DECAPITATION OF SHOOT TIP ENHANCED GROUNDNUT PRODUCTIVITY

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ABSTRACT

Excision of shoot tip has been established to relieve plant of apical dominance there by encourage the growth of lateral branches. Arising from this, field experiments were carried between May and July in 2016 and 2017 cropping seasons to determine the appropriate length of shoot apex to be excised for improving growth and yield in two varieties of groundnut (SAMNUT 10 and 11). The field layout followed complete randomized block design with three replications. There were six treatments of shoot excision (0, 1, 2, 3, 4 and 5 mm). The two groundnut varieties were decapitated at different lengths at two weeks after planting (WAP) when the shoot apices were well exposed. The results showed that decapitation had a marked influence on the growth and physiological characters such as plant height, number of leaves, number of primary branches, leaf area, and above-ground dry weight when the shoot tips were excised between 3 mm and 4 mm lengths. The same treatments improved the yield components and yield with about 45% increment over the control. The study revealed that for better productivity of the two varieties of groundnut studied, shoot excision should be done between 3 mm and 4 mm from the shoot apex.

KEY WORDS: *apical dominance, decapitation, groundnut, growth, yield.*

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), known as *Asiboko* (Igbo), *Gwwada* (Hausa) and *Epa* (Yoruba). It is also known as peanut, earthnut, monkeynut and goobers. It is one of the world's most important oilseed crops (Dwivedi *et al*., 2003). It ranked the 13th most important food crop and 4th most important oilseed crop of the world (Surendranatha *et al*., 2001). The crop is cultivated in more than 100 countries in six continents (Sharma and Mathur 2006). The kernels contain 40-50% fat, 20-50% protein and 10-20% carbohydrate and rich in vitamin E, niacin, riboflavin, thiamine, falacin, calcium, phosphorus, magnesium, zinc, iron and potassium (USDA, 2010). Groundnut kernels are consumed directly as raw, roasted or boiled kernels or oil extracted from the kernel is used as culinary oil. Oil extracted from the seeds, and the haulms of groundnut are used as animal feed while the oilcakes are used as industrial raw material and fertilizer (Ayele, 2010). These multiple uses of groundnut plant makes it an excellent cash crop for domestic markets as well as for foreign trade in several developing and developed countries.

Several agronomic practices are employed to boost crop productivity. Some of these agronomic practices include weed control using herbicides, fertilizer application, hormone application, land preparation method and flower removal (Olayinka, *et al.*, 2015). The technique of removing the shoot have been variously reported to boost crop productivity. Thayamini & Krishanthy (2009) had stated that removal of shoot tip about 1 cm long at 3 weeks after planting promoted higher productivity when compared to other weeks after planting in green gram.

Increasing crop productivity required appropriate agronomic practices, literature abounds had shown that removal of shoot apex which relief the plant of apical dominance resulted in formation of many lateral branches (Kothari *et al.,* 2003; Kumar *et al*., 2014). However, excision of the shoot tip of groundnut at different lengths is scanty in literature. In this study, effort is geared towards finding appropriate length or lengths of the shoot tip that should be excised which will translate to higher productivity in terms of yield in the two varieties studied.

MATERIALS AND METHODS

Site description. The field experiments were conducted at the University of Ilorin Botanical Garden, Nigeria. The location of the study area was at longitude 4.57^0 and latitude 8.3^0. The soil of the site was loamy- sand with a pH of 6.55. The organic carbon was 0.45%. Available nitrogen was moderate (0.15%), available phosphorus was low (3.87 mg kg^{-1}). The soil was low in exchangeable magnesium and potassium with respective values 0.42cmolkg^{-1} and 0.11 cmolkg but high in calcium (4.84 cmolkg^{-1}). The Cation Exchange Capacity (2.82 cmolkg^{-1}) was low.

Experimental design and treatment details. The layout of the field followed split-plot design. The variety was assigned to the main plot and excision of the shoot tip at different lengths to the sub-plot. The plot has a gross dimension of 25.50 m by 11.50 m consisting of 72 subplots. Each sub-plot was 2.0 m by 2.0 m. Each sub-plot has four ridges with plant to plant spacing of 0.4 m. The excision of shoot in the main plots was arranged following completely randomized block design with three replications. There were six treatments of excising of shoot tip at different lengths: T_0 = No excision of shoot tip; T_1 = excision of shoot tip at 1 mm; T_2 = excision of shoot tip at 2 mm; T_3 = excision of shoot tip at 3 mm; T_4 = excision of shoot tip at 4 mm; T_5 = excision of shoot tip at 5 mm.

