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Effect of Decapitation on the Growth and Yield of Pepper (*Capsicum annuum l.)* in Obio Akpa, Akwa Ibom State

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Abstract

A screen house study was conducted at the Akwa Ibom State University Obio Akpa Campus Teaching and Research Farm, between the month of November -April 2022, to determine the effect of decapitation on the growth and yield of chili pepper (Capsicum annum L.). The experiment was laid out in a completely randomized design and replicated three times. The treatments were different times of decapitation (10, 20, 30, and 40 days) after transplanting (DAT) and a control (no decapitation). Data collected were plant height (cm), leaf area (cm^2), number of branches, stem girth (cm), number of fruits, fruit circumference (cm), fruit length (cm) and fruit yield (t/ha). Results showed significant differences in plant height, number of branches per plant, and fresh fruit yield. Pepper decapitated at 10 DAT gave the highest yield (19.24 t/ha), while the least fresh fruit yield was recorded at 40 DAT (10.72 t/ha). The result of this study indicates that decapitation at 10 DAT may increase the pepper fruit yield in the Obio Akpa farming community.

Key words: Chili pepper, Decapitation, Growth, Yield, Obio Akpa, Akwa Ibom State.

1. Introduction

Pepper (*Capsicum annuum* L.) is among the top economically valuable vegetable crops. Pepper originated from Mexico in the Central America regions. It is one of the most widely used vegetables in the world, belonging to the Solanaceae family (Wien, 1997). The genus capsicum contains 30 species of pepper some of which include Tabasco pepper (*Capsicum frutescens*), Habańero pepper (*Capsicum chinense*), Cayenne pepper (*Capsicum annuum*), Rocoto pepper (*Capsicum pubescens*) and Thai pepper (*Capsicum frutescens*) (Grubben & Mohamed, 2004)

According to Matloub et al. (1989) peppers are usually classified as sweet or hot pepper; these two types have many cultivars, which vary by fruit shape, flavor, pungency, and color. It can be used in diverse forms, such as culinary, pickling, grinding, roasting, drying, and freezing (ISU, 2009). Aregheore (2009) explained that Nigeria was reported to produce over 720,000 tonnes from 90,000 ha in 2004. Nigeria is the largest producer of pepper among the sub-Saharan African Countries; pepper is both an annual and perennial crop that completes its life cycle within one year and has a regenerating ability (Ikeh et al., 2012). It grows up to a height of 1.5m with several branches. It has a relatively extensive root system including a tap root which varies depending on available moisture and variety (IIRR, 1993). Pepper is an important annual cash crop, that most countries grow for its pungent fruits. Pepper also has a lot of economic, health and medicinal uses in humans it works internally as a stimulant and a carminative and externally as a counter-irritant (Grubben & Tahir, 2004). It is equally good as an additive in poultry bird feed formulation. In Akwa Ibom State pepper is cultivated in an open field or in a screen house.

Decapitation or de-troping (beheading or pinching) is viewed as the removal of the apex of a crop and has been widely studied in vegetables (Firoz et al., 2010; Mollah et al., 2015; Borelli, 2013; Patil et al., 2012; Thayamini & Seran, 2009). Apical dominance (the removal of apical buds) by decapitation or pruning encourages lateral bud growth (Pessarakli & Dris, 2003); proper pruning practices lead to the increase in the production of more fruit and a relatively large size fruit with better quality (Tinni et al., 2014).

Decapitation is an ethnic-agriculture practice, often carried out by farmers to increase the yield potentials of many crops (Medani & Taha, 2015). Decapitation has many advantages in vegetables decapitation increases branching components, inflorescence number and yield (Argall & Stewart, 1984; Islam & Igba, 1992). A study on legume plants revealed that apex removal before flowering increased vegetative growth (Islam & Igba, 1992), delayed leaf and nodule senescence and encouraged accumulation of nitrogen in shoots (Gautam et al., 1993). Brooker et al. (2003), also noted that removing the apical bud, lowers the concentration of auxin hormones, therefore allowing the lateral buds to grow and produce new shoots

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Decapitation causes more rapid growth of all the branches below the cut, producing more flowers and, ultimately more fruits (Borreli, 2013; Singh et al., 2011). Due to the high demand for pepper in Akwa Ibom State, many people now engage in its cultivation. Presently, its production is far below its demand, and this lopsided relationship between demand and supply emphasizes the need to investigate and subsequently develop strategies that can enhance pepper production. There is insufficient literature on the study of the of decapitation on pepper production in this region. Therefore, this study aimed to investigate the effects of different timing of decapitation on the growth and yield of pepper.

2.0 Materials and Methods

2.1 Experimental Site, Design and Treatment

The study was carried out in the 2021 and 2022 cropping seasons at the Akwa Ibom State University Teaching and Research Screen House at the Obio Akpa Campus. The area lies within south-eastern Nigeria's humid tropical rainforest zone and has a mean temperature of 27^{o}C (Peters et al., 1989; Enwezor et al., 1989; SLUS - AK, 1989). Oruk Anam has a relative humidity of 88%, wind speed (m/s) of 0.4, and evaporation rate `of 2.3cm. The experiment was laid out in a completely randomized design and replicated three times. The treatments were different times of decapitation (10, 20, 30 and 40 days after transplanting, DAT) and a control (no decapitation).

2.2 Soil Sampling and Analysis

Soil samples were obtained, dried, crushed, and sieved through a 2.0 mm mesh and taken for laboratory analysis. Soil pH was determined by using a pH meter with glass electrode. Total nitrogen was obtained by the macro kjeldahl digestion methods while available phosphorus was determined by using the Bray p-1 method (Udo et al., 2009). Exchangeable bases were extracted using IM NH_4OAc solution (Grossman & Reinseh, 2002), the concentration of Na and K were determined using flame analyzer. The contents of Ca and Mg were determined using EDTA titration, exchangeable acidity was determined by extractions with KCL solution. The total acidity from the exchangeable hydrogen and aluminium were determined by titration as described by Udo et al. (2009). Effective cation exchange capacity (ECEC) was obtained by the summation of exchangeable acidity (TEB) and exchangeable acidity (TEA) (Udo *et al.*, 2009), as follows:

$$ECEC = (Ca + Mg + Na + K) + (Al + H) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. Equation\ 1$$

Base saturation was calculated as follows:

$$BS = \frac{Ca + Mg + Na + K}{ECEC} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. Equation\ 2$$

Where:

ECEC = Effective cation exchange capacity
Bs = Base saturation (%)
Ca = Calcium
Mg =Magnessium
Na = Sodium
K = Potassium

Electrical conductivity was measured in the extract from soil water suspension using a conductivity bridge and particle size distribution was determined with a dispersing agent using the Bouyoucos hydrometer method (Gee & Or, 2002; Udo et al. 2009). Soil texture class was determined using the textural triangle.

2.3 Agronomic Practices

2.3.1 Nursery Management, Transplanting, and Trellising of Pepper

The loamy rich soil was treated using the rough sterilization method by heating the soil for 2 hours and allowing to cool for 1 day before planting to kill any soil-borne pathogens. In addition, chlorine was added to the source of the drip irrigation system to purify the water. The perforated black cellophane bags were used in filling the already treated soil; this served as a prepared seed bed for the cultivation of pepper. Efia F1 pepper varieties produced by the East-West Seed Breeding Company were used in the experiment.

The pepper seeds were sown in a nursery tray. The seeds emerged after one week of sowing. The seedlings were well managed by regular watering until they attained the age of 45 days before they were transplanted to the screen house in the evening hours to aid the seedlings to adjust for a longer time during the night (cooler temperature). The screen house was cleaned, and debris from former plants' stumps were removed before planting. One week prior to transplanting, the pepper plants were hardened up by exposing them to sunlight for 2 – 6 hours progressively. Trellising was done after 14 days of transplanting. This was done to provide support to the plant by driving a wooden stake next to the plant for every 4 feet (1.2 m) per row. The main stem and branches of the plants were tied loosely to a stake (using torn sheets and jute ropes) and raised to the roof of the screen house.

2.3.2 Irrigation, Weeding, Fertilizer Application, and Decapitation

Drip irrigation was used through drip lines that supply water directly to the root zone of the plant in a uniform manner at least once a day, especially when the soil was dry. Weeding was done manually at 2, 6, and 8 WAT. Poultry droppings were applied into the perforated black cellophane bags in the screen house at the rate of 20g per hole in each of the bags two weeks before transplanting. The terminal