

Growth and yield characters of three varieties of cowpea (*vigna unguiculata* L. walp.) in response to different concentrations of indole-3-acetic acid

¹Mshelmbula, B.P., ¹Atabo, F.O., ²Odenore, V.D. and ¹Sulieman, S.

¹Department of Botany, Federal University, Lafia, Nasarawa State, Nigeria.

²Nigerian Institute for Oil palm Research, Benin City. Edo state, Nigeria

E-mail: barkapeter5@gmail.com

Received October 22, 2019

Accepted for publication January 22, 2020

Published April 15, 2020

Abstract

This study was conducted to determine the response of Indole -3-acetic acid (IAA) on the agronomical and yield characters of three varieties of Cowpea (*Vigna unguiculata*) (SP6, SP9 and SP11) at four different concentrations of IAA; 250mg/l, 500mg/l, 750mg/l and 1000mg/l respectively. Results showed that IAA at different concentrations had certain effects on the growth and yield parameters in the three varieties of cowpea. There was a general increase in the number of leaves of SP6, SP9 and SP11 with increased IAA concentration. Moderate concentrations of IAA (500mg/l and 750mg/l) enhanced the development of leaf area across the three varieties investigated. However, number of pod/plant increased on exposure to the least concentration (250mg/L) of IAA, higher concentrations of IAA had no significant effect on the number of seeds. In Variety SP11 and SP6, no visible differences were observed in the number of days to germination across all treatment levels including the Control.

Keywords: Cowpea, indole-acetic acid, yield, plant growth

Introduction

Cowpea is of major importance to the nutrition and livelihoods of millions of people in less-developed countries of the tropics. Cowpea is consumed in many forms. Young leaves, green pods and green seeds are used as vegetables whereas dry seeds are used in a variety of food preparations (Nielsen *et al.*, 1997). Trading of fresh produce and processed cowpea foods and snacks provides rural and urban women with an opportunity for earning cash income. The use of growth regulators in crop production is widely adopted in enhancing plant growth and development. Indole-3-Acetic acid (IAA) is the first known natural ubiquitous auxin in plants (Davies, 2004). IAA has been implicated in a wide range of developmental processes, some of them include elongation growth, photo-and gravitropism, apical dominance, lateral root initiation, the differentiation of vascular tissues, embryogenesis, fruit setting and ripening and senescence. Auxins play a major role in plant growth and development (often called phytohormones or plant hormone). They are either natural or synthetic compounds and can be applied directly to plants in various ways to alter life processes and structure or both in some beneficial way, so as to improve quality or to facilitate harvesting. Auxins are important phytohormones, and the auxin indole-3-acetic acid (IAA) was shown to promote several growth and developmental events, such as cell division, elongation, and differentiation (Asgher *et al.*, 2015).

The development of a plant is commonly measured by its increase in height, number of leaves, branches, stem girth and fruit, tuber or grain yield (Sabieli *et al.*, 2014). These parameters are often affected by the plants environment and genetic makeup. Plant growth regulators may be introduced to accelerate or retard plant development depending on the desire of the crop breeder or producer. More often, auxins are used to promote the growth of plants for early maturity and production of food for the benefit of man and livestock in the face of the ever growing population especially in the developing countries.

Cowpea is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation with it (Carsky *et al.*, 2002; Tarawali *et al.*, 2002; Sanginga *et al.* 2003). Early maturing cowpea varieties can provide the first food from the current harvest sooner than any other crop (in as few as 55 days after planting), thereby shortening the “hungry period” that often occurs just prior to harvest of the current season’s crop in farming communities in the developing world.

Materials and Methods

Description of the Study Area

Lafia, the capital of Nasarawa State is located in the Southern Guinea Savanna Region of North- Central Nigeria, on Latitude 8.51667°E, and Longitude 8.4916°N. With a population of about 330,712, it is home to abundant food crops that produce important fruits which meet the immediate dietary needs and also serve as the major source of income for the inhabitants. Major crops produced in Lafia include *V. unguiculata* (cowpea), *Magnifera indica* (mango), *Citrus senensis* (orange), *Musa acuminata* (banana) and *Anacardium occidentale* (cashew) (Binbol and Marcus, 2007).

Collection of planting materials

Three varieties of cowpeas (Sampea 6, Sampea 9, and Sampea 11) were collected from AGRICTROPICS LTD, Lafia, Nasarawa state.

Soil collections

Garden soil was used for the study. The top soil from Federal university lafia botanical garden were collected. 5kg of soil were measured into polythene bags, the polythene bags were perforated at the bottom in order to prevent the soil from retaining excess water. The bags was then placed placed at the Research Garden at a spacing of 60cm x 30cm, as proposed by Okeleye *et al.*, (1999) The soil was measured into 48 polybags for the three cultivars, with three (3) replicates for each Indole acetic acid concentration. The polybags were labeled based on the concentrations with masking tape.

Preparation of Plant hormone Solution

Four different Indole acetic acid concentrations were prepared on weight basis, viz. 250mg, 500mg, 750mg and 1000mg respectively. The various concentrations were dissolved in 1liter of water. The control used was distilled water.

Experimental design

Seeds were soaked for 2 hours in Petri dishes containing the prepared concentrations of IAA. Experimental treatments were laid in a Randomized Completely Blocked Design (RCBD). With each treatment consisting of 3 replicates.

Sowing

The seed were sown directly into the soil. Planting was done in the evening, just beyond sunset following the method of (Ikhajagbe, 2004). Seeds were sown at a rate of 3 seeds per pot in each of the polythene bags including the control portion. Thereafter, constant irrigation was carried out every morning and evening all

through the experiment until full maturity and yield is attained.

Insect control

Plants were sprayed with Kombat® insecticides 6 weeks after planting at a concentration of 2ml per 20 litters. This was to prevent insect attack which is very common to Cowpea.

Parameters considered

On the field, plants were assessed for both vegetative and yield parameters like plant height, number of leaves, total leaflet area, number of days to germination, as well as estimated yield, number of pods per plant, number of flowers per plant, (Mshelmbula *et al.*, 2012).

Data analysis

Data collected was subjected to one-way Analysis of Variance (ANOVA), and the treatment means were compared using the Duncan New Multiple Range Test (DNRMT) at 5% probability level $P < 0.05$.

Results and Discussion

Effects of different concentrations of IAA on the number of leaves and plant height

Results of the number of leaves and Plant height are shown in Table 1; there were no significant differences in the number of leaves of variety SP6 between the control and all the different treatments except treatment 750 which was significantly higher than others (14.02). In variety SP9, treatment 750 had the highest number of leaf (20.05) and was significantly different from that of other treatments except with control. Treatment 1000 had the lowest number of leaves (5.14) and was significantly different from the others. Also in variety SP11, the highest number of leaves (16.86) was observed in treatment 1000 and is not significantly different from those of treatments 500 and control. There were no significant differences in the plant height of variety SP6 between the control and treatments 500 and 1000. Treatment 750 had the highest plant height (19.64 cm) and was significantly different from others except treatment 250. In variety SP9, only treatment 1000 which had the lowest plant height (8.07 cm) was significantly different from others. There was no significant difference in the plant heights of the control and treatments 250, 500 and 750. Also in variety SP11, the lowest plant height (15.31 cm) was observed in treatment 750 and it was significantly different from the control and other treatments.

From the results, variety SP6 exposed to the second to the highest treatment (750mg/L) showed the highest number of leaves (14.02) when compared to the control (6.75). This agrees with Mshelmbula *et al.*, (2015) who reported that IAA at concentrations of 50ppm and 100 ppm increased the number of leaves in Sesame (*Sesamum indicum*). This was also seen in SP9 variety which showed highest number of leaves (20.05) at 750mg/L treatments. This was significantly different from the other treatments except with the control. However, SP11 variety had the highest number of leaves (16.86cm) upon exposure to 1000mg/L of IAA solution even though it was not significantly different from treatment 500mg/L and the control. In the same vein, there was increase in plant height (19.64cm) in variety SP6 when treated with the second to the highest treatment (750mg/L) of indole-3-acetic acid solution. For variety SP9, there was no significant difference in the plant height in the control and 250 mg/L, 500mg/L and 750mg/L treatments while treatment 1000mg/L recorded the lowest plant height (8.07cm) which is significantly different from others. Again, variety SP11 there was increase in plant height among all the treated seeds except for 750mg/L which showed a reduction in plant height (15.31cm).

These results show that varietal differences among all the cowpea accessions responded differently to the various IAA concentrations ranging from increasing to decreasing of the plant height. This is in concert with

Mshelmbula *et al.*, (2015) who reported that IAA at 50ppm and 100ppm increased the plant height in Sesame (*Sesamum indicum*).

Effects of different concentrations of IAA on the stem girth and leaf area

As shown in Table 2, there were no significant differences in the stem girth of variety SP6 across all treatments. In variety SP9, there was no significant difference in treatment control, 250 and 1000, however, treatments 500 and 750 were significantly different from treatment control, 250 and 1000. In variety SP11, the highest stem girth was recorded in Control (0.80) and it was not significantly different from treatment 250, 500, 750 and 1000. There was no significant difference in Leaf area of variety SP6 between the control, treatment 250, 500 and 1000, however, there was significant difference between treatment 750 and other treatments. In variety SP9, there was no significant difference between control and treatment 250 and 500. However, treatment 750 has the highest Leaf area (24.40) and was significantly different from others except Control. In variety SP11, treatment 500 (26.80) was significantly different from treatment 750 and 1000, however it was not significant to control and treatment 250. Treatment 500 was not significantly different to Control and treatment 250 and 500.

There were no significant differences in the stem girth across all treatments in SP6. As for SP9, there are no significant difference in the control, 250mg/L and 1000mg/L, but the highest stem girth was seen in treatment 500mg/L (0.62cm) while variety SP11, the control (0.80cm) had the highest stem girth even though it was not significantly different from the other treatments. Results also found that the second to highest concentration 750mg/l had the highest leaf area (23.11cm²) in comparison with the control (10.98cm²) in variety SP 6. Treated with the same concentration of 750mg/L, Variety SP9 had the highest leaf area (24.40cm²) and it showed no significant difference to the other treatments except the control. In SP11, the highest leaf area (26.80cm²) is seen at a moderate concentration of 500mg/l when compared with the control (24.90cm²) and other treatment which agrees with Lakshmipathi *et al.* (2017) who reported that IAA at 100ppm which is also the moderately used concentration significantly increased the leaf area of cashew .

Effects of different concentrations of IAA on the number of flowers and number of pod/plant

As shown in Table 3, there was no significant difference in the number of flowers of variety SP6 between control and every other treatment. In variety SP9, there was no significant difference in the number of flowers between control and other treatments except in treatment 1000. However, treatment 1000 was not significantly different from treatment 500 and 750. In Variety SP11, treatment 500 and treatment 750 are significantly different from each other, however, control was not significantly different from other treatments except treatment 500. There was no significant difference in the number of Pod of Variety SP6 between control and every other treatment. In variety SP9, treatment 750 recorded the highest number of Pod and was not significantly different from every other treatment including Control. Also, variety SP11, there was no significant difference in the number of Pod across all treatment, including the control treatment

There was no significant difference in the number of pod/plant in variety SP6, though the highest number of pod (0.70) was observed in the least concentration 250mg/L which is in concert with Abou-Hussein *et al.* (2010) who reported that 25 mg/L and 50 mg/L treatments showed a significant increase in number of pods but the higher concentrations of IAA had no significant effect in increasing number of pods .In variety SP9 750 mg/L treatment recorded the highest number of pod thou it is not significantly different from every other treatment and the control. However, in SP11, there are no significant difference in the number of pods across all treatments although treatment 500 mg/L showed the highest number of pods. These observations also just like in the case of the leaf area indicated that moderate concentration of IAA triggered an increase in the number of pod /plants which is in concert with El-saed *et al.* (2010) who reported that moderate concentration of IAA resulted in a general increase in the number of pod/plant while the highest concentration did not have any significant effect on the number of pod/plants.

There is no significant difference in the number of flowers of variety SP6 between control and every other treatment. In variety SP9, there is no significant difference in the number of flowers between control and other treatments except treatment 1000mg/L, however, treatment 1000mg/L is not significantly different from treatment 500mg/L and 750mg/L. In Variety SP11, treatment 500mg/L and treatment 750mg/L are significantly different from each other, however, control is not significantly different from other treatments except treatment 500mg/L.

Effect of different concentrations of IAA on the number of seeds and days to germination

As shown in Table 4, there was no significant difference in the number of seed of variety SP6 between control and every other treatment. In variety SP9, control recorded the highest number of seed and was significantly different from every other treatment. In variety SP11, there were no significant differences in the number of seed across all treatment, including the control treatment. There was no significant difference in the number of days to germination of variety SP6 between control and every other treatment. In variety SP9 the number of days to germination, control was not significantly different from treatment 250 and 1000. Also, there were no significant differences between treatment 500 and 750, however, treatment 500 and 750 were significantly different from all other treatments including control. In variety SP11, there was no significant difference in the number of days to Germination across all treatments including the control.

As reported by El-saed *et al.* (2010), higher concentrations of IAA had no significant effect in increasing the number of seeds. This was seen across all the treatments in the three different varieties. The moderate treatments 500mg/l in SP11 showed highest number of seeds (16.00cm) when compared to the other treatments and the control. In SP6 and SP9, there were no significant differences across all treatments in the two varieties although the control in SP9 had the highest number of seed. In SP6 the germination vigour increased in the control when compared to the other treatments. However, in SP9, 1000mg/l increased the germination vigour when compared to the other treatments and the control. In variety SP11, the least concentration 250mg/l showed the fastest germination rate when compared with the other treatments and the control.

Conclusion

The findings from this study highlighted variations in three varieties of cowpea during growth and yield character responses to phytohormone application. The growth supplementation with IAA at several concentrations was insignificant to the number of flowers and stem girth of variety SP6. Whereas, there were significant effects of IAA levels in these growth characters in the other cowpea varieties examined. Generally, there were diverse effects of the concentrations of IAA used on the various cowpea varieties investigated. This buttresses the complexity of genetic and environmental interaction in the growth and developmental processes of plants.

Acknowledgements

The authors are grateful to the Editorial Team of the Society for Underutilized Legumes for accepting to publish their work

Conflict of Interests

The authors declare no conflict of interests

Tables, Figures and Charts

Table 1: Number of leaves and plant height of the three varieties under different treatments

Treatment	Number of leaves			Plant height		
	SP6	SP9	SP11	SP6	SP9	SP11
Control	6.74 ^a ±0.95	17.33 ^{ab} ±1.89	16.67 ^a ±1.16	11.24 ^a ±1.37	20.99 ^d ±1.47	25.23 ^c ±0.99
250	9.33 ^a ±1.13	13.24 ^{ac} ±1.23	11.98 ^a ±0.87	16.12 ^{bc} ±1.38	20.56 ^d ±1.64	22.33 ^c ±1.64
500	9.26 ^a ±1.04	11.97 ^a ±0.96	17.19 ^a ±2.22	12.55 ^{ab} ±1.30	25.14 ^d ±1.59	23.56 ^c ±1.24
750	14.02 ^b ±0.98	20.05 ^b ±1.93	8.83 ^e ±1.20	19.64 ^c ±1.28	25.27 ^d ±1.23	15.31 ^c ±1.86
1000	9.71 ^a ±1.22	5.14 ^d ±1.33	16.86 ^a ±1.51	14.31 ^{ab} ±1.68	8.07 ^c ±1.83	25.24 ^c ±1.28

Values represent mean ± standard error

Values with the same superscript across same column are not significantly different (P≤0.05)

Table 2: The stem girth (cm) and leaf area of the three varieties under different treatments.

Treatment	Stem Girth			Leaf Area		
	SP6	SP9	SP11	SP6	SP9	SP11
Control	1.10 ^x ±0.60	0.53 ^{ab} ±0.11	0.80 ^d ±0.50	10.98 ^d ±1.64	22.31 ^{qa} ±2.13	24.90 ^{cd} ±1.23
250	0.50 ^x ±0.11	0.33 ^{ab} ±0.10	0.23 ^d ±0.04	14.40 ^d ±1.70	18.60 ^q ±1.50	21.80 ^{cd} ±2.20
500	0.50 ^x ±0.14	0.62 ^b ±0.13	0.30 ^d ±0.04	12.54 ^d ±1.40	8.61 ^q ±1.80	26.80 ^d ±2.94
750	0.80 ^x ±0.14	0.60 ^b ±0.12	0.22 ^d ±0.10	23.11 ^e ±1.90	24.40 ^a ±1.70	15.30 ^b ±2.23
1000	0.54 ^x ±0.11	0.22 ^a ±0.10	0.32 ^d ±0.10	14.70 ^d ±2.30	6.40 ^c ±1.60	20.04 ^{bc} ±1.53

Values represent mean ± standard error

Values with the same superscript across same column are not significantly different (P≤0.05)

Table 3: Number of flowers and pods/plant

Treatment	Number of flower			Number of pods/plant		
	SP6	SP9	SP11	SP6	SP9	SP11
Control	0.02±0.02 ^a	0.23±0.10 ^l	0.20±0.10 ^{zn}	0.00±0.00 ^a	1.00±0.00 ^e	1.00±0.00 ⁿ
250	0.10±0.10 ^a	0.30±0.10 ^f	0.21±0.10 ^{zn}	0.70±0.33 ^a	0.70±0.33 ^e	1.00±0.60 ⁿ
500	0.10±0.10 ^a	0.10±0.10 ^{vf}	0.50±0.22 ⁿ	0.33±0.33 ^a	0.70±0.33 ^e	2.00±1.00 ⁿ
750	0.10±0.10 ^a	0.12±0.10 ^{vf}	0.10±0.04 ^z	0.33±0.33 ^a	3.70±3.70 ^e	0.00±0.00 ⁿ
1000	0.02±0.02 ^a	0.00±0.00 ^v	0.30±0.11 ^{zn}	0.00±0.00 ^a	0.00±0.00 ^e	1.00±1.00 ⁿ

Values with the same superscript across same column are not significantly different (P≤0.05)

Values represent mean ± standard error

Table 4: Number of seeds per pod and days of germination

Treatment	Number of seed			Number of days to germination		
	SP6	SP9	SP11	SP6	SP9	SP11
Control	0.00 ^m ±0.00	4.70 ^a ±0.70	10.70 ^u ±2.96	2.60 ^w ±1.33	3.00 ^{ab} ±0.00	3.33 ^r ±0.33
250	1.70 ^m ±0.90	1.00 ^b ±0.60	5.33 ^u ±2.91	3.33 ^w ±0.33	3.00 ^{ab} ±0.00	3.00 ^r ±0.00
500	1.70 ^m ±1.70	2.00 ^b ±1.00	16.00 ^u ±13.00	3.70 ^w ±0.33	4.33 ^b ±0.33	3.70 ^r ±0.33
750	1.00 ^m ±1.00	0.70 ^b ±0.70	0.00 ^u ±0.00	2.70 ^w ±1.33	4.70 ^b ±0.33	3.33 ^r ±1.70
1000	0.00 ^m ±0.00	0.00 ^b ±0.00	5.00 ^u ±3.61	5.00 ^w ±0.00	1.33 ^a ±1.33	3.50 ^r ±0.31

Values with the same superscript across same column are not significantly different (P≤0.05)

Values represent mean ± standard error

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