NJB, Volume 35 (2), 115-126, Dec, 2022

SEED EMERGENCE AND SEEDLING GROWTH OF TWO VARIETIES OF CUCURBITS AS AFFECTED BY VARYING CONCENTRATIONS OF HORMONES

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Received 15th February, 2023: accepted 1st March, 2023

ABSTRACT
Despite the economic relevance of *Citrullus lanatus* (Thunb) and *Citrullus colocynthis (*Schrad**)**, there is decline in the production of the cucurbits due to poor germination and low growth of the plants. This study investigated effects of varying concentrations of Indole acetic acid (IAA), Gibberellic acid (GA_3), *Bryophyllum pinnatum* leaf extract (BPLE) and coconut water (CW) on germination and seedling growth (SG) of *C. lanatus* and *C. colocynthis* (L.). Seeds of the two cucurbits were pre-soaked for 13 hours in 50, 100, 150, 200 and 250 mg/L of the hormones and sown in Petri dishes. The experiment was a factorial design arranged in completely randomised design in five replicates. Percentage Germination (PG) of seeds of the two cucurbits was influenced by varying concentrations of hormones. Highest PG (99.0%) was observed in the seeds of *C. lanatus* soaked in 150 mg/L BPLE. The highest germination rate (GR) (11.00) was observed in *C. colocynthis* seeds treated with 100 mg/l BPLE. Seedling index (1161.76) was significantly higher in *C. colocynthis* seedlings whose seeds were soaked in 50 mg/l CW, seedling dry weight (1.13 g) in the seedling of same variety whose seeds were soaked in 50 mg/l BPLE while highest plumule length (46.20 cm) was observed in the seedling of the *C. colocynthis* whose seeds were soaked in 50 mg/L 1AA. The highest seedling vigour (9.62) was observed in the *C. lanatus* seedlings produced by seeds soaked in 250 mg/l BPLE. Seedling length (18.70) and radicle length (8.30) were highest in the seedings produced by *C. lanatus* seeds soaked in 50mg/l BPLE. Variations in the concentration of the hormones studied had significant changes in PG, germination rate of seeds and seedling vigour of *C. lanatus* and *C. colocynthis* even at the lowest concentration. The concentration of 100 and 150 mg/l of IAA, GA_3 and BPLE produced better effects on the PG and GR of the cucurbit seeds while 50 mg/l of the hormones improved SG of the cucurbits. The concentration of 50-150 mg/l of the hormones is recommended for farming.
Keywords: Agronomic parameters; percentage germination rate; seedling growth; radicle length; plumule length
https://dx.doi.org/10.4314/njbot.v35i2.3

INTRODUCTION
Citrullus lantus (Thunb) and *Citrullus colocynthis* (L.) Schrad are underutilised plants which belong to the family *Cucurbitaceae*. They are commonly referred to as cucurbits or melons (Oyeleke *et al*., 2012).The plants consist of 125 genera and 980 species with a high level of genetic diversity due to edaphic factors and erratic change in weather conditions (Milind and Kulwant, 2011; Wehner *et al.*, 2020). The cucurbits undergo long distance dispersals (Schaefer *et al*., 2009; Duchen and Renner, 2010; Sosef *et al.*, 2017; Maroyi, 2017). Soro *et al.* (2019) and Giwa *et al*. (2010) reported that about 300 species of the plants are found in tropical Africa but only 21 genera are represented in Nigeria. Typical examples are *C. lanatus* and *C. colocynthis.* These two varieties of the cucurbits are herbaceous, annual, moist vines found growing prostrate, climbing or trailing along the ground (Ajuru and Nmom, 2017; Wehner *et al.*, 2020). The plants possess simple to palmately compound leaves, unisexual flowers and are pollinated by bees (Ajuru and Nmom, 2017). They require well irrigated, fertile loamy soil for cultivation (Rahman, 2013). Though underutilised, they are sometimes cultivated as food crops due to the appreciable amount of nutritional, therapeutic and economic values of the plants (Achu *et al*.,

2005). According to Ogbonna and Obi, (2007) and Ajayi *et al* (2022), the cucurbits are used for preparation of assorted foods, especially indigenous African delicacies, and can also be roasted and eaten as snacks among many tribes.

Despite the relevance of these plants, the rate of their production is low due to poor viability of their seeds and the low rate of germination as affected by germination conditions and erratic change in climatic conditions. This often results in poor growth and reduction in mass production of the plants for both domestic and commercial purposes.

In an attempt to boost the production of the plants, several efforts have been put in place by farmers, some of which include good farming practices, appropriate use of fertilizers and other growth or germination promoters. These efforts have not yielded the desired results. This may be due to inability of the farmers to determine the precise quantity of growth promoters required by the plants. Moreover, most of the growth promoters often used are very expensive and cannot be afforded by subsistence farmers. There is, therefore, the need for cheap plant- based growth promoters and the exact quantity needed by plants as possible alternative to enhance maximum germination of seeds and better production of the plants. There is also the is need to study the effects of some synthetic and natural growth promoters on germination of seeds and growth of seedlings of the plants. This study was aimed to evaluate the effects of varying concentrations of Indole acetic acid (IAA), Gibberellic acid (GA_3), *B. pinnatum* leaf extract and coconut water on the seed germination and seedling growth of *C. lanatus* and *C. colocynthis.*

MATERIALS AND METHODS

This experiment was conducted at Teaching and Research Botanical Garden, Department of Pure and Applied Botany, Federal University of Agriculture, Abeokuta, Nigeria

Sources of seeds: Viable seeds of *C. lanatus* and *C. colocynthis* were obtained from the Institute of Agricultural Research and Training (IAR&T), Ibadan, Oyo State, Nigeria.