Pre-planting operation and procedure for excision of shoot tip. Dress force was applied at the rate of 0.5 x 10^3 mg/kg of seeds to be planted to prevent the soil borne diseases. Seeds were sown at a depth of 0.2 m at a spacing of 0.4 m so as to obtain five stands per ridge and a total of twenty plants per sub-plot. At two weeks after planting, the groundnut plants were decapitated aseptically, using a sterilised blade at the appropriate length as mentioned earlier. Plants were carefully thinned to one plant per stand while hand weeding were done at interval of two weeks to prevent weed competition so as ensure crop growth and development.

Morpho-physiological growth characters. Morphological growth parameters were recorded from each experimental unit using non-destructive approach. Plant height, stem diameter, number of leaves and primary branches, number of pegs per plant were estimated appropriately. Physiological growth such as leaf area index, leaf area (assimilatory system) and above-ground dry weight were also determined.

Reproductive characters. In each experimental unit, the time taken to achieve 50% and 100% flowering was determined. This was achieved by counting the number of days from the day half or all of the plants in each treatment produced at least one flower. At harvest, number of matured pods per plant, and the corresponding seed number and weight were determined. From the bulk harvest in each treatment, the 100-seed weight was determined. Pod and seed yields in kilogramme were estimated from the net plot size of 4 m^2. Harvest index were also determined.

Statistical analysis. Data collected were analyzed using Univariate analysis of variation under general linear model of Statistical Package for Social Science (SPSS) software version 17. In this model, variety, treatments and replicate were taken as fixed factors for the determination of the effects of varietal differences on growth and yield parameters that were assessed. The results of the two years were pooled together on account of no significant interaction. Treatment means were separated using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Growth parameters such as plant height, number of leaves, number of primary branches, and number of pegs per plant were significantly influenced by variety and decapitation at different lengths (Table 1). Excision of shoot apices from 1 to 4 mm had marked influence on these growth parameters when compared to control and decapitation at 5 mm. The effect was more pronounced when the decapitation was carried out between 3 mm and 4 mm (Table 1). Varietal means showed that SAMNUT 11 showed significantly higher plant height, number of primary branches and pegs production than SAMNUT 10. Significant difference was not recorded between the two varieties with respect to stem diameter. Leave production was significantly higher in SAMNUT 10 than SAMNUT 11 (Table 1). The interaction effects between variety and treatment were significant except for stem diameter. Removals of shoot apex between 1 mm and 4 mm slightly relieved the plants of the inhibitory influence of apical dominance not only on the outgrowth of lateral buds but further promote an increase in plant height, number of foliage and peg production. Removing the source of auxin, by decapitation of the apical bud makes possible the lateral buds to undertake the synthesis of their own auxin, leads to decrease in ABA concentration and create the suitable conditions for the outgrowth of lateral buds (Elizbieta *et al.*, 1998). Earlier studies on different plants had shown that removal of apical bud at the appropriate lenght had marked influence growth and yield of crops such as *Trigonella foenumgraecum* (Vasudevan *et al.*, 2008); in *Salvia officinalis* (Kristen,1988); in *Mentha arvensis* (Singh *et al*. 1986); in *Chrysanthemum* (Jhon *et al.*, 1995); in *Chlorophytum borivilianum* (Kothari *et al.*, 2003) and in *Stevia rebaudiana* (Kumar *et al.*, 2014).

TABLE 1: Plant height, number of leaves, number of primary branches, stem diameter and number of pegs per plant of two varieties of groundnut as influenced by decapitation of the shoot apex at different lengths

Treatment	Plant height	Number of leaves	Number of primary branches	Stem diameter (mm)	Number of pegs per plant
	-----------------	-----------------	at harvest	-----------------	
V_1	37.50±2.34^b	280.00±56.13^a	17.25±3.27^b	5.66±0.67^a	55.13±17.52^b
V_2	39.63±5.02^a	227.17±28.04^b	19.10±3.49^a	5.76±0.47^a	68.50±13.64^a
T_0	35.38±0.63^d	209.00±23.02^f	15.25±0.59^d	5.34±0.67^b	56.50±14.80^c
T_1	37.50±1.78^c	256.00±20.82^d	15.10±1.25^d	5.56±0.30^a	52.50±4.95^e
T_2	38.15±0.54^c	259.50±27.93^c	19.40±2.67^c	5.46±0.51^a	54.40±7.26^d
T_3	41.75±5.24^b	317.00±47.10^a	21.40±3.21^b	6.03±0.53^a	79.00±16.44^b
T_4	43.75±1.99^a	266.50±69.56^b	22.15±1.54^a	6.20±0.62^a	81.50±8.23^a
T_5	34.85±1.60^d	213.50±14.79^e	15.75±0.63^d	5.68±0.35^a	47.00±8.80^f
Mean	38.56±4.01	253.58±51.28	18.18±3.46	5.71±0.57	61.82±16.90
V	< 0.001	< 0.001	< 0.001	0.61	< 0.001
T	< 0.001	< 0.001	< 0.001	0.08	< 0.001
V x T	< 0.001	< 0.001	< 0.001	0.79	< 0.001

