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EFFECT OF SOWING DEPTH ON GROWTH PERFORMANCE OF SELECTED MEMBERS OF THE FAMILY CUCURBITACEAE

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ABSTRACT

A field experiment was conducted to investigate the agronomical responses of *Citrullus colocynthis*, *Luffa cylindrica* and *Citrullus lanatus* to varying sowing depths (2, 4, 6 and 8 cm). Agronomic parameters such as number of leaves, fruit weight, leaf area, vine length and width were taken. The Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Ratio (LAR) for each cucurbit were determined from the data on leaf area and dry weight of seedling. The number of leaves and vines, vine length and width of cucurbits at 2 cm soil depth increased significantly compared with those at 8 cm. However, agronomical responses of the cucurbits at 2 cm soil depth were similar to those at 4 cm. At 2 cm sowing depth, the fruit weight of *C. lanatus*, *L. cylindrica* and *C. colocynthis* increased by 47%, 35% and 20%, respectively compared with those at 8 cm. Also, the RGR, NAR and LAR of *C. colocynthis, L. cylindrica* and *C. lanatus* at 2 cm sowing depth increased significantly (p<0.05) compared with those at 8 cm. The findings showed that the vegetative and physiological characteristics of *C. colocynthis, L. cylindrica and C. lanatus* increased when sown at depths of 2 - 4 cm.

Keywords: Sowing depth; cucurbits; agronomical attributes; growth performance

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INTRODUCTION

Cucurbitaceae (Gourd family) is a moderately large family of flowering plants, mostly climbers and trailers (Ajuru and Okoli, 2013). The members of the family are crop plants of high economic importance with fruits of shapes, sizes and flavours. Among the cucurbits, *Luffa cylindrica* (L.) M.J. Roem is a unique vegetable found in the sub-tropical region that requires warm summer temperatures and a long frost-free growing season when grown in the temperate region (Azeez *et al*., 2013). Moreover, *Citrullus lanatus* (Thunb.) Matsumura & Nakai is widely cultivated but also native to desert regions in Africa and grown commercially in areas with warm temperatures (Lilly, 2013). However, *Citrullus colocynthis* (L.) Schrad is well known for its use in preparing assorted foods, especially indigenous African delicacies, and can also be roasted and eaten as snacks (Ogbonna and Obi, 2007).

In Nigeria, cucurbits represent almost 21 genera and 41 species, perhaps, having more cultivated species than any other family (Ajuru and Nmom, 2017). *C. lanatus* is largely cultivated in the Northern part of Nigeria, dominated by humid and drier savanna agro-ecologies (Adekunle *et al*., 2007). However, *C. colocynthis,* a popular vegetable crop, is widely cultivated in the South-Western and Eastern parts of Nigeria due to its economic importance (Olaniyi, 2008).

To increase food availability for the burgeoning population, agronomic practices that promote yield and physiological characteristics of crops are necessary. Sowing depth is an important factor for maximising the growth of *Butea frondosa* (Ahirwar, 2015) and *Vicia faba* (Ali and Idris, 2015). Previous studies showed that sowing depth and orientation of some crops improved the development and yield of crops (Srivastava *et al*., 2006; Yagmur and Digdem, 2009). Aikkins *et al*. (2006) reported that deep planting resulted in the reduction of growth and yield of maize. However, the effect of sowing depth on yield and agrophysiological responses of cucurbits is yet to be reported.

The Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Ratio (LAR) serve as the function of plant dry weight, leaf area and time, which are known to be the key variables that influence the physiology of plants (Grime, 2001). Conversely, low relative growth rates for a long period serve as indicator of plant death (Gilner *et al.*, 2013). The RGR, NAR and LAR of *C. lanatus, L. cylindrica* and *C. colocynthis* planted under varying soil depths have not been previously reported.

To achieve good germination, emergence, quality growth and yield of cucurbits, suitable sowing depth is necessary. Thus, this study aimed to determine agronomical responses of *C. lanatus, L. cylindrica* and *C. colocynthis* planted under varying soil depths in order to determine suitable sowing depth that will improve germination and seedling growth of cucurbits.

MATERIALS AND METHODS

Field Investigations

The field experiment was conducted at the experimental field of the Department of Pure and Applied Botany, Federal University of Agriculture, Abeokuta, Nigeria (70^0 30' N, 30^0 54' E) in 2018 during the cropping season (June- August). The soil is sandy loam with a pH of 6.7 and organic matter content of 3.88% (Table 1). The mean monthly rainfall and temperature during the cropping season varied between 162 - 221 mm and 22.6 - 23.0^0C, respectively (Table 2). The soil temperature was measured at 2 cm and 8 cm using a soil thermometer.
Viable seeds of *L. cylindrica*, *C. lanatus* and *C. colocythis* obtained from the Institute of Agricultural Research and Training (IAR&T), Ibadan, Oyo State, Nigeria were sown on raised beds of 20 cm high and 50 cm wide at varying sowing depths (2, 4, 6 and 8 cm). The experiment was laid out in a Randomised Complete Block Design with three replicates. Each plot had an area of 30 m^2 (6 m x 5 m) with a planting density of 20 plants per m^2. The intra and inter-row spacing was 20 cm and 30 cm, respectively. During the study, neither organic nor inorganic fertilizers were applied. Weeding, pesticide application and other important agronomic practices were carried out when necessary.

Measurement of Agronomic Characteristics

Agronomic parameters such as vine length, number of leaves, number of vines, vine diameter, leaf area and total dry weight were measured at 2-week interval from the seedling stage, 2 weeks after planting (WAP) until maturity stage (12 WAP). For each treatment, five plants were randomly selected for measurement. At the reproductive stage, the number of flowers, number of fruits per plant and number of seeds per fruit were recorded. Also, the number of leaves and the number of vines were counted. The vine length and vine diameter were measured using meter rule and vernier caliper, respectively. The leaf area of the randomly selected plants was measured using Leaf Area Meter (YMJ-A). At physiological maturity, each cucurbit in an area of 1m^2 was sampled for fresh and dry weight measurements. Harvested plants were divided into different plant parts (leaves, vines, roots and fruits). The weights of each part of the entire shoot except the fruit were measured after drying for 72 hours at 70^0C using an electric oven (DHG-9202-1SA). However, the fresh fruits were weighed with a weighing balance.

Determination of RGR, NAR and NAR of *C. colocynthis*, *L. cylindrica* and *C. lanatus*

The Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Ratio (LAR) were computed as reported by Hoffman and Poorter (2002).

$$RGR = \frac{Log_e W_2 - Log_e W_1}{t_2 - t_1} \quad \text{....................................} (1)$$

$$NAR = \frac{W_2 - W_1}{A_2 - A_1} . \frac{Log_e A_2 - Log_e A_1}{t_2 - t_1} \quad \text{....................................} (2)$$

$$LAR = \frac{W_2 - W_1}{t_2 - t_1} . \frac{Log_e A_2 - Log_e A_1}{W_2 - W_1} \quad \text{....................................} (3)$$

W_1 and W_2 are dry weights at the first and second harvests, A_1 and A_2 are the leaf area at the first and second harvests while t_1 and t_2 are the times corresponding to the first and second harvests, respectively.

Statistical Analysis

Data were subjected to one-way analysis of variance to determine the effect of the sowing depth on each cucurbit using Statistical Analysis Software version 9.3 (SAS Institute Inc., Cary, NC., USA). Means were separated using Duncan's Multiple Range Test (DRMT) at $p < 0.05$.

Table 1: Soil properties of the experimental site

Properties	Soil
Sand (%)	84.11
Clay (%)	9.37
Silt (%)	6.48
pH (1:25 water)	6.67
Organic Carbon (%)	2.24
Organic Matter (%)	3.88
Available Phosphorous (mg/kg)	13.32
Exchangeable Na^+ (cent/kg)	0.345
Exchangeable K^+ (cent/kg)	0.509
Exchangeable Mg^{2+} (cent/kg)	0.265
Exchangeable Ca^{2+} (cent/kg)	0.357
Exchangeable Fe^{2+} (mg/kg)	0.872
Exchangeable Cu^{2+} (mg/kg)	1.008
Exchangeable Zn^{2+} (mg/kg)	7.014

Table 2: Monthly mean temperature, rainfall, relative humidity and soil temperature of the experimental site during the cropping season in 2018

		June	July	August
Maximum Temperature (^{0}C)		30.4	27.5	29.1
Minimum Temperature (^{0}C)		22.7	23.0	22.6
Total Rainfall (mm)		172.9	221.1	161.8
Relative Humidity (%)		76.3	80.3	77.2
Sunshine Hours		3.6	3.2	1.9
Evaporation (mm)		2.8	1.9	2.0
Mean Temperature (^{0}C)		26.6	25.3	25.8
Soil Temperature (^{0}C)	2 cm depth	27.2	26.4	26.0
	8 cm depth	27.6	26.9	26.4

RESULTS

Effects of sowing depth on the number of leaves and leaf area of *C. colocynthis, L. cylindrica* and *C. lanatus*

Figure 1 shows the number of leaves of each cucurbit at different weeks after planting (WAP) under varying sowing depths. At 2 WAP, the number of leaves of each cucurbit was comparable among the varying treatments except that of *L. cylindrica*, which had an increased number of leaves at 2 cm sowing depth. At 12 WAP, the number of leaves of *C. colocynthis*, *L. cylindrica and C. lanatus* planted at 2 cm sowing depth increased by 73 %, 25 % and 75%, respectively, compared with those planted at 8 cm.

Variation exists in the response of the leaf area of cucurbits to the different sowing depths (Table 3). At early vegetative stages (2 and 6 WAP), leaf area of the studied cucurbits sown at 2 cm depth increased significantly (p<0.05) compared with those sown at the other depths. However, the effect was similar at 12 WAP across the studied cucurbits except for *C. colocynthis* with increased leaf area at 2 cm sowing depth.

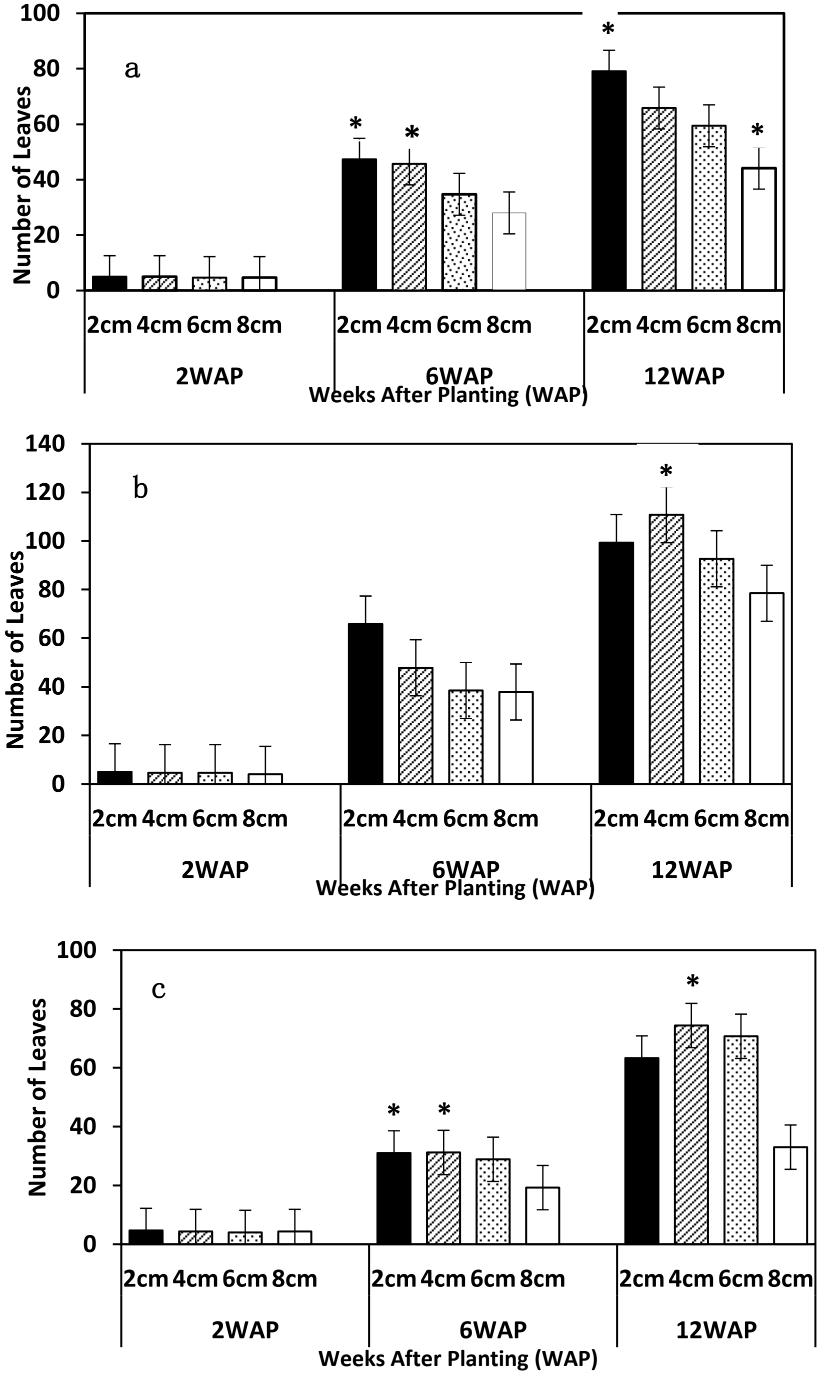

Figure 1: Number of leaves of cucurbits at varying sowing depths: a, b and c indicate *C. colocynthis*, *L. cylindrica* and *C. lanatus,* respectively. Means significant at $p < 0.05$

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Table 3: Effect of sowing depth on leaf area of *C. colocynthis*, *L. cylindrica* and *C. lanatus*

Cucurbit	Sowing depth (cm)	Leaf Area		
		2WAP	6WAP	12WAP
C. colocynthis	2	49.72$\pm$ 8.85^{a}	171.41$\pm$ 19.48^{a}	244.41$\pm$ 71.00^{a}
	4	[illegible].93^{b}	167.02$\pm$ 16.35^{ab}	182.67$\pm$ 6.06^{b}
	6	29.54$\pm$ 3.71^{b}	163.72$\pm$ 15.88^{ab}	175.47$\pm$ 13.54^{a}
	8	26.39$\pm$ 6.22^{b}	164.62$\pm$ 16.10^{ab}	172.04$\pm$ 3.54^{b}
L. cylindrica	2	49.72$\pm$ 8.05^{a}	141.63$\pm$ 5.22^{a}	163.60$\pm$ 3.72^{a}
	4	31.77$\pm$ 1.93^{b}	141.21$\pm$ 4.81^{ab}	152.55$\pm$ 10.98^{a}
	6	29.54$\pm$ 3.71^{b}	133.66$\pm$ 15.15^{ab}	159.08$\pm$ 7.67^{a}
	8	26.54$\pm$ 3.71^{b}	102.32$\pm$ 17.96^{c}	118.47$\pm$ 22.29^{a}
C. lanatus	2	31.72$\pm$ 8.05^{a}	182.14$\pm$ 43.02^{a}	204.85$\pm$ 37.12^{a}
	4	26.39$\pm$ 6.22^{b}	158.61$\pm$ 6.11^{ab}	204.81$\pm$ 37.12^{a}
	6	31.77$\pm$ 1.93^{b}	130.54$\pm$ 16.15^{ab}	164.85$\pm$ 7.64^{a}
	8	29.54$\pm$ 3.71^{b}	81.72$\pm$ 32.10^{b}	105.45$\pm$ 13.02^{a}

Data indicate means of three replicates $\pm$ standard error. Treatment values within a column for each cucurbit followed by the same letter are not significantly different at $p < 0.05$

Effects of sowing depth on the number of vines, vine length and vine width of *C. colocynthis, L. cylindrica,* and *C. lanatus*

Planting *C. colocynthis and C. lanatus* at a shallow depth of 2 cm and 4 cm significantly increased the number of vines and vine length compared with 8 cm depth at the vegetative stage (6 WAP). However, the number of vines of *L. cylindrica* at 6 WAP at varying sowing depths was comparable among treatments whereas the vine length significantly increased by 15% when planted at 2 cm depth compared with 8 cm.

At 12 WAP, the vine length and vine width were significantly higher in *C. colocynthis* by 12% and 23%, *L. cylindrica* by 34% and 29%, *and C. lanatus* by 39% and 14%, respectively at 2 cm compared with those at 8 cm sowing depth (Table 4). The number of vines produced by *C. colocynthis* and *C. lanatus* under the varying sowing depths was similar; however, the number of vines produced by *L. cylindrica* at 2 cm sowing depth was significantly ($p< 0.05$) higher than those at 8 cm (Table 4).

Table 4: Effect of sowing depth on number of vines, vine length and vine width of *C. colocynthis*, *L. cylindrica* and *C. lanatus*

Cucurbit	Sowing depth (cm)	Number of vines 6WAP	Number of vines 12WAP	Vine length (cm) 6WAP	Vine length (cm) 12WAP	Vine width (mm) 6WAP	Vine width (mm) 12WAP
C. colocynthis	2	7.43 ± 0.47^{ab}	12.61 ± 0.24^{a}	141.77 ± 12.77^{a}	244.67 ± 13.32^{ab}	2.45 ± 0.08^{a}	3.98 ± 1.25^{a}
	4	8.83 ± 0.33^{a}	13.93 ± 2.94^{a}	124.43 ± 3.98^{ab}	273.00 ± 10.53^{a}	2.47 ± 0.14^{a}	2.87 ± 0.14^{ab}
	6	5.43 ± 1.23^{b}	12.58 ± 1.72^{a}	120.13 ± 9.60^{ab}	239.00 ± 32.92^{ab}	2.47 ± 0.07^{a}	2.63 ± 0.07^{b}
	8	2.47 ± 0.12^{c}	10.27 ± 0.81^{a}	117.53 ± 10.46^{ab}	218.00 ± 8.89^{b}	2.43 ± 0.13^{a}	3.23 ± 1.23^{ab}
L. cylindrica	2	5.67 ± 1.99^{a}	16.67 ± 2.67^{a}	209.20 ± 47.63^{a}	328.03 ± 45.82^{ab}	2.33 ± 0.12^{a}	2.50 ± 0.11^{a}
	4	6.03 ± 1.07^{a}	12.90 ± 1.51^{ab}	215.60 ± 36.38^{a}	370.50 ± 21.75^{a}	2.07 ± 0.03^{ab}	2.30 ± 0.05^{ab}
	6	5.97 ± 0.84^{a}	13.83 ± 2.49^{ab}	191.93 ± 3.39^{b}	311.33 ± 3.18^{ab}	1.95 ± 0.03^{ab}	2.30 ± 0.15^{ab}
	8	5.70 ± 1.04^{a}	8.67 ± 2.03^{b}	181.17 ± 25.52^{b}	244.70 ± 49.39^{b}	1.67 ± 0.23^{b}	1.93 ± 0.32^{b}
C. lanatus	2	5.67 ± 0.33^{a}	8.20 ± 0.10^{a}	176.50 ± 3.83^{a}	308.97 ± 6.02^{a}	2.13 ± 0.07^{a}	2.48 ± 0.25^{a}
	4	4.67 ± 0.67^{a}	8.50 ± 0.76^{a}	166.50 ± 5.66^{a}	307.03 ± 3.41^{a}	2.17 ± 0.00^{a}	2.40 ± 0.25^{a}
	6	4.00 ± 1.53^{ab}	6.83 ± 2.24^{a}	111.70 ± 2.15^{b}	222.62 ± 2.51^{b}	1.90 ± 0.06^{b}	2.47 ± 0.30^{a}
	8	1.67 ± 0.33^{b}	4.83 ± 0.33^{a}	72.67 ± 5.30^{c}	222.00 ± 3.51^{b}	1.93 ± 0.03^{b}	2.20 ± 0.06^{a}

Data indicate means of three replicates ± standard error. Treatment values within a column for each cucurbit followed by the same letter are not significantly different at $p < 0.05$

Effect of sowing depth on the number of flowers, fruit weight, fruit width and number of seeds of *C. colocynthis, L. cylindrica* and *C. lanatus*

The number of flowers, fruit weight, fruit width and the number of seeds of the three cucurbits significantly decreased as the sowing depth increased except for the number of flowers of *L. cylindrica* (Table 5). The number of flowers of *C. colocynthis* and *C. lanatus* at 2 cm sowing depth increased by 37% and 72% compared with 8 cm sowing depth; however, the number of flowers of *L. cylindrica* responded similarly under the varying treatments.

The average fruit width of *C. colocynthis*, *L. cylindrica* and *C. lanatus* sown at 2 cm depth was 17%, 14% and 28 % higher in relation to those sown at 8 cm, respectively (Table 5). The fruit weight of *C. colocynthis*, *L. cylindrica* and *C. lanatus* sown at 2 cm depth increased by 20%, 35% and 47%, respectively compared to those sown at 8 cm depth. The fruit weight of *L. cylindrica* sown at 2, 4 and 6 cm depth was similar but significantly higher than those at 8 cm.

Table 5: Effect of sowing depth on number of flowers, fruit weight, fruit diameter and number of seeds of *C. colocynthis*, *L. cylindrica* and *C. lanatus*

Cucurbit	Sowing depth (cm)	Number of flowers	Fruit weight (g)	Fruit width (cm)	Number of seeds
C. colocynthis	2	15.23±2.56[a]	613.50±1.19[a]	40.62±0.61[a]	105.33±2.60[a]
	4	9.53±2.78[ab]	534.00±1.29[b]	33.67±0.38[ab]	70.33±1.45[b]
	6	10.03±0.53[ab]	505.75±1.03[c]	32.65±0.43[ab]	50.00±1.15[c]
	8	9.53±3.01[b]	490.50±3.23[d]	31.82±1.67[ab]	48.67±0.88[c]
L. cynlindrica	2	2.93±0.23[a]	42.01±1.26[a]	19.35±0.64[a]	96.00±2.31[a]
	4	3.77±0.39[a]	39.23±1.38[a]	17.14±0.99[b]	86.33±1.20[ab]
	6	3.80±0.39[a]	33.37±1.28[a]	16.99±0.52[b]	76.67±1.76[ab]
	8	3.27±0.50[a]	27.44±0.86[b]	16.61±0.24[b]	70.67±2.33[b]
C. lanatus	2	13.27±0.43[a]	945.43±7.00[a]	46.52±0.86[a]	345.33±8.09[a]
	4	8.33±0.08[ab]	687.91±5.45[c]	43.93±1.04[ab]	225.67±1.85[b]
	6	4.20±0.66[ab]	862.31±6.83[b]	41.51±1.35[ab]	218.67±1.45[bc]
	8	3.70±0.35[b]	500.21±1.86[d]	38.62±2.87[b]	206.33±1.45[c]

Data indicate means of three replicates± standard error. Treatment values within a column for each cucurbit followed by the same letter (s) are not significantly different at $p < 0.05$

Effect of sowing depth on RGR, NAR and LAR of *C. colocynthis, L. cylindrica,* and *C. lanatus*

Table 6 shows the effect of sowing depth on RGR, NAR and LAR of *C. colocynthis, L. cylindrica* and *C. lanatus*. The RGR, NAR and LAR decreased as the sowing depth increased across cucurbits. The cucurbits planted at 2 and 8 cm sowing depths had the highest and lowest RGR, NAR and LAR, respectively. The sowing depth of 2 cm increased the RGR of *C. colocynthis*, *L. cylindrica* and *C. lanatus* by 93%, 97% and 96%, respectively when compared with 8 cm depth. Also, the NAR of *C. colocynthis*, *L. cylindrica* and *C. lanatus* increased significantly by 96%, 84% and 91%, respectively at 2 cm compared with 8 cm soil depth. Similarly, planting *C. colocynthis*, *L. cylindrica* and *C. lanatus* at 2 cm depth increased LAR by 90%, 70% and 65%, respectively when compared with planting at 8 cm depth (Table 6).

Table 6: Effect of sowing depth on RGR, NAR, and LAR of *C. colocynthis*, *L. cylindrica,* and *C. lanatus*

Cucurbit	Sowing depth (cm)	RGR	NAR	LAR
C. colocynthis	2	0.87± 0.06[a]	0.25± 0.07[a]	0.61± 0.03[a]
	4	0.34± 0.03[b]	0.18± 0.02[b]	0.41± 0.03[b]
	6	0.17± 0.02[c]	0.12± 0.02[ab]	0.21± 0.03[c]
	8	0.06± 0.01[c]	0.01± 0.01[c]	0.06± 0.01[d]
L. cylindrical	2	0.55± 0.09[a]	0.39± 0.01[a]	0.86± 0.04[a]
	4	0.28± 0.02[b]	0.21± 0.01[b]	0.68± 0.02[b]
	6	0.13± 0.01[c]	0.18± 0.01[b]	0.48± 0.01[c]
	8	0.02± 0.01[c]	0.06± 0.01[c]	0.26± 0.03[d]
C. lanatus	2	0.24± 0.02[a]	0.24± 0.02[a]	1.22± 0.12[a]
	4	0.20± 0.18[b]	0.17± 0.01[b]	0.95± 0.01[b]
	6	0.07± 0.01[b]	0.11± 0.02[c]	0.73± 0.02[c]
	8	0.01± 0.01[c]	0.02± 0.01[d]	0.44± 0.02[d]

Data indicate means of three replicates ± standard error. Treatment values within a column for each cucurbit followed by the same letter are not significantly different at p <0.05.

DISCUSSION

The results of this study showed that sowing depth had significant effect on the productivity and agronomic characteristics of the cucurbits planted in sandy-loam soil. The decrease in fruit weight of *C. lanatus*, *L. cylindrica* and *C. colocynthis* with increasing sowing depth could be attributed to the decrease in agronomic attributes such as leaf area, number of leaves, vine length and vine width. Singh and Girish (2013) observed that leaf area index and dry matter production decreased with increasing sowing depth. The increased leaf area and the number of leaves of cucurbits planted at 2 and 4 cm depths could be due to increased photosynthetic activities, which resulted in the significant increase in fruit weight and yield. Ayobola *et al*. (2010) observed that reduced leaf area and the number of leaves resulted in lower photosynthetic activities and decreased crop growth.

The increased level and availability of soil macro and micronutrients in addition to adequate moisture content at the shallow sowing depth of 2 cm and 4 cm possibly resulted in the increase in cell division, enlargement and differentiation that were responsible for the significant increase in the number of vines and vine width compared with other sowing depths (Sikuku *et al*., 2010). The increased RGR and NAR of the cucurbits at 2 and 4 cm indicated that sowing cucurbits at the shallow depth stimulate and improves seed germination and seedling vigour by providing a moist environment around the seeds to prevent them from drying out (Rusdy and Sjahril, 2015). Soil nutrient and microbial activities decrease as soil depth increases. At the shallow depth of 2-4 cm, an abundant population of microorganisms possibly existed thereby improving soil nutrient availability for plant uptake by plants. At the deeper layer of the soil, the population of beneficial microorganisms decreased as a result of the reduction in soil organic matter.

Root biomass and number of rootlets are important characteristics used to determine nutrient uptake efficiency (Fitter and Stickland, 1992). Although this study did not investigate the root size and root architecture of cucurbits as influenced by sowing depth, the increased agronomic response of cucurbits at the shallow depth of 2-4 cm indicates a high nutrient uptake efficiency from the rhizosphere. This could be as a result of the increase in rootlet biomass, root length, radius and density. Birara *et al.* (2016) reported that crop yield and plant growth are positively related to root system development. The increase in root biomass improves the rate of water and nutrient uptake from the soil to the plant. At the deeper sowing depth, the emergence of rootlets was probably restricted due to reduced root interception (Kato and Okami, 2010).

The zero application of organic and inorganic fertilizer and non-agronomic cultivation practices such as ridging and tilling, which are common practices of the farmers in this region, were considered as limitations to this study. This could be responsible for the significant effect of sowing depth on the agronomic characteristics of cucurbits. Further study to incorporate fertilizer application and cultural practices is hereby recommended in addition to the effect of sowing depth on the economic characteristics of cucurbits.

Although the agronomic responses in cucurbits were significantly higher at 2 cm sowing depth compared with 8 cm, 2 cm and 4 cm sowing depths had similar effects on agronomic characteristics of the cucurbits. Therefore, the sowing depth of 2 – 4 cm is considered the optimum planting depth to ensure good germination and establishment of *C. lanatus*, *L. cylindrica* and *C. colocynthis.*

CONCLUSION

Varying sowing depth had a significant effect on the yield and agronomic characteristics of the cucurbits studied. *Citrolus lanatus*, *L. cylindrica* and *C. colocynthis* showed optimum growth and maximum productivity at 2 cm and 4 cm sowing depths by improving their growth rate and agronomic characteristics.

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