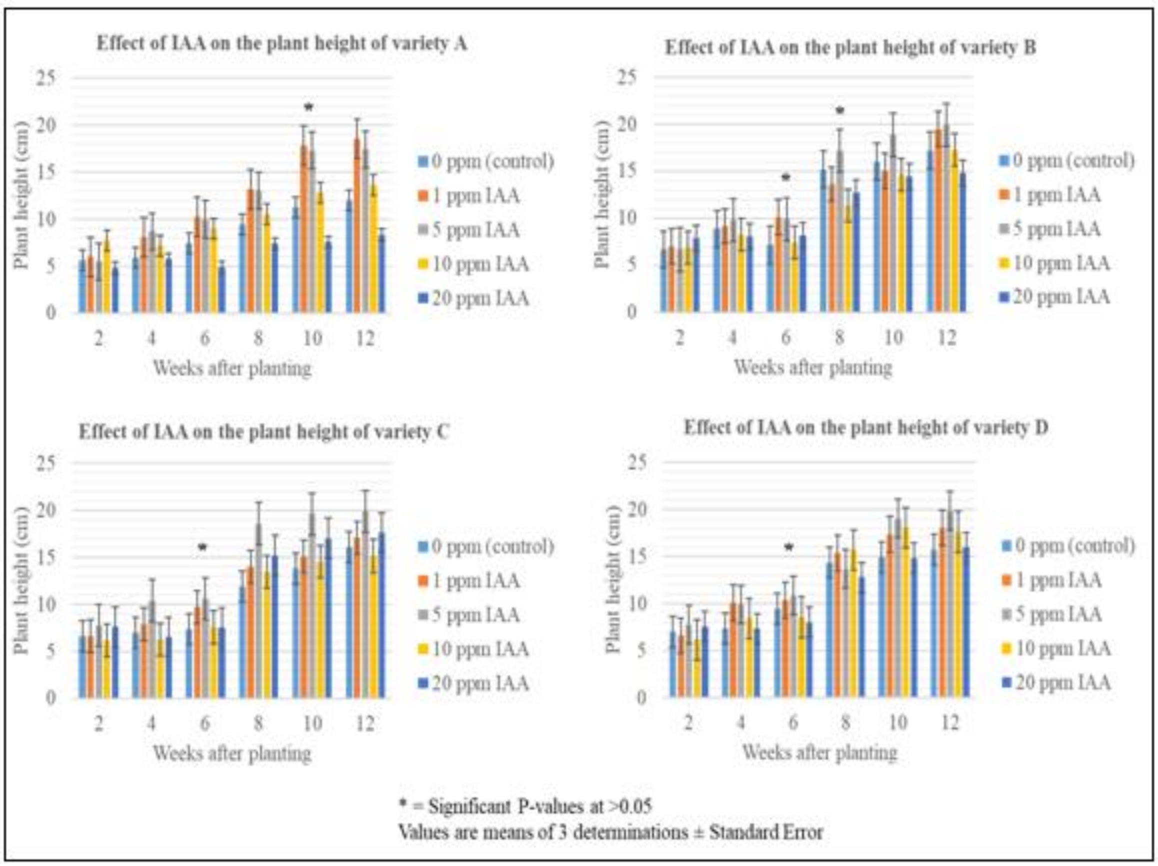


Figure 1. Effects of IAA on the plant height (cm) of *Citrullus lanatus.*

C. lanatus variety C, at the second week after sowing, the control had a value of 4.67 ± 0.88; the 5 ppm had 4.67 ± 0.33. At the fourth week, the control had 19.67 ± 6.01 while 5 ppm had 14.00 ± 5.03. At the sixth, eighth, tenth and twelfth week, the control had 11.00 ± 6.03, 16.33 ± 5.36, 9.33 ± 1.76 and 7.67 ± 1.86 respectively while 20 ppm had 26.67 ± 5.78 at the sixth week, 5 ppm had 14.00 ± 3.06, 10.67 ± 1.67 and 9.33 ± 1.76 at the eighth, tenth and twelfth week in that order. *C. lanatus* variety D, at the second week after sowing, the control had a value of 5.00 ± 0.58; the 20 ppm had 6.00 ± 0.00. At the fourth week, the control had 14.33 ± 3.48 while 20 ppm had 19.00 ± 5.13. At the sixth, eighth, tenth and twelfth week, the control had 18.67 ± 1.20, 11.67 ± 2.03, 6.67 ± 2.40 and 4.00 ± 2.31 respectively while 20 ppm had 25.67 ± 9.13, 16.67 ± 3.39, 10.33 ± 5.24 and 11.00 ± 2.65 at the sixth week, eighth, tenth and twelfth week in that order.