Hormones, *Bryophyllum pinnatum* leaf extract and coconut water preparations

Different concentrations (50 mg/l, 100 mg/l, 150 mg/l, 200 mg/l and 250 mg/l) of Indole Acetic Acid (IAA), Gibberellic Acid (GA_3), *B. pinnatum* leaf extract and coconut water used were prepared according to the method of Agboola and Adedire (1998). Distilled water served as the control.

Experimental layout

Petri dishes of 9 cm dimension were prepared for germination according to the method of Agboola and Adedire (1998) as modified by Ajiboye and Agboola (2011). A total of 105 Petri dishes used for seeds of each plant were surface-sterilised using ethanol and cotton wool and then washed with sterile distilled water. Two sterile filter papers were cut to fit into the Petri dishes, moistened with water and labeled. The seeds were pre-treated for five minutes to soften their coats and to ensure reactivation of primary metabolites needed for germination. The pre-treated seeds were then plated in each of the 9 cm well-labeled Petri dishes. Twenty (20) seeds were plated into each Petri dish per treatment and kept in the laboratory at room temperature at 14 - 21^{o}C and relative humidity of 48- 64% at night and during the day, respectively (Yu *et al.*, 2014). The protrusion of radicle up to 1.0 cm was taken as evidence of successful germination (Zangoie *et al*., 2012). The experiment was 4 x 5 x 2 factorial (four hormones at five different concentrations and two varieties of cucurbits) arranged in completely randomised design (CRD) in five replicates. The seeds were inspected and moistened regularly with water. The experiment lasted for a period of 16 days after sowing in Petri dishes.

Determination of seedling vigour, seedling index, seedling dry weight, seedling length, plumule length and radicle length

The seedling vigour was calculated according to Kim *et al*. (1994). The seedling vigour index was calculated by multiplying germination % by seedling length. Seedling length, plumule length and radicle length were measured according to the method of Agboola and Adedire (1998). Dry weight of the seeds was determined by using muffle furnace at 932 ºF – 1112 ºF for 2-3 hours. Percentage germination and germination rate of the seeds were determined according to the method of Zangoie *et al*. (2012).

Percentage germination and germination rate of the seeds were determined by using the formulas:

$$\text{Percentage germination} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds plated}} \times 100$$

$$\text{Germination rate} = \frac{\text{Number of germinated seeds observed in the nth daily count}}{\text{Number of days after the seeds were plated to germinate in the nth count}}$$

Statistical analysis

Data were subjected to two-way analysis of variance using Statistical Analysis Software version 9.3 (SAS Institute Inc., Cary, NC., USA). Means were separated using the Duncan's Multiple Range Test (DRMT) at 95% confidence limit.

RESULTS

Effects of varying concentrations of hormones on percentage germination of *C. lanatus* and *C. colocynthis* seeds.

Results showed that germination percentage of *C. lanatus* and *C. colocynthis* seeds were significantly influenced by varying concentrations of IAA, GA_3 BPLE and CW from 2 -16 DAS. The germination percentage increased from day 2 through 16 DAS. However, highest percentage germination (99.0%) was observed in the seeds of CL soaked in 150 mg/L BPLE compared with other concentrations of the hormones for the two varieties of the cucurbits (Tables 1).

Effects of varying concentrations of hormones on germination rate of *C. lanatus* and *C. colocynthis* seeds.

Table 2 shows the effects of hormone types and their varying concentrations in germination rate of *C. lanatus* and *C. colocynthis* seeds after sowing. The results showed significant difference in the germination rate of seeds of the two varieties of cucurbits soaked with varying concentrations of four hormones and observed at 13 DAS. The highest germination rate of 11% was observed in *C. colocynthis* seeds treated with 100 mg/l BPLE, followed by 1% observed in the seeds of *C. lanatus* treated with 150 mg/l.

Effects of varying concentrations of hormones on seedling growth of *C. lanatus* and *C. colocynthis*

Table 3 shows that varying concentrations of the hormones resulted in significant increase in seedling vigour, seedling index, seedling dry weight, seedling length, plumule length and radicle length of *C. lanatus* and *C. colocynthis*. The highest seedling index (1161.76) was observed in the seedlings of *C. colocynthis*, which seeds were soaked in 50 mg/l CW. The highest seedling weight (1.13 g) was observed in the seedlings of the same variety of cucurbit which seeds were soaked in 50 mg/l BPLE. The highest plumule length (46.20 cm) was observed in the seedlings of *C. colocynthis*, which seeds were soaked in 50 mg/L 1 AA. The highest seedling vigour (9.62) was observed in the *C. lanatus* seedlings produced by seeds soaked in in 250 mg/l BPLE. The highest seedling length (18.70 cm) and radicle length (8.30 cm) were observed in seedings produced by *C. lanatus* seeds soaked in 50 mg/l BPLE.

