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Impact of Gibberellic Acid (GA_3) on Growth, Yield and Nodulation on Two Accessions of Cowpea (*Vigna unguiculata* (L.) Walp)

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ABSTRACT: Cowpea (*Vigna unguiculata*) is one of the most ancient crops known to man and is grown across various climatic zones, most commonly in the dry savanna regions of sub-Saharan Africa. The objective of this work was therefore to investigate the impact of Gibberelic acid on the growth and yield of cowpea. Field experiments was conducted during the 2019 rainy season at the Botanical Garden of Federal University of Lafia. The cowpea accessions were submerged into various concentrations of GA_3 (90mg/L, 120mg/L, and 150mg/L). The results showed varying response of the accessions in varying GA_3 concentrations. Both Accessions (TVU-1 and TVU-4) recorded no significant difference across all treatments in the number of flowers. In TVU-1 accession, the least concentration, 90mg/L recorded the highest number of flowers (0.22) at 12 (WAP); while in TVU-4, the seeds exposed to the highest concentration recorded the highest number of flowers. Similar result was observed in the number of pods of both accessions (TVU-1 and TVU-4) were there was no significant difference ($P \leq 0.5$) recorded. There was increase in the number of root nodules with increased in the growth hormone concentrations as treatment 150mg/L showed the highest number of root nodules in both accessions; even though no significant difference was recorded. It is therefore recommended that different accessions at different concentrations of gibberelic acid be tired to see their responses.

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Gibberellins are numerous groups of plant hormones that in addition to auxins are one of the main groups of plant regulators (Bethke, 1998). They all differ in physiological activity and structure, and the first identified gibberellins was Gibberellic acid (GA_3). Gibberellins are extensively involved in all phases of plant growth and development, from seed germination to senescence. They promote seed germination, stimulate stem elongation, leaf expansion, flowering, pollen, and seed development, delay ripening, and inhibit senescence (Tundzynski, Holter, 1998). Cowpea is a multifunctional crop, providing food for man and livestock and serving as a valuable and dependable revenue-generating commodity for farmers and grain traders (Langyintuo *et al.*, 2003). Cowpea is a major importance to livelihoods of relatively poor people in less developed countries of the tropics including South Sudan, especially where animal protein is not easily available. Cowpea is treated as an important food legume in tropical and sub-tropical regions of the world, especially where drought is prominent due to low and uneven rainfall patterns thus causing major limitation to crop production (Singh *et al*., 1997). It is widely grown in east Africa and south-east Asia, primarily as a leafy vegetable (Hallensleben *et al.*, 2009) due to its high protein content. The objective of this paper is to evaluate the Impact of Gibberellic Acid (GA_3) on Growth, Yield and Nodulation on Two Accessions of Cowpea (*Vigna unguiculata* (L.) Walp)

MATERIALS AND METHODS

Study Area: The study was carried out in Lafia, Nasarawa state. The experiment took place at the Botanical Garden, Federal University of Lafia.

Collection of Planting Materials: Two (2) different accessions of cowpea (TVU-1 and TVU-4) were collected from International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria.

Soil Collection: The soil used was garden soil. The polythene bags were perforated at the bottom so as to allow excess water to flow out. The bags were then placed at the Research Garden at a spacing of 60cm x 30cm, as proposed by Okeleye *et al*., (1999).

Preparation of Plant Growth Hormone: The Plant Growth Hormone that was used for the study is

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Gibberellic Acid (GA_3). 90mg, 120mg and 150mg of Gibberellic acid were measured with the aid of a weighing balance and dissolved into 1 litter of distilled water. Another portion of distilled water without any additive was also measured and used as control as described by Mshelmbula *et al*. (2020) with little modification.

Pre-treatment of seeds with Gibberellic acid: The cowpea was placed in the selected solutions, submerged, and exposed for two hours. The treated seeds were washed in running water to remove excess chemicals and exudates from the seeds.

Sowing: The presoaked seeds were sown directly into the soil. Planting was done in the evening, just beyond sunset following the method of Ikhajiagbe (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 done every morning and evening throughout the experiment until full maturity and yield is attained.

Pest Control: To prevent pest infestation, the insecticide Kombat was applied once during the growing period at 6 weeks after planting at a measurement of 3 ml/20 liters of water.

Experimental Design: The experimental design was Randomized Complete Block Design (RCBD). Each treatment consisting of 3 replicates. In other to avoid bias and misidentification, treatments bags were properly labeled according to a given treatment name and replicate number. Treatment bags were randomly placed over the whole plot, each bearing an identification tag.

For example:

TVU1-150 R3	TVU4-90 R1	TVU1-120 R1	TVU1-150R1	TVU1-90R2	TVU4-90R2
TVU4-120 R1	TVU1-90C	TVU4-120 R3	TVU4-150R1	TVU1-90R1	TVU4-150R2
TVU4-120C	TVU4-150C	TVU1-90R3	TVU4-90C	TVU1-120R3	TVU4-150R3
TVU1-150C	TVU4-90R3	TVU1-120C	TVU1-150R2	TVU1-120R2	TVU4-120R2

KEYS: TVU 1 and TVU 4 – Accessions, R1, R2 & R3 – Replicate number, C- Control, 90,120,150 – Different Concentrations

Parameters Considered On the field, parameters considered were Length of girth, Number of germination percentage attained, Total Leaflet area, Number of leaves per Plant, Plant height, Number of flowers per plant, Number of pods per plant, Seeds per pod, Weight of 100 seeds per plant.

Statistical Analysis: One-way ANOVA was used to analyze the data. Significant means were separated using LSD.

RESULTS AND DISCUSSION

Results obtained showed that there were significant differences in the number of leaves of accession TVU-1 subjected to different treatments of GA_3 (table 1). The highest number of leaves at 12 (WAP) was observed in treatment 150mg/L and was significantly different from treatment 120mg/L. However, the number of leaves in the control was not significantly different from the GA_3 treatments. As for accession TVU-4, the number of leaves in the control was the highest and was significantly different from all the treatments of GA_3. Also, there were significant differences in the number of leaves among all the GA_3 treated seeds. There were no significant differences in the plant heights between control and GA_3 treated TVU-1 accession of cowpea even though, treatment 90mg/L had the highest plant height (11.09 cm) which was significantly different from that of treatment 120mg/L (4.73 cm) and not significantly different from treatment 150mg/L (9.54 cm). For accession TVU4, the plant height for the control was the highest (13.44 cm) and was significantly different from all GA_3 treatments except that of treatment 120mg/L. There were no significant differences in the stem girth of accession TVU-1 subjected to different treatments of GA_3. As for accession TVU-4, the stem girth in the control was the highest (0.40) and it was significantly different from all the GA_3 treated seeds. Also, treatment 90mg/L (0.00) did not vary significantly to treatment 150mg/L (0.10).

Table 1: The Number of Leaves, Plant Height (cm) and stem girth (cm) of the two accessions of Cowpea subjected to different treatments of Ga3 at 12 WAP Treatments

Treatments	No. of leaves		Plant Height (cm)		Stem Girth (cm)	
	TVU 1	TVU4	TVU 1	TVU 4	TVU 1	TVU 4
CONTROL	$3.86^{C} \pm 0.67$	$8.83^{a} \pm 0.91$	$8.11^{a} \pm 1.12$	$13.14^{a} \pm 0.99$	$0.22^{m} \pm 0.04$	$0.40^{a} \pm 0.10$
90	$5.47^{ca} \pm 0.72$	0.00^{b}	$11.09^{ab} \pm 1.12$	0.00^{c}	$0.25^{m} \pm 0.04$	$0.00^{b} \pm 0.00$
120	$2.33^{cb} \pm 0.56$	$5.42^{b} \pm 0.99$	$4.73^{ac} \pm 1.18$	$11.56^{ad} \pm 1.82$	$0.14^{m} \pm 0.02$	$0.20^{cd} \pm 0.03$
150	$5.06^{ca} \pm 0.92$	$2.86^{e} \pm 0.74$	$9.54^{ab} \pm 1.41$	$8.74^{ad} \pm 2.08$	$0.20^{m} \pm 0.04$	$0.10^{bd} \pm 0.03$

Values represent mean ± standard error; Values with the same superscript across same column are not significantly different ($P \leq 0.05$)

Table 2: The Number Area, Number of Flowers and Number of Pod of the two accession of Cowpea subjected to different treatment of Ga3 at 12 WAP

Treatments	Leaf Area		Number of Flowers		Number of Pod	
	TVU 1	TVU4	TVU 1	TVU 4	TVU 1	TVU 4
CONTROL	$3.56^{a} \pm 0.73$	$13.70^{a} \pm 1.61$	$0.21^{b} \pm 0.11$	$0.14^{a} \pm 0.10$	$1.00^{a} \pm 0.00$	$0.70^{b} \pm 0.33$
90	$8.83^{b} \pm 1.23$	$0.00^{b} \pm 0.00$	$0.22^{b} \pm 0.13$	$0.00^{a} \pm 0.00$	$0.70^{a} \pm 0.40$	$0.00^{b} \pm 0.00$
120	$3.71^{cb} \pm 0.94$	$7.90^{c} \pm 1.60$	$0.14^{b} \pm 0.10$	$0.26^{a} \pm 0.10$	$1.00^{a} \pm 1.00$	$1.00^{b} \pm 0.60$
150	$3.55^{a} \pm 1.02$	$3.24^{b} \pm 0.10$	$0.06^{b} \pm 0.06$	$0.03^{a} \pm 0.03$	$0.60^{a} \pm 0.60$	$0.00^{b} \pm 0.00$

Values represent mean ± standard error; Values with the same superscript across same column are not significantly different ($P \leq 0.05$)

Table 3: The Number of Seeds, Dry weight of Seed and Wet weight of Root of the two accessions of cowpea subjected to different treatments of Ga3 at 12 WAP

Treatments	No. of leaves		Plant Height (cm)		Stem Girth (cm)	
	TVU 1	TVU4	TVU 1	TVU 4	TVU 1	TVU 4
CONTROL	$4.70^{a} \pm 1.20$	$3.70^{c} \pm 1.90$	$3.85^{c} \pm 1.91$	$8.90^{d} \pm 4.63$	$1.19^{b} \pm 1.19$	$4.90^{a} \pm 0.50$
90	$2.33^{a} \pm 1.20$	$0.00^{c} \pm 0.00$	$6.50^{c} \pm 3.54$	$0.00^{d} + 0.00$	$1.40^{b} \pm 0.80$	$0.00^{a} \pm 0.00$
120	$3.70^{a} \pm 3.70$	$5.00^{c} \pm 2.64$	$2.11^{c} \pm 2.11$	$9.20^{d} \pm 4.90$	$0.00^{b} \pm 0.00$	$2.72^{a} \pm 1.54$
150	$3.00^{a} \pm 3.00$	$0.00^{c} \pm 0.00$	$2.90^{c} \pm 2.90$	$0.00^{d} \pm 0.00$	$1.41^{b} \pm 0.73$	$2.41^{a} \pm 2.64$

Values represent mean ± standard error; Values with the same superscript across same column are not significantly different ($P \leq 0.05$)

At higher concentrations, results revealed that were no significant differences in the leaf area of the accessions considered (table 2). However, lower concentration (90mg/L) recorded increase in leaf area 8.83) compared to the control (3.54). There was also significant differences in the number of flowers and in the number of pods in both TVU-1 and TVU-4, accession subjected to different treatments of GA_3. From Table 3, there were no significant differences in the number of seed, dry weight of 100 seeds as well as wet weight in both accessions TVU-1 and TVU-4 subjected to different treatments of GA_3. Table 4 showed that, there were no significant differences in the Dry weight of Root and Number of root nodules in both the accessions subjected to different treatments of GA_3. There were also no significant differences in the number of Days to Germination in accession TVU-1 subjected to different treatments of GA_3. As for accession TVU4, the number of days to germination in treatment 90mg/L was significantly different from other GA_3 treatments. However, there was no significant difference in Control and treatments 120mg/L and 150mg/L. From Table 5, results showed that there were no significant differences in the Number of Days to 50% Maturity as well as in the number of days to full maturity in both accessions considered when subjected to different treatments of GA_3.

Table 4: The Dry weight of Root, Number of Root Nodules and Numbers of Days of Germination of the two accessions of cowpea subjected to different treatments of Ga 3 at 12 WAP

Treatments	Leaf Area		Number of Flowers		Number of Pod	
	TVU 1	TVU4	TVU 1	TVU 4	TVU 1	TVU 4
CONTROL	$0.60^{d} \pm 0.60$	$1.92^{a} \pm 0.80$	$3.70^{b} \pm 3..70$	$14.33^{a} \pm 4.33$	$6.00^{c} \pm 0.60$	$4.33^{a} \pm 0.33$
90	$0.70^{d} \pm 0.44$	$0.00^{a} \pm 0.00$	$2.33^{b} \pm 1.50$	$0.00^{a} \pm 0.00$	$4.33^{c} \pm 0.33$	$0.00^{b} \pm 0.00$
120	$0.00^{d} \pm 0.00$	$1.14^{a} \pm 0.62$	$0.00^{b} \pm 0.00$	$5.33^{a} \pm 0.35$	$5.00^{c} \pm 1.00$	$3.33^{a} \pm 1.80$
150	$0.63^{d} \pm 0.32$	$1.16^{a} \pm 1.16$	$3.70^{b} \pm 2.03$	$9.33^{a} \pm 9.33$	$3.07^{c} \pm 1.90$	$3.00^{a} \pm 1.53$

Values represent mean ± standard error; Values with the same superscript across same column are not significantly different ($P \leq 0.05$)

Table 5: The Number of Days to 50% Maturity and Number of Days to Full Maturity of the two accessions of cowpea subjected to different treatment of Ga3 at 12 WAP

Treatments	Number of Days to 50% Maturity		Number of Days to Full Maturity	
	TVU 1	TVU4	TVU 1	TVU4
CONTROL	$65.33^{d} \pm 3.71$	$40.70^{a} \pm 20.34$	$80.00^{b} \pm 2.10$	$47.00^{a} \pm 23.50$
90	$41.00^{d} \pm 2.84$	$0.00^{a} \pm 0.00$	$49.33^{b} + 24.91$	$0.00^{a} \pm 0.00$
120	$17.33^{d} \pm 17.33$	$39.00^{a} \pm 19.52$	$20.00^{b} \pm 20.00$	$44.00^{a} \pm 22.01$
150	$18.70^{d} \pm 18.70$	$0.00^{a} \pm 0.00$	$21.33^{b} \pm 21.33$	$0.00^{a} \pm 0.00$

Values represent mean ± standard error; Values with the same superscript across same column are not significantly different ($P \leq 0.05$)

The growth and yield effect of GA_3 on the morphological characters of some accessions of Cowpea was investigated. Results showed that, TVU-1 accession treated with the lowest concentration of GA_3 increased the Number of Leaves compared to the control (Table 1). This finding however disagrees with Mshelmbula *et al.,* 2015 who reported that lower concentrations of IAA which is also a growth promoter reduced the number of Leaves of Sesame. It was also observed that in TVU-4 accession, there was no observable effect of GA_3 on the number of leaves compared to the control. In the same vein, lower concentration of GA_3 solution increased the plant height of TVU-1 compared to the Control. However, at 120Mg/L concentration of GA_3, TVU-4 showed increased in plant height compared to the control. The

observation made on TVU-1 is not in concert with work done by Emongor (2007) who opined that increase in GA_3 concentration increased the plant height in Cowpea while TVU-4 treatment collaborates with the aforementioned work done by Emongor (2007). On the stem girth, (Table 1), TVU-1 accession had no significant differences across all treatments; however, the lowest concentration (90mg/L) had the highest stem Girth. Generally, on the stem girth, it was noticed that TVU-4 and TVU-1, showed no variations as there were no significant differences across all treatments. Results on the Leaf Area (Table 2), indicated that the lowest treatments (90mg/L) had significant difference (8.83cm) on TVU-1 compared to other treatments (120mg/L and 150mg/L). This finding agrees with Emongor (2007) who working on cowpea reported similar result of which lower concentrations of GA_3 drastically increased the leaf area. TVU-4 Accession treated with 120mg/L had the highest Leaf Area (7.90cm) compared to the other GA_3 treated seeds, although it showed no significant difference to the control (13.70cm). Furthermore, across all treatments, the effects of GA_3 concentration on the Number of Flowers of TVU-1 accession (Table 2) showed no significant difference. However, the lowest treatment 90mg/L had the highest number of flowers at 12 WAP (0.22). Also, it is interesting to note that TVU-4 Accession had similar clear observation just like in TVU-1 treated with 90mg/L; but TVU-4 had the highest number of flowers when treated with 120mg/L GA_3 solution. This finding correlates with Rahman *et al*., (2015) who reported that there was increase in Number of Flowers of Tomato treated with 4-CPA + GA_3 as the concentration increases. Going further, there was no significant difference on the Number of Pod across all treatments in TVU-1 and TVU-4. Although, TVU-1 treated with 120mg/L and control had the same Number of Pods at 12 WAP which suggests that there was no visible effect of GA_3 on this particular accession; TVU-4 treated with the same GA_3 solution (120mg/L) had the highest number of Pod (1.00) at 12 WAP compared to other treatments. This quite agrees with Verma *et al*. (2009) who reported that the number of pods of Chickpea increased with increased GA_3 concentrations. The effects of GA_3 concentration on the Number of seeds per pod (Table 3) of TVU-1 accession had no significant difference across all the treatments and the control even though, it was observed that treatment 120mg/L of GA_3 had the highest number of seeds (3.70) at 12 WAP. Similar observations were deduced with TVU-4 where seeds treated with 120mg/L of the growth promoter had the highest Number of Seeds at the end of Week 12 which agrees with Emongor (2007) who reported that exogenous application of GA_3 increased the number of Seeds of Cowpea. Similarly, the Dry weight of 100 seeds (Table 3) for TVU-1 indicated that there was no significant difference across all the treatments. However, the seeds treated with the least GA_3 (90mg/L) had the highest Dry weight of 100 seeds (6.50g). This result disagrees with Emongor (2002) who reported that increased Ga_{4+7} concentration significantly reduced 100 seed weight of cowpea; but agrees with Mohammed and Ismail (2018) and Emongor (2007) who reported that increase in GA_3 brought about increase in the dry weight of groundnut and cowpea respectfully. Similar results were observed for TVU-4 accession where there was no significant difference across all treatment as par the effects of the GA_3 on the dry weight. From table (3), the Wet weight of TVU-1 suggests that there was no significant difference across all treatment. However, the highest treatment (150mg/L) had the highest Wet weight of root. Similar result was found in TVU-4, though the second treatment (120mg/L) had the highest Wet weight of Root (2.72g) at the end of Week 12. In the same vein, lower concentration of GA_3 increased the dry weight of root compared to the control, However, the highest concentration had the highest concentration of GA_3 had the highest dry weight of root (Table 4) (1.16g) at the end of week 12 compared to other treatment. The effects of GA_3 concentration on the number of Root Nodules of Accession TVU-1 had no significant differences; the highest concentration had the highest number of root nodules alongside the control. Similar results were observed in TVU-4. Application of GA_3 affected the number of days to germination on Accession TVU-1 (Table 4). The highest concentration had the fewest number of days to germination. It thus implied that increased in GA_3 concentration triggered faster germination rate both accessions considered.

Worthy of note is that there were no significant differences in the number of Days to 50% maturity (Table 5) in TVU-1 accession, however, the second highest concentration had the fewest number of days to 50% maturity. Similar result was also recorded in TVU-4 accession. It can therefore be concluded that 120mg/L GA_3 enhances faster 50% maturity of Cowpea particularly in TVU-1 and TVU-4 accessions. Finally, it was found that in both TVU-1 and TVU-4 accession, the second highest concentration had the fewest number of Days to full Maturity (Table 5) while the control had the highest number of days to Full maturity (80.00).

*Conclusion***:** At higher concentrations (120mg/L), GA_3 was found to be a very important tool in cowpea improvement for growth and yield parameters which can be employed in crop improvement in cowpea. It

also pointed to the fact that depending on the reason for the cultivation of cowpea either as a fodder or for its fruits, different concentrations of GA_3. Influenced different parameter as reported in this study; and also, the test plant responded differently to different concentration of the growth regulator used.

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