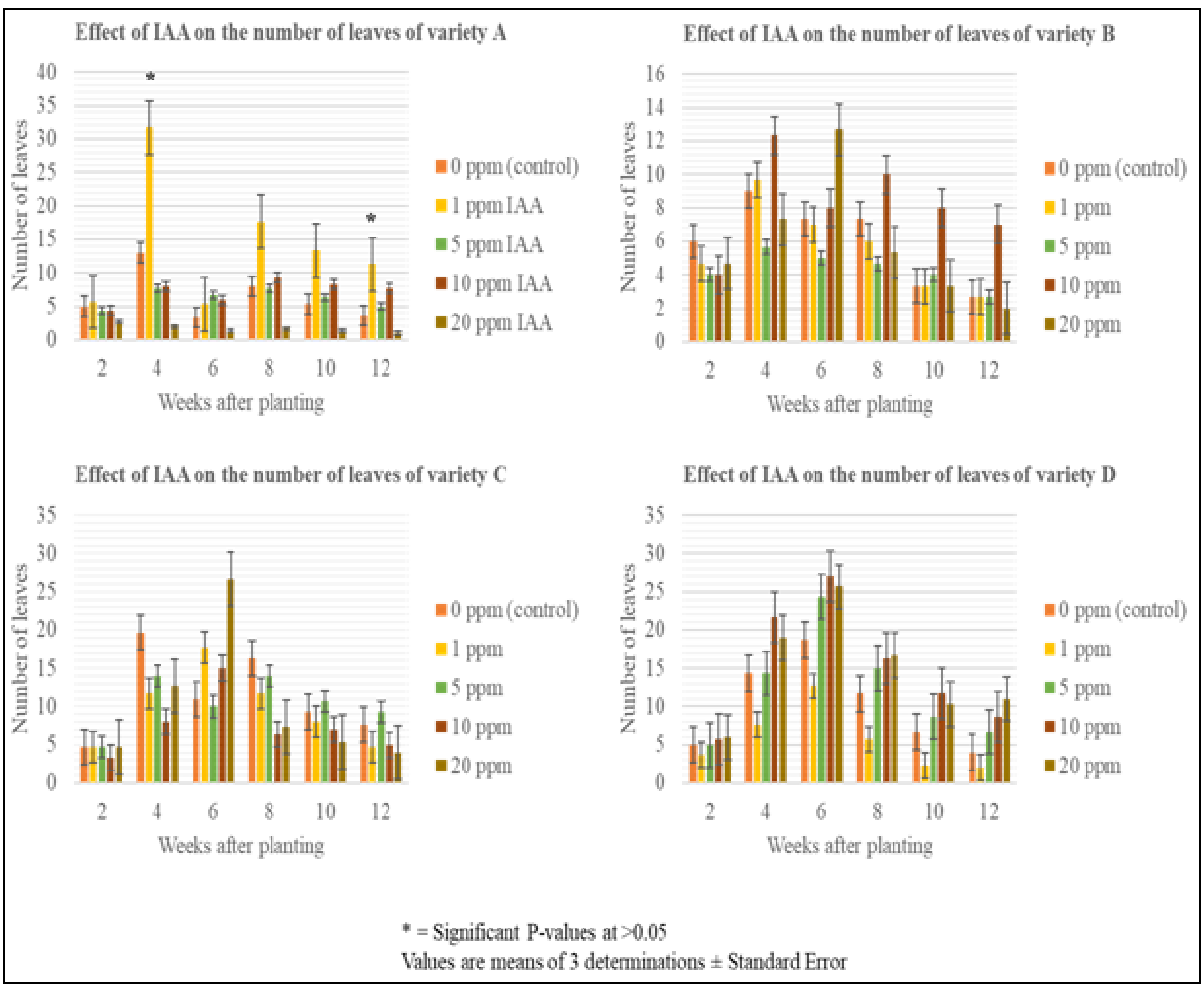


Figure 2. Effect of IAA on the number of leaves of *Citrullus lanatus*

The effect of different concentrations of IAA on the number of flowers of *C. lanatus* is presented in figure 3. For variety A, second week after sowing, the control had a value of 0.33 ± 0.33; the 1 ppm had 1.33 ± 0.33. At the fourth week; the control, 5 ppm and 10 ppm had 0.33 ± 0.33. At the sixth, eighth, tenth and twelfth week, the control and 20 ppm had 0.00 ± 0.00 while 5 ppm and 10 ppm had 0.33 ± 0.33 in the sixth week and eighth weeks in that order.

C. lanatus variety B, at the second week after sowing, the control had a value of 1.00 ± 0.00; the 1 ppm and 20 ppm had 0.67 ± 0.33. At the fourth week; the control had 0.00 ± 0.00 while 10 ppm had 0.33 ± 0.00. At the sixth week, the control and 5 ppm was 1.33 ± 0.33 while the 1 ppm, 10 ppm and 20 ppm were 1.00 ± 0.58, 0.67 ± 0.33 and 3.00 ± 0.58 in that order. At the eight week the control, 1 ppm, 5 ppm, and 20 ppm were 0.00 ± 0.00 while the 10 ppm had 0.33 ± 0.33. At the tenth week and twelfth week, all treatments had 0.00 ± 0.00.