Table 1: Effects of varying concentrations of hormones on the percentage germination of *C. lanatus* and *C. colocynthis* seeds

Conc(mg/l). X Variety	Days after sowing					
	2	4	7	10	13	16
50mg/l IAA CL	9.00± 0.01^{h}	41.00± 0.08^{h}	60.00±0.52^{f}	62.00±0.61^{gh}	62.00±1.50^{hi}	64.00±0.55^{cd}
50mg/l IAA CC	34.00± 1.16^{f}	71.00± 0.13^{ef}	80.00±0.46^{b}	82.00±1.18^{cd}	84.00±0.05^{e}	84.00±0.96^{b}
50mg/l GA_3 CL	10.00± 0.03^{g}	61.00± 0.07^{f}	86.00±0.04^{bc}	89.00±0.05^{bc}	89.00±0.62^{de}	89.00±0.61^{b}
50mg/l GA3 CC	42.00± 1.74^{e}	74.00± 0.05^{de}	79.00±0.05^{c}	81.00±1.18^{cd}	84.00±0.32^{e}	85.00±1.15^{b}
50mg/l BPLE CL	29.00± 0.30^{g}	69.00± 0.05^{ef}	81.00±0.36^{b}	82.00±0.04^{cd}	93.00±0.84^{c}	93.00±1.29^{ab}
50mg/l BPLE CC	42.00± 0.21^{e}	83.00± 0.64^{bc}	85.00±0.03^{b}	86.00±1.74^{c}	92.00±1.33^{c}	92.00±0.11^{ab}
50mg/l WC CL	6.00± 0.09^{h}	23.00± 0.08^{l}	60.00±0.59^{f}	73.00±0.29^{e}	79.00±1.15^{fg}	83.00±0.44^{bc}
50mg/l WC CC	58.00± 0.55^{d}	75.00± 0.09^{c}	92.00±0.29^{b}	92.00±1.16^{b}	98.00±0.58^{ab}	92.00±0.62^{ab}
100mg/l IAA CL	10.00± 0.18^{g}	48.00± 0.05^{h}	66.00±0.52^{f}	68.00±0.17^{f}	73.00±0.39^{g}	75.00±0.05^{c}
100mg/l IAA CC	20.00± 0.07^{g}	58.00± 0. 05^{gh}	73.00±0.39^{de}	75.00±0.03^{d}	76.00±0.59^{fg}	76.00±1.17^{c}
100mg/l GA3 CL	4.00± 0.12^{g}	40.00± 0.16^{h}	59.00±0.40^{g}	64.00±0.02^{cd}	75.00±1.33^{fg}	77.00±0.05^{c}
100mg/l GA3 CC	20.00± 0.14^{g}	65.00± 0.68^{ef}	77.00±0.72^{c}	78.00±0.03^{d}	78.00±1.79^{fg}	78.00±0.71^{c}
100mg/l BPLE CL	13.00± 0.35^{g}	69.00± 0. 61^{ef}	90.00±0.25^{b}	94.00±0.62^{b}	94.00±1.21^{bc}	94.00±2.11^{ab}
100mg/l BPLE CC	67.00± 0.12^{b}	92.00± 0. 14^{ab}	94.00±0.33^{b}	95.00±1.15^{ab}	96.00±0.36^{ab}	97.00±0.05^{ab}
100mg/l WC CL	5.00± 0.57^{h}	23.00± 0. 32^{l}	58.00±0.16^{g}	68.00±1.15^{f}	76.00±0.05^{fg}	76.00±0.57^{c}
100mg/l WC CC	53.00± 0.39^{d}	76.00± 0. 08^{c}	82.00±0.39^{b}	82.00±2.89^{cd}	89.00±1.15^{de}	91.00±1.16^{ab}
150mg/l IAA CL	7.00± 0.29^{h}	45.00± 0. 58^{h}	61.00±0.20^{f}	69.00±0.04^{f}	77.00±2.89^{fg}	81.00±1.73^{bc}
150mg/l IAA CC	3.00± 0.02^{i}	35.00±1. 09^{i}	54.00±0.61^{gh}	56.00±0.52^{g}	56.00±0.52^{ij}	56.00±1.73^{d}
150mg/l GA3 CL	2.00± 0.02^{i}	50.00±1. 60^{gh}	64.00±1.19^{f}	69.00±0.03^{f}	72.00±1.15^{g}	77.00±4.04^{c}
150mg/l GA3 CC	16.00± 0.03^{g}	63.00± 0. 63^{f}	74.00±0.62^{de}	76.00±1.15^{d}	87.00±2.89^{e}	92.00±0.52^{ab}
150mg/l BPLECL	17.00± 0.17^{g}	93.00± 0.59^{a}	99.00±0.07^{a}	99.00±0.17^{a}	99.00±1.50^{a}	99.00±0.02^{a}
150mg/l BPLECC	56.00± 0.03^{d}	81.00± 1.09^{bc}	85.00±1.56^{b}	85.00±1.16^{c}	87.00±0.36^{e}	90.00±2.31^{ab}
150mg/l WC CL	3.20± 0.43^{i}	42.20± 0.51^{h}	67.00±0.05	73.00±0.05^{e}	76.00±0.59^{fg}	96.00±1.73^{ab}
150mg/l WC CC	60.00± 0.09^{c}	77.00± 0.51^{c}	84.00±1.79^{bc}	84.00±1.75^{c}	87.00±1.50^{e}	89.00±1.50^{b}
200mg/l IAA CL	8.00± 0.08^{h}	40.00± 0.32^{h}	47.00±0.40^{h}	47.00±0.29^{h}	49.00±0.54^{j}	51.00±2.31^{d}
200mg/l IAA CC	4.00± 0.04^{i}	26.67± 0.34^{j}	47.00±0.63^{h}	49.00±0.02^{h}	50.00±1.55^{j}	51.00±0.28^{d}
200mg/l GA3 CL	5.00± 0.06^{h}	35.00± 0.59^{i}	65.00±0.39^{e}	73.00±0.05^{e}	77.00±0.49^{fg}	78.00±0.63^{c}
200mg/l GA3 CC	6.00± 0.29^{h}	44.00± 0.05^{h}	65.00±0.59^{e}	68.00±1.74^{f}	72.00±1.17^{g}	72.00±1.52^{c}
200mg/l BPLE CL	11.00± 0.17^{g}	62.00± 0.21^{f}	82.00±0.54^{b}	86.00±0.58^{c}	92.00±0.05^{c}	93.00±2.31^{ab}