Values are presented as mean ± standard deviation. Values followed by same superscripts along a column are not significantly different ($p > 0.05$). V_1 = Samnut 10, V_2 = Samnut 11, T_0 = 0 mm (control), T_1 = 1 mm, T_2 = 2 mm, T_3 = 3 mm, T_4 = 4 mm, T_5 = 5 mm. V = Variety, T = Treatment. Number of observation (n) = 3.

The leaf area index a dimensionless unit increased with age of the crop in both varieties and treatments. It peaked at 12 WAP after planting and thereafter declined till final sampling day (15 WAP) (Table 2). Significant differences were not recorded between 6 and 9 WAP for varieties and treatments. At 12 WAP, groundnut plants that had their apical bud removed at 3 mm showed significantly higher leaf area index than other treatments and control. Leaf area index values were statistically similar when the decapitations were done at 1, 2, 4 and 5 mm. The control showed significantly lowest value of leaf area index when compared to other treatments. At 15 WAP, similar trend of results was recorded except that decapitation of the shoot apex at 2, 3 and 4 mm did not show statistical differences. These were however significantly higher when compared to decapitation at 1mm and the control (Table 2). The results of leaf area and above-ground dry weight were significantly influenced by variety and decapitation as shown in Table 2. These parameters were highest when the decapitation was done at 4mm from the apical bud and followed in decreasing order of magnitude by those at 3, 2 and 1 mm. Decapitation at 5 mm showed low leaf area and above-ground dry weight respectively. Generally, the control (no decapitation) showed the lowest value over all other treatment except for leaf area where significant difference was not recorded between the control and decapitation at 5 mm from the apical bud (Table 2). Varietal means showed that above-ground dry weight was higher in SAMNUT 11 than SAMNUT 10. The case was reversed with respect to leaf area which could be ascribed to rate of shedding of leaves which was observed to be higher in the former than latter. Generally, leaf areas were higher in SAMNUT 11 than SAMNUT 10 in all the sampling periods (Table 2). In this present investigation, the enhanced components of growth analysis such leaf area, leaf area index, above-ground tissues dry weight, are due to increase in number of leaves and maximum number of primary branches most importantly when the height of the decapitation was between 3 and 4 mm. Similar observation had observed by Olayinaka & Etejere (2015) and Olayinka *et al.* (2017) in their studies of weed control in groundnut and tomato respectively.

TABLE 2: Leaf area, leaf area index (LAI) and total dry matter accumulation of two varieties of groundnut as influenced by decapitation of the shoot apex at different lengths

Treatment	Leave area index (WAP)				Leaf area (cm^2)	Above-ground dry weight(g)
	6	9	12	15	--------- at harvest ---------	
V_1	0.68	0.91	1.21	0.94	1198.33±359.97a	35.89±5.69b
V_2	0.61	0.69	0.95	0.68	838.33±80.90b	39.05±4.49a
T_0	0.50	0.37	0.51^{b}	0.25^{b}	$810.00±120.50^{e}$	$37.00±6.04^{c}$
T_1	0.64	0.82	0.99^{ab}	0.70^{ab}	$945.00±115.02^{d}$	$31.92±1.69^{e}$
T_2	0.64	0.86	1.33^{ab}	1.05^{a}	$1000.00±164.32^{c}$	$36.75±3.05^{c}$
T_3	0.74	1.01	1.45^{a}	1.20^{a}	$1195.00±246.48^{b}$	$39.00±4.42^{b}$
T_4	0.79	1.01	1.33^{ab}	1.08^{a}	$1350.00±547.72^{a}$	$44.90±3.41^{a}$
T_5	0.58	0.73	0.86^{ab}	0.59^{ab}	$810.00±10.96^{e}$	$35.25±2.02^{d}$
Mean	0.65	0.80	1.08	0.81	1018.33±315.35	37.47±5.30
V	0.68	0.22	0.25	0.12	< 0.001	< 0.001
T	0.94	0.32	0.01	0.02	< 0.001	< 0.001
V x T	1.00	0.92	0.61	0.21	< 0.001	< 0.001

Values are presented as mean ± standard deviation. Values followed by same superscripts along a column are not significantly different ($p > 0.05$). TDMA = Total dry matter accumulation, WAP = Weeks after planting. V_1 = Samnut 10, V_2 = Samnut 11, T_0 = 0 mm (control), T_1 = 1 mm, T_2 = 2 mm, T_3 = 3 mm, T_4 = 4 mm, T_5 = 5 mm. V = Variety, T = Treatment. Number of observation (n) = 3.

The number of days to achieved 50% and 100% flowering were only influenced significantly by the decapitation treatments in both varieties (Table 3). Groundnut whose shoot tips were decapitated between 3 mm and 4 mm had their days to 50% flowering four days earlier (28 days) than the control (32 days). Generally, decapitation favoured early flowering as shown in Table 3. The results of 100% flowering followed similar trend as recorded for 50% flowering except that groundnut receiving decapitation at 1 mm and the control had their 100% flowering at 51 days after planting when compared to other treatments which ranged from 48 to 50 days after planting (Table 3). Number of matured pods per plant, pod weight per plant and number of seeds per seed weight per plant and 100-seed weight plants were statistically influenced by the decapitation treatments. The shoot excisions done between 3 mm and 4 mm increased significantly the above mentioned yield components when compared to the control and shoot excisions between 1 mm and 2 mm (Tables 3-4). Varietal means showed no significant effect on yield components as shown in Tables 3 and 4. The results of pod and seed yield and harvest index were significantly influenced ($p<0.05$) by variety and treatments. Decapitation of shoot tips at 2, 3, 4 and 5 mm increased pod yield by 1.2%, 26%, 45% and 2.6% respectively over the control (0%). Seed yield showed marked increase when the decapitations were done at 3, 4 and 5 mm with percent increase of 20.5, 45.7and 9.4 respectively when compared with control (0%). Generally, shoot tips excisions from 1-2 mm did not favoured yield increase in both varieties. Harvest index which is the economic yield over biological yield increased with increase in seed yield as shown in Table 5.

TABLE 3: Days to 50% flowering, 100% flowering, number of matured pods per plant, pod weight per plant and number of seeds per plant of two varieties of groundnut as influenced by decapitation of the shoot apex at different lengths

Treatment	Days to 50% flowering	Days to 100% flowering	No. of matured pods per plant	Pod weight per plant (g)	No. of seeds per plant
V_1	30.56±1.36^a	49.90±1.32^a	27.17±3.39^a	27.52±3.59^a	46.33±8.26^a
V_2	30.22±1.92^a	50.34±1.56^a	28.17±2.89^a	28.34±2.76^a	46.84±6.55^a
T_0	32.00±0.64a	51.04±1.17^{ab}	27.00±0.96^c	27.02±0.98^c	44.00±1.36^c
T_1	31.84±0.51ab	51.67±0.76^a	24.17±0.76^d	24.40±0.44^d	40.84±1.35^d
T_2	30.67±0.78b	50.67±0.65^{bc}	26.50±1.10^c	26.90±0.92^c	43.84±3.50^c
T_3	28.17±1.38c	48.34±0.39^d	29.83±3.85^b	29.55±3.72^b	49.67±9.16^b
T_4	28.84±0.49c	48.84±1.01^d	31.50±2.77^a	32.12±3.18^a	57.67±6.61^a
T_5	30.84±0.93b	50.17±0.96^c	27.00±1.86^c	27.61±1.88^c	43.50±2.81^c
Mean	30.39±1.65	50.12±1.44	27.67±3.15	27.93±3.19	46.58±7.35
V	0.074	0.052	0.052	0.001	0.057
T	< 0.001	0.000	< 0.001	< 0.001	< 0.001
V x T	< 0.001	0.002	< 0.001	< 0.001	< 0.001

Values are presented as mean ± standard deviation. Values followed by same superscripts along a column are not significantly different ($p > 0.05$). V_1 = Samnut 10, V_2 = Samnut 11, T_0 = 0 mm (control), T_1 = 1 mm, T_2 = 2 mm, T_3 = 3 mm, T_4 = 4 mm, T_5 = 5 mm. V = Variety, T = Treatment. Number of observation (n) = 3.

TABLE 4: Seed weight per plant and 100-seed weight of two groundnut varieties as influenced by decapitation of the shoot apex at different lengths

Treatment	Seed weight per plant	100-seed weight
V_1	14.84±2.69a	42.02±1.64^a
V_2	14.65±2.33a	41.04±2.30^b
T_0	14.32±0.36^c	40.85±0.82^{bc}
T_1	13.73±0.78^d	40.15±0.93^{cd}
T_2	13.57±0.56^d	39.61±1.64^d
T_3	15.98±3.11^b	43.85±1.64^a
T_4	17.97±2.85^a	43.09±1.33^a
T_5	12.92±1.66^e	41.65±1.85^b
Mean	14.75±2.48	41.53±2.03
V	0.263	0.312
T	< 0.001	< 0.001
V x T	< 0.001	< 0.001

Values are presented as mean ± standard deviation. Values followed by same superscripts along a column are not significantly different ($p > 0.05$). V_1 = Samnut 10, V_2 = Samnut 11, T_0 = 0 mm (control), T_1 = 1 mm, T_2 = 2 mm, T_3 = 3 mm, T_4 = 4 mm, T_5 = 5 mm. V = Variety, T = Treatment.

TABLE 5: Pod yield per hectare, seed yield per hectare and harvest index of two varieties of groundnut as influenced by decapitation of the shoot apex at different lengths

Treatment	Pod yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Harvest index
V_1	1527.42 ± 472.66	1371.39±447.65	0.43±0.53
V_2	1983.73±546.15	1658.21±493.08	0.42±0.51
T_0	1655.63±31.05^{e}	1476.75±13.51^{d}	0.41±0.32
T_1	1014.51±37.88^{f}	899.20±0.86^{f}	0.43±0.56
T_2	1674.76±552.81^{d}	1165.96±170.06^{e}	0.39±0.65
T_3	2086.75±686.84^{b}	1779.84±587.92^{b}	0.43±0.48
T_4	2402.47±35.11^{a}	2151.76±95.19^{a}	0.42±0.25
T_5	1699.34±226.11^{c}	1615.32±293.95^{c}	0.40±0.85
Mean	1755.58±554.01	1514.80±486.39	0.43±0.51
V	< 0.001	< 0.001	0.949
T	< 0.001	< 0.001	0.978
V x T	< 0.001	< 0.001	0.998

Values are presented as mean ± standard deviation. Values followed by same superscripts along a column are not significantly different ($p > 0.05$). V_1 = Samnut 10, V_2 = Samnut 11, T_0 = 0 mm (control), T_1 = 1 mm, T_2 = 2 mm, T_3 = 3 mm, T_4 = 4 mm, T_5 = 5 mm. V = Variety, T = Treatment. Number of observation (n) = 3.

It suffices to mention at this point that time taking to achieve 50% flowering and 100% flowering was achieved earlier when the decapitation height was between 3 mm and 4 mm compared with the control. The earlier flowering coupled with higher number of primary branches increased the peg production which in turn translated to significant increase in yield components and yield in the two varieties studied. With the improved cultural practice such as decapitation, the present study had shown that yield can be significantly improved if the lower axillary buds where the bulk of pegs are produced are released from the apical dominance. The resultant effect is increase in pegs production most importantly from lower branching and further reduction of the distance the pegs had to travel for successful penetration. Proximity of pegs to soil when methods of land preparations are modified had been established to increase yield in groundnut (Olayinka, *et al*., 2015). Similarly, removal of apical dominance by decapitation has been shown to have significant effects on yield in many crops like in *Mentha arvensis* (Singh *et al*., 1986); in *Salvia officinalis* (Kristen,1988); in *Chrysanthemum* (Jhon *et al.,* 1995); in *Chlorophytum borivilianum* (Kothari *et al.,* 2003); *Trigonella foenumgraecum* (Vasudevan *et al.,* 2008); in *Stevia rebaudiana* (Kumar *et al*., 2014) and in *Swertia chirayita* (Pancy *et al*., 2018). The results of harvest index did not show statistical significant difference between the decapitation and the control. This implies that that relieving the groundnut from apical dominance did not reduce the economic yield it rather enhances it. Evident in support of the foregoing statement is traceable to yield components such as number of pods per plant, number of seeds per plant, 100-seed weight which were significantly higher where the decapitations were carried between 3 mm and 4 mm from the apical bud. Olayinka *et al*. (2015) had shown that yield increase in groundnut is closely correlated with the increase in yield components.

CONCLUSIONS

The results of this study had shown that decapitation practice done between 3 mm and 4 mm may slightly improve the yield in the two varieties of groundnut studied. Studies on decapitation in groundnut appears scanty in literature and this report could be considered as first information on the slight existence of apical dominance in groundnut and how the crop could be relieved from the effect.

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