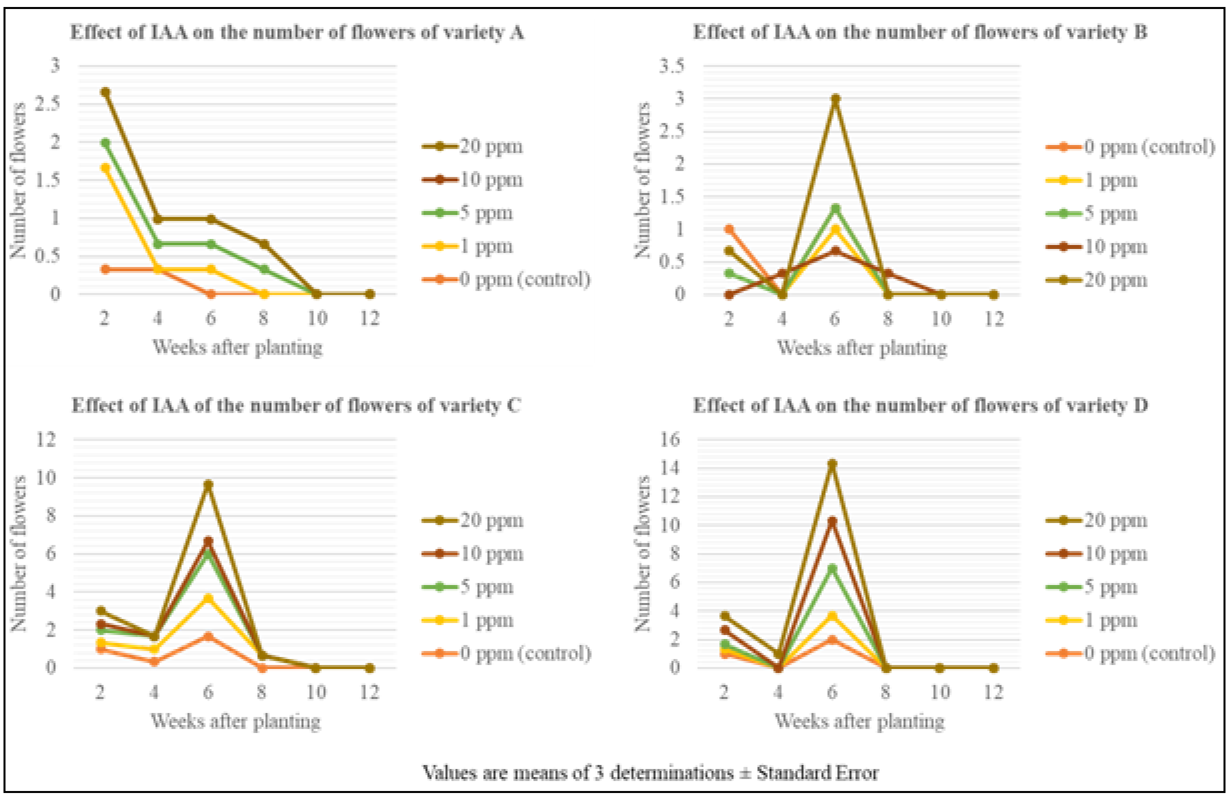
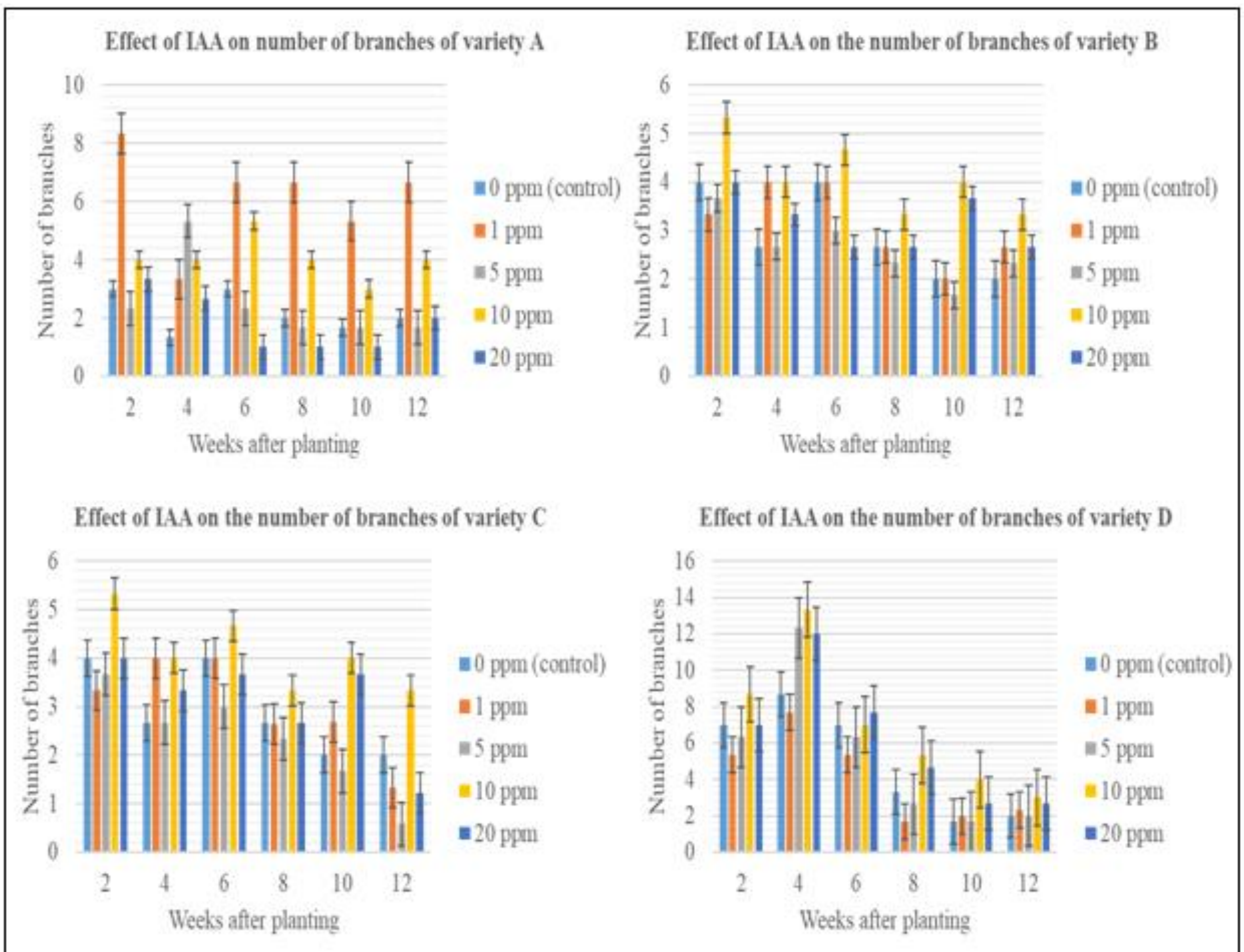


Figure 3. Effect of IAA on the number of flowers of *Citrullus lanatus.*

C. lanatus variety C, at the second week after sowing, the control had a value of 1.00 ± 0.58; the 5 ppm and 20 ppm had 0.67 ± 0.33. At the fourth week; the control had 0.33 ± 0.33 while 1 ppm and 5 ppm had 0.67 ± 0.67; 10 ppm and 20 ppm were 0.00 ± 0.00. At the sixth week the control had 1.67 ± 1.20 while 1 ppm, 5 ppm 10 ppm and 20 ppm were 2.00 ± 1.00, 2.33 ± 0.33, 0.67 ± 0.67 and 3.00 ± 0.58 in that order. The control, 5 ppm, 10 ppm and 20 ppm had 0.00 ± 0.00 at the eighth week while 1 ppm was 0.67 ± 0.67. At the tenth and twelfth weeks, all treatments had 0.00 ± 0.00.

C. lanatus variety D, at the second week after sowing, the control had a value of 1.00 ± 0.00; the 1 ppm and 5 ppm had 0.33 ± 0.33 while 10 ppm and 20 ppm had 1.00 ± 1.00. At the fourth week, all treatments had 0.00 ± 0.00. At the sixth week, the control had 2.00 ± 0.00 while 1 ppm, 5 ppm 10 ppm and 20 ppm were 1.67 ± 0.33, 3.33 ± 1.33, 3.33 ± 1.20 and 4.00 ± 1.53 respectively. At eight, tenth and twelfth weeks all treatments had 0.00 ± 0.00.



Values are means of 3 determinations ± Standard Error

Figure 4. Effect of IAA on the number of branches of *Citrullus lanatus.*

The effect of different concentrations of IAA on the number of branches of *C. lanatus* is presented in figure 4. For variety A, fourth week after sowing, the control had a value of 3.00 ± 2.08; 1 ppm had 8.33 ± 4.33 while 5 ppm, 10 ppm and 20 ppm were 2.33 ± 0.88, 4.00 ± 1.15 and 3.33 ± 0.67 respectively. At the sixth week, the control had 1.33 ± 0.67 while 5 ppm had 5.33 ± 1.76 and the 20 ppm was 2.67 ± 1.33. At the eighth, tenth and twelfth week, the control had 3.00 ± 2.08, 2.00 ± 1.15 and 1.67 ± 1.20 respectively while the 1 ppm had 6.67 ± 2.67 at the eight and tenth weeks in that order and 5.33 ± 2.33 on the twelfth week.

C. lanatus variety B, at the fourth week after sowing, the control had a value of 4.00 ± 1.15; the 10 ppm had 5.33 ± 1.76 while 1 ppm 5 ppm and 20 ppm were 3.33 ± 1.76, 3.67 ± 1.20, and 4.00 ± 2.00 respectively. At the sixth week, the control had 2.67 ± 0.67 while 20 ppm had 8.33 ± 1.86 and the 5 ppm was 2.67 ± 1.33. At the eighth, tenth and twelfth week, the control had 4.00 ± 1.15, 2.67 ± 0.67 and 2.00 ± 0.00 respectively while the 10 ppm had 4.67 ± 1.33, 3.33 ± 0.67 and 2.00 ± 1.15 at the eight, tenth and twelfth weeks in that order.

C. lanatus variety C, at the fourth week after sowing, the control had a value of 4.00 ± 1.15; the 10 ppm had 5.33 ± 1.76 while 1 ppm, 5 ppm and 20 ppm were 3.33 ± 1.76, 3.67 ± 1.20 and 4.00 ± 2.00 respectively. At the sixth week, the control had 2.67 ± 0.67 while 20 ppm had 8.33 ± 1.86 and the 5 ppm was 2.67 ± 1.33. At the eighth, tenth and twelfth week, the control had 4.00 ± 1.15, 2.67 ± 0.67 and 2.00 ± 0.00 respectively while the 10 ppm had 4.67 ± 1.33, 3.33 ± 0.67 and 2.00 ± 1.15 at the eight, tenth and twelfth weeks in that order.

C. lanatus variety D, at the fourth week after sowing, the control had a value of 7.00 ± 1.53; the 20 ppm had 9.00 ± 4.04. At the sixth week, the control had 8.67 ± 1.33 while 10 ppm had 13.33 ± 3.71. At the eighth, tenth and twelfth week, the control had 7.00 ± 1.53, 3.33 ± 0.67 and 1.67 ± 0.86 respectively while the 20 ppm had 7.67 ± 2.96, 4.67 ± 1.76 and 2.67 ± 1.76 at the eight week, tenth and twelfth weeks in that order.

4. DISCUSSION

An evaluation of the effects of IAA on the growth and development of C. *lanatus* has been conducted using plant height, branches, leaves and flowers. IAA is the most important and abundant endogenous auxin with extensive *in vivo* roles including stem growth, root formation, inhibiting lateral bud development, fruit and leaf abscission, fruit development and activating cambium cells (Bartel et al., 2000; El-Eslamboly, 2014). The experimental modification of the growth, flowering and fruiting characteristics of cucurbits using IAA have been shown to affect their yield (Abdel-Rahman and Thompson, 1969). The results of Oh (2008) suggest that other effective forms of auxin include naphthalene acetic acid (NAA), 2, 4-dichlorophenoxyacetic acid (2,4-D) and 2-chloro-4-pyridyl-N-phenylurea (CPPU). The studies of Sadak et al. (2013) and Ogwu et al. (2015) revealed that IAA treatments has positive effects on growth criteria (plant height, leaves number, fresh and dry weight per plant), photosynthetic pigments (chlorophyll *a*, *b* and carotenoids), total carbohydrate, polysaccharide, free amino acid, proline and total phenolic contents in cultivars. IAA is the most active form of auxin in most plants (Raza et al., 2014).

Higher levels of auxin increase differentiation and result in greater vascular vessel density (Martens et al., 1994). In the study, the results also suggest that high concentration of about 20 ppm may promote flower promotion between four and six weeks. Beyond this period, flower production was drastically reduced (Fig 3). Application of IAA also had stimulatory effects on plant height (Sarkar et al., 2002). This is supported by the results obtained in this study as the mean plant height showed significance at 6 and 10 weeks for varieties B, C, D and A respectively. This implies that there may be variety specific response to IAA with regards to plant height. At the end of the second week, 10 ppm and 1 ppm had the highest height for variety A and B respectively while variety C and D had their highest plant height at 5 ppm. At the end of the fourth-week variety A, B, C and D had highest height at 5ppm. At the end of the sixth-week variety B at highest height at 1 ppm while at 5 ppm variety A, C and D had recorded highest height. A remarkable increase in height was recorded at the end of the eighth week. Variety A at 1 ppm had highest height at 1 ppm for the eight, tenth and twelfth weeks respectively while at 5 ppm variety B, C and D had highest height for the same period. Variety A had significant F-value at the tenth week, variety B at the sixth and eight weeks, variety C at the sixth week and variety D at the fourth week. Therefore, 5 ppm IAA may be proposed as optimum for plant height for variety A, B, C and D since the highest amount of height were obtained at 5 ppm in the four varieties; when compared with the other levels. Auxins have been reported to be involved in the efficiency of water and nutrient assimilation (Aloni, 1987).

IAA exerts influence on plant growth by enlarging leaves and increasing photosynthetic activities in plants (Naeem et al., 2004). The analysis of the effect of IAA on the number of leaves produced shows that at 1 ppm IAA is optimum for leaf production in the four varieties of *C. lanatus*. At the end of the fourth and eight weeks, a remarkable increase in the number of eaves was recorded. This was adversely affected by abscission of the leaves. Variety A had significant F- values in the fourth and twelfth weeks while varieties B, C and D had no significant F- values. Thus, the levels of IAA that stimulates shoot growth as well as root growth. This is in accordance with the report of El-Eslamboly (2014), which suggests that of all the plant hormones, auxins have the greatest effect on root formation and development in a cutting especially Indole butyric acid, used on its own or in combination with NAA. Root mass increases would improve the uptake ability of the plant for water and nutrients when stress occurs (Martens et al., 1994).

IAA and can manipulate a variety of growth and developmental phenomena in various crops (Sarkar et al., 2002). In this study, the analysis of the mean number of flowers and branches produced were poor and showed a high amount of abscission. The values were not significantly different at $P>0.05$. At the end of the second, fourth and sixth week; a small number of flowers were produced at 1ppm and 5 ppm. The eight to twelfth week no flowers were produced. In a different study, the combination of CPPU, NAA, and 2,4-D at 50 mg/kg each was most effective on watermelon fruit set while other traits of watermelon fruit were not affected uniformly when applied using a hand sprayer compared with other combinations or the control (Oh, 2008). From their results, Abdel-Rahman and Thompson (1969) suggest that spraying the watermelon with IAA modified sex expression toward femaleness, which could be attributed to increasing the number of pistillate flowers, decreasing the number of staminate flowers or both. More so, natural and synthetic auxins promote pistillate flower development in cucumber (Maynard, 2007). The sexual differentiation is controlled by endogenous levels of auxins, which developed flowering primordia and during flowering act as anti-gibberellin substance (Ghani et al., 2013). At the end of the fourth week, variety A had highest number of branches at 1 ppm while varieties B, C and D had highest number of branches at 10 ppm. At the end of the sixth-week variety, A and D had highest number of branches at 5 ppm while variety B and C at 20 ppm. At 1 ppm variety, A had it highest number of branches at the eight, tenth and twelfth weeks while same was recorded at 10 ppm for variety B and C. Variety D recorded the highest number of branches at 20 ppm at the eight, tenth and twelfth weeks. This can be attributed to environmental factor especially the soil. In a similar study by Sarkar et al. (2002), 100 ppm IAA produced the highest 1 plant height, number of flowers, number of pods, percentage of fruit set, number of seed per plant, seed yield per plant and seed yield (t haG), as compared to other plant growth regulators and 1 control. IAA at 200 ppm increased the number of branches, a number of leaves, and leaf area per plant, 100-seed weight and net assimilation rate. More so, foliar application of plant growth regulators such as IAA at 50, 100 and 150 ppm, was found to influence different morpho-physiological characters in *Jatropha curcas* including plant height, collar diameter, tree spread, flower initiation, number of inflorescence per plant, number of male and female flowers per inflorescence, and the ratio of male: female flowers per inflorescence (Joshi et al., 2011). It was also observed by Hala et al. (2001) that foliar application of the plants with indole acetic acid (IAA) at three concentrations (12.5, 25 and 50 ppm) induced increments of the plants height, fresh and dry weights, number of branches and number of leaves/plant as well as yield components (pods/plant, seeds/pod, weight of pod, weight of seeds/plant and weight of seeds/feddan). In the present study, flower abscission was very high. The growth regulators 2,4-D and CPPU were reported by Oh (2008) as most damaging to watermelon seedlings.

5. CONCLUSIONS

In conclusion, this work has established the shoot height and number of leaves inducing effects of different IAA treatments especially at 5 ppm IAA and 1 ppm IAA respectively. Since environmental factors (especially the soil) was a barrier to the growth and development of the plant; before cultivation of watermelon in Benin City, Edo state the soil should be treated to avoid bacterial and fungal attack. Fertilizer may be applied in combination with IAA treatment on the plant for better yield. It can, therefore, be concluded that watermelon can be cultivated in Benin City and since it does not require too much water for growth, it should be planted towards the end of the rainy season.

6. ACKNOWLEDGEMENTS

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