200mg/l BPLE CC	60.00± 0.12[c]	86.00± 1.19[b]	98.00±0.62[ab]	95.00±0.58[ab]	91.00±1.15[ab]	94.00±0.29[ab]
200mg/l WC CL	9.00± 0.01[h]	53.00± 0.02[gh]	69.00±0.64[d]	85.00±1.17[c]	88.00±0.62[de]	89.00±0.21[b]
200mg/l WC CC	67.00± 0.13[b]	79.00± 0.65[bc]	86.00±0.55[bc]	86.00±2.31[c]	94.00±0.61[bc]	97.00±1.18[ab]
250mg/l IAA CL	3.00± 0.09[i]	24.00± 0.36[l]	32.00±0.61[i]	33.00±1.73[i]	38.00±1.15[l]	45.00±1.19[e]
250mg/l IAA CC	0.00± 0.00[j]	5.00± 0.39[m]	16.00±1.44[j]	23.00±1.73[i]	23.72±1.45[m]	24.00±0.14[f]
250mg/l GA3 CL	4.00± 0.35[i]	29.00± 0.62[j]	64.00±0.61[f]	70.00±0.52[e]	79.00±1.16[fg]	79.00±0.57[c]
250mg/l GA3 CC	3.00± 0.06[i]	33.00± 0.52[i]	61.00±0.55[f]	61.00±1.15[gh]	63.00±0.63[hi]	63.00±0.32[cd]
250mg/l BPLE CL	7.00± 0.07[h]	43.00± 0.31[h]	78.00±0.90[c]	80.00±1.15[d]	88.00±1.17[de]	93.00±0.11[ab]
250mg/l BPLE CC	76.00± 0.59[a]	89.00± 1.09[b]	96.00±0.04[ab]	97.00±0.61[ab]	98.00±1.18[ab]	93.00±0.30[ab]
250mg/l WC CL	24.00± 0.02[g]	54.00± 0.28[gh]	77.00±0.83[c]	79.00±0.61[c]	83.00±1.07[e]	85.00±0.57[b]
250mg/l WC CC	48.00± 0.61[e]	83.00± 0.61[bc]	91.00±1.33[b]	91.00±1.16[b]	95.00±0.52[bc]	95.00±1.11[ab]
Control CL	3.00± 0.17[i]	37.00± 0.14[f]	48.00±0.50[h]	49.01±0.93[h]	56.00±0.64[ij]	66.00±0.04[cd]
Control CC	38.00± 0.02[f]	61.00± 0.61[k]	67.00±0.59[e]	73.00±1.33[e]	78.00±0.07[fg]	78.00±0.60[c]

Mean values (± Standard Error) with different superscripts in the same column are significantly different at $p < 0.05$. IAA (Indole acetic acid), GA_3 (Gibberellic acid), BPLE= *Bryophyllum pinnatum* leaf extract, WC= Coconut water

Table 2: Effects of varying concentrations of hormones on germination rate of *Citrullus lanatus*

Conc (.mg/l	Days after sowing				
	2	4	7	10	13
50 IAA CL	1.80±0.17^{f}	4.80± 0.35^{d}	0.60±0.06^{d}	0.00±0.00^{f}	0.00±0.00^{g}
50 IAA CC	4.80±0.29^{c}	3.00±1.16^{d}	0.20±0.03^{f}	0.40±0.12^{d}	0.00±0.00^{g}
50 GA3 CL	2.00±0.08^{f}	9.00± 1.16^{abc}	0.20±0.06^{f}	0.00±0.00^{f}	0.00±0.00^{g}
50 GA3 CC	6.60±0.07^{bc}	3.60± 0.12^{d}	0.40±0.06^{e}	0.40±0.17^{d}	0.40±0.03^{e}
50 BPLE CL	5.80±0.17^{c}	6.60± 0.17^{c}	0.20±0.06^{f}	0.00±0.00^{f}	0.40±0.05^{e}
50 BPLE CC	7.40±0.11^{b}	4.00± 0.58^{d}	0.00±0.00^{ab}	0.00±0.00^{f}	0.00±0.00^{g}
50 WC CL	1.00±0.07^{f}	2.40± 1.12^{e}	2.00±0.58^{ab}	0.60±0.01^{c}	1.00±0.45^{c}
50 WC CC	4.80±0.18^{c}	2.20± 0.06^{e}	0.20±0.02^{f}	0.00±0.00^{f}	0.00±0.00^{g}
100 IAA CL	2.00±0.13^{f}	4.80± 1.39^{d}	0.80±0.23^{c}	0.00±0.00^{f}	1.00±0.03^{c}
100 IAA CC	3.60±0.09^{de}	3.80± 1.33^{d}	0.80±0.12^{c}	0.40±0.01^{de}	0.00±0.00^{g}
100 GA3 CL	0.80±0.12^{f}	6.00±1.16^{c}	1.00±0.03^{b}	0.80±0.12^{bc}	1.80±0.21^{a}
100 GA3 CC	3.60±0.08^{de}	5.60±1.21^{c}	0.80±0.06^{c}	0.00±0.00^{f}	0.00±0.00^{g}
100 BPLE CL	2.60±0.11^{f}	9.00± 1.16^{abc}	1.00±0.12^{b}	0.00±0.00^{f}	0.00±0.00^{g}
100 BPLE CC	11.00±0.58^{a}	1.60± 0.17^{bc}	0.00±0.00^{g}	0.20±0.02^{e}	0.00±0.00^{g}
100 WC CL	1.00±0.12^{f}	4.40± 0.87^{d}	1.20±0.06^{ab}	0.80±0.06^{bc}	0.40±0.05^{e}
100 WC CC	8.40±0.35^{b}	2.40±0.87^{e}	0.00±0.00^{g}	0.00±0.00^{f}	0.00±0.00^{g}
150 IAA CL	1.40±0.21^{f}	5.80±0.40^{c}	0.20±0.06^{f}	2.40±0.58^{a}	1.00±0.36^{c}
150 IAA CC	00.60±0.01^{f}	4.80±0.46^{d}	2.40±0.58^{a}	0.00±0.00^{f}	0.00±0.00^{g}
150 GA3 CL	0.400±0.12^{f}	7.40±0.12^{bc}	1.00±0.29^{b}	0.60±0.01^{c}	0.60±0.01^{d}
150 GA3 CC	3.00± 0.02^{e}	7.00±1.16^{bc}	0.60±0.06^{d}	0.20±0.05^{e}	0.80±003^{cd}
150 BPLE CL	3.40± 0. 23de	10.00±1.16^{a}	0.40±0.17^{e}	0.00±0.00^{f}	0.00±0.00^{g}
150 BPLE CC	7.40± 0.23^{b}	2.80±0.23^{e}	0.40±0.06^{e}	0.00±0.00^{f}	0.00±0.00^{g}
150 WC CL	0.80± 0.12^{f}	7.80±0.87^{bc}	1.00±0.29^{b}	0.40±0.12^{d}	0.60±0.04^{d}
150 WC CC	7.00± 1.16^{b}	0.80±0.12^{bc}	0.40±0.12^{e}	0.00±0.00^{f}	0.40±0.05^{e}
200 IAA CL	1.60±0.12^{f}	5.20±0.17^{c}	0.20±0.01^{f}	0.00±0.00^{f}	0.20±0.05^{f}
200 IAA CC	0.80±0.06^{f}	3.60±0.35^{d}	1.40±0.06^{e}	0.00±0.00^{f}	0.00±0.00^{g}
200 GA3 CL	0.40± 0.12^{f}	4.20±0.06^{d}	0.60±0.01^{d}	1.00±0.35^{b}	0.60±0.05^{d}
200 GA3 CC	1.20± 0.12^{f}	7.20±0.69^{bc}	0.80±0.17^{c}	0.00±0.00^{f}	0.00±0.00^{g}
200 BPLE CL	2.20±0.06^{f}	8.20±0.58^{bc}	0.60±0.01^{d}	0.00±0.00^{f}	1.60±0.05^{ab}
200 BPLE CC	8.00±1.16^{b}	3.60±0.17^{d}	0.20±0.03^{f}	0.00±0.00^{f}	0.20±0.03^{f}
200 WC CL	1.80±0.06^{f}	8.00±2.31^{bc}	1.00±0.05^{b}	1.20±0.04^{ab}	0.60±0.02^{d}
200 WC CC	6.40±0.23^{bc}	0.60±0.17^{f}	0.20±0.03^{f}	0.00±0.00^{f}	0.20±0.02^{f}
250 IAA CL	0.60±0.17^{f}	3.00±0.58^{d}	0.40±0.03^{e}	0.00±0.00^{f}	1.00±0.01^{c}
250 IAA CC	0.00±0.00^{f}	0.80±0.12^{f}	1.60±0.17^{ab}	0.40±0.03^{d}	0.00±0.00^{g}
250 GA3 CL	0.80±0.17^{f}	3.80±0.29^{d}	2.00±0.17^{ab}	1.00±0.52^{b}	0.80±0.12^{d}
250 GA3 CC	0.60±0.17^{f}	4.80±0.46^{d}	1.00±0.13^{b}	0.00±0.00^{f}	0.00±0.00^{g}
250 BPLE CL	1.20±0.12^{f}	5.20±0.58^{e}	1.20±0.05^{b}	0.00±0.00^{f}	0.00±0.00^{g}
250 BPLE CC	11.20±0.12^{a}	1.00±0.06^{f}	0.80±0.18^{c}	0.20±0.03^{f}	0.00±0.00^{g}
250 WC CL	4.60±1.33^{c}	4.40±0.58^{d}	0.40±0.02^{e}	0.20±0.05^{e}	0.00±0.00^{g}
250 WC CC	6.40±1.73^{bc}	2.60±0.17^{e}	0.20±0.06^{f}	0.00±0.00^{f}	0.60±0.14^{d}
Control CL	0.60±0.12^{f}	4.00±0.58^{d}	0.60±0.12^{fgh}	0.20±0.08^{e}	1.40±0.17^{ab}
C0ontrol CC	2.80±0.58^{f}	3.40±0.17^{d}	0.40±0.06^{e}	1.00±0.12^{b}	0.00±0.00^{g}

Mean values (± Standard Error) with different superscripts in the same column are significantly different at $p < 0.05$. IAA (Indole acetic acid), GA_3 (Gibberellic acid), BPLE= *Bryophyllum pinnatum* leaf extract, WC= Coconut water

Table 3: Effects of varying concentrations of hormones on germination and seedling growth of *Citrullus lanatus* and *Citrullus colocynthis*

Conc. (mg/l)	Parameters					
	Seedling vigour	Seedling index	Seedling dry weight	Seedling length	Plumule length	Radicle length
50 IAA CL	4.48± 0.02d	241.69±0.02^{j}	0.25± 0.01^{f}	14.5± 0.04^{b}	8.43± 0.3^{bc}	6.13± 0.20^{b}
50 IAA CC	5.36± 0.02^{c}	843.62± 0.02^{e}	0.92± 0.01^{ab}	11.00± 1.15^{c}	46.20± 1.83^{a}	4.40± 0.29^{cd}
50 GA_3 CL	8.50± 0.2^{b}	443.78± 0.01^{g}	0.30± 0.12^{e}	16.70± 0.12^{ab}	9.61± 0.24^{b}	7.10± 0.12^{ab}
50 GA_3 CC	6.40± 0.46^{c}	793.30±1.59^{e}	0.88± 0.01^{b}	10.40± 0.35^{c}	7.51± 0.29^{c}	2.90± 0.23^{d}
50 BPLE CL	7.12± 0.01^{bc}	433.58± 4.04^{g}	0.29± 0.01^{f}	15.94± 0.54^{b}	7.60± 0.23^{c}	8.30± 0.35^{a}
50 BPLE CC	5.98±0.05^{c}	998.84± 0.60^{de}	1.13± 0.02^{a}	9.60± 0.18^{d}	6.54± 0.31^{c}	3.04± 0.38^{d}
50 CW CL	6.88± 0.01^{c}	405.78± 0.69^{h}	0.32± 0.06^{e}	15.40± 0.46^{b}	8.20± 0.63^{bc}	7.20± 0.75^{ab}
50 CW CC	7.84± 0.06^{bc}	1161.76± 0.59^{a}	0.94± 0.12^{ab}	12.50± 0.81^{bc}	8.00±1.20^{b}	4.50± 0.13^{cd}
100 IAA CL	7.52± 1.13^{bc}	291.32± 1.44^{i}	0.27± 0.02^{f}	15.70± 0.35^{b}	10.80± 0.40^{b}	4.90± 0.66^{cd}
100 IAA CC	3.06±0.05^{de}	567.18± 1.74^{f}	0.79± 0.01^{b}	8.40± 0.04^{d}	5.10± 0.52^{c}	3.30± 0.08^{d}
100 GA_3 CL	8.62± 0.40^{b}	400.44± 1.09^{g}	0.25± 0.05^{f}	16.60± 0.30^{ab}	9.80± 0.40^{b}	6.80± 0.50^{b}
100 GA_3 CC	6.94±0.52^{c}	875.24± 0.52^{e}	0.80± 0.02^{b}	13.80± 0.28^{bc}	8.90± 0.02^{cd}	4.90± 0.59^{cd}
100 BPLE CL	7.04± 0.03^{bc}	363.24± 0.87^{h}	0.37± 0.01^{e}	11.80± 0.29^{c}	7.70± 0.52^{c}	4.10± 0.29^{cd}
100 BPLE CC	6.34± 0.23^{c}	1119.92± 1.37^{b}	1.12± 0.02^{ab}	10.50± 0.46^{c}	6.40± 0.58^{bc}	4.10± 0.05^{cd}
100 CW CL	5.62± 0.02^{c}	386.72± 0.59^{h}	0.31± 0.02^{d}	15.90± 0.59^{b}	8.30± 0.46^{bc}	7.60± 0.06^{ab}
100 CW CC	6.40± 0.59^{c}	1121.80± 0.62^{b}	1.05± 0.06^{ab}	11.50± 0.58^{c}	7.00± 0.64^{c}	4.50± 040^{cd}
150 IAA CL	5.46± 0.63^{c}	251.60± 0.79^{j}	0.27± 0.03^{d}	13.30± 0.69^{bc}	7.30± 0.52^{c}	6.00± 0.13^{b}
150 IAA CC	3.26± 0.16^{ef}	427.68± 0.72^{g}	0.70± 0.08^{bc}	10.60± 0.76^{c}	5.74± 0.01^{cd}	4.86± 0.17^{cd}
150 GA_3 CL	7.56± 0.59^{bc}	357.60± 0.34^{h}	0.22± 0.02^{f}	15.30± 0.74^{b}	9.80± 0.24^{b}	5.50± 0.13^{c}
150 GA_3 CC	6.70± 0.52^{c}	969.68± 0.63^{de}	0.90± 0.01^{ab}	11.60± 0.16^{c}	7.30± 0.26^{c}	4.30± 0.13^{cd}
150 BPLE CL	7.72± 0.51^{bc}	516.14± 0.66^{fg}	0.42± 0.02^{f}	12.70± 0.82^{bc}	7.80± 0.02^{c}	4.90± 0.02^{cd}
150 BPLE CC	6.52± 0.31^{c}	804.52± 1.17^{e}	0.90± 0.16^{ab}	9.40± 0.18^{c}	7.00± 0.15^{c}	2.40± 0.12^{d}
150 CW CL	5.92± 0.38^{c}	442.16± 0.77^{f}	0.42± 0.06^{d}	12.40± 0.35^{bc}	6.20± 0.14^{c}	6.20± 0.02^{b}
150 CW CC	7.06± 0.29^{bc}	979.86± 1.19^{de}	0.91± 0.04^{ab}	9.20± 0.16^{c}	8.00± 0.09^{bc}	3.80± 0.03^{d}
200 IAA CL	4.52± 0.40^{d}	137.26±0.39^{j}	0.14± 0.02^{f}	14.10± 0.13^{b}	9.20± 0.08^{b}	4.90± 0.13^{cd}
200 IAA CC	3.40±0.36^{de}	468.10± o.91^{g}	0.98± 0.02^{ab}	12.50± 0.75^{d}	6.50± 0.07^{c}	6.00± 0.13^{b}
200 GA_3 CL	8.06± 0.64^{b}	337.90± 0.58^{h}	0.25± 0.05^{f}	17.08± 1.16^{ab}	10.50± 0.43^{b}	7.30± 0.19^{ab}
200 GA_3 CC	4.78± 0.16^{d}	654.16± 0.57^{f}	0.76± 0.05^{bc}	11.50± 0.35^{d}	6.50± 0.03^{c}	5.00± 0.07^{c}

200 BPLE CL	9.56± 0.46^{ab}	563.56± 0.51^{f}	0.33± 0.02^{e}	18.70± 0.29^{a}	10.20± 0.01^{b}	8.30± 0.09^{a}
200 BPLE CC	7.90± 0.14^{b}	1052.86± 1.45^{d}	0.96± 0.01^{ab}	11.30± 0.15^{bc}	8.00± 0.06^{bc}	3.30± 0.10^{d}
200 CW CL	7.72± 0.13^{bc}	486.84± 0.61^{g}	0.35± 0.07^{e}	15.80± 0.21^{b}	8.70± 0.24^{bc}	7.10± 0.30^{ab}
200 CW CC	5.72± 0.39^{c}	873.82± 1.14^{e}	1.010± 0.12^{ab}	8.90± 0.07^{d}	5.80± 0.18^{cd}	3.20± 0.03^{d}
250 IAA CL	2.82± 0.14^{e}	247.48± 0.45^{i}	0.44± 0.06^{d}	10.00± 0.58^{i}	6.40± 0.01^{c}	3.60± 0.08^{d}
250 IAA CC	1.26± 0.17^{e}	79.64± 0.50^{e}	0.32± 0.03^{e}	9.22± 0.28^{d}	5.20± 0.14^{cd}	4.02± 0.36^{cd}
250 GA_3 CL	6.60± 0.14^{c}	371.52± 0. 80^{h}	0.31± 0.02^{e}	16.50± 0.12^{ab}	9.40± 0.13^{b}	7.20± 0.01^{ab}
250 GA_3 CC	4.66± 0.06^{d}	559.48± 0.62^{f}	0.65± 0.12^{c}	9.50± 0.38^{d}	7.30± 0.02^{c}	5.40± 0.08^{c}
250 BPLE CL	9.62± 0.35^{a}	526.92± 0.57^{f}	0.35± 0.07^{e}	15.70± 0.46^{b}	10.40± 0.55^{b}	5.30± 0.13^{c}
250 BPLE CC	7.04± 0.32^{bc}	1094.24±1.15^{c}	0.90± 0.01^{ab}	12.40± 0.82^{bc}	7.20± 0.59^{c}	5.20± 0.11^{c}
250 CW CL	7.22± 0.13^{bc}	433.18± 0.31^{g}	0.33± 0.01^{e}	16.70± 0.46^{ab}	9.30± 0.12^{b}	7.40± 0.24^{ab}
250 CW CC	7.08±0.44^{bc}	1072.90± 0.45^{d}	0.98± 0.17^{ab}	11.40± 0.09^{c}	7.40± 0.08^{c}	4.00± 0.09^{cd}
Control CL	6.46± 0.29^{c}	574.30± 0.32^{ef}	0.50± 0.08^{cd}	15.60± 0.20^{b}	9.00± 0.12^{b}	6.60± 0.13^{b}
Control CC	5.06±0.13^{c}	775.02± 0.71^{e}	0.64± 0.12^{c}	12.00± 0.14^{bc}	6.70± 0.07^{c}	5.30± 0.01^{c}

Mean values (± Standard Error) with different superscripts in the same column are significantly different at $p < 0.05$. IAA (Indole acetic acid), GA_3 (Gibberellic acid), BPLE= *Bryophyllum pinnatum* leaf extract; WC= Coconut water

DISCUSSION

The use of phytohormones or their alternatives is becoming increasingly important in farming practices for many cultivated plants due to their precise effects on plant growth (Rafeekher *et al*., 2002) depending on the concentrations and their sensitivity on the organ concerned (Naeem *et al*., 2004). The effects of varying concentrations of phytohormones and botanicals on germination and seedling growth evaluated in this study resulted in significant variations in germination, a mechanism which controls morphological, physiological and biochemical alterations in the seed metabolites (Muller *et al*., 2006).

The percentage germination and germination rate recorded could have been influenced by the ability of varying concentrations of the hormones and botanicals to penetrate through the seed coat into the cotyledons and stimulate hydrolytic action of hydrolases. A similar finding was reported by Roy *et al*. (2012), who observed rapid germination in seeds of two vegetables using aqueous extracts of four herbal plants. Effects of concentrations on the germination and seedling growth of *C. lanatus* and *C. colocynthis* may be attributed to the ability of these concentrations to soften the adhesive covering of the seeds for easy water or gas permeability and initiation of hydrolysis in the cotyledons (Muhammed *et al*., 2013).

The hydrolysis might have increased nucleic acid metabolism and protein synthesis needed by the cotyledons to supply nutrients for radicle and plumule emergence and the development of the epicotyl (Guan *et al*. 2014). Coconut water and BPLE mobilised food reserves embedded in the seeds to the cotyledons of growing seeds, which was used for emergence of radicle and plumule as well as its photosynthetic activities (Ajiboye and Agboola, 2011). The BPLE at 150 mg/l and 250 mg/l greatly enhanced percentage germination and seedling vigour of *C. lanatus* as well as *C. colocynthis* at 200 mg/L. This suggests the presence of growth-regulatory substances in BPLE and coconut water. The regulatory substances stimulated morphological, physiological and biochemical changes such as breaking of dormancy, hydrolysis, metabolism, mobilisation of metabolites and activation of enzymes (Farooq *et al*., 2009). Talukder *et al*. (2015) observed that germination of Turnip and Ladies finger was maximum when treated with aqueous leaf extract of *Terminalia arjuna* while aqueous extract of Neem resulted in the inhibition of seed germination.

Higher seedling and radicle length observed in the plant grown from the seeds treated with the BPLE at 50 mg/l and 200 mg/l in *C. lanatus* as well as higher seedling dry weight recorded in the seeds of *C. colocynthis* might be due to the growth-promoting potential of the BPLE or the ability of the extracts to initiate cell division within the apical meristem (Roy *et al*., 2012) and its growth-promoting ability due to the presence of growth- regulatory substances. The result also suggests low concentration of allelopathic compounds such as coumarin and phenol in the botanicals.

The high seedling index and seedling dry weight observed in the untreated *C. lanatus (*control) and in *C. colocynthis* treated with 50 mg/l coconut water indicates that the treatments were effective even at low concentration to stimulate cell division, seed germination, seedling establishment and growth. Soaking *C. colocynthis* and *C. lanatus* seeds in 100 mg/l of GA_3 resulted in increased plumule and seedling length while IAA at 100 mg/l and 200 mg/l greatly enhanced the plumule length of *C. lanatus* and radicle length of *C. colocynthis* seedlings. Studies have shown that IAA, GA_3 enhance developmental processes in plants (Copeland and McDonald 2001; Seyed *et al*., 2012; Dewa, 2014; Olajide *et al*., 2014; Sunil *et al*., 2015).

CONCLUSION

Variations in the concentration of hormones resulted in significant changes in germination, germination rate as well as seedling growth of *C. lanatus* and *C. colocynthis* even at the lowest concentration. Between 100 and 150 mg/l of IAA, GA_3 and BPLE produced better effects on the percentage germination and germination rate of the cucurbit seeds; at 50 mg/l, the hormones enhanced seedling growth. Therefore, between 50-150 mg/l of the hormones is recommended for farming, to promote uniform germination, growth rate and better performance of agronomic charaters of the cucurbits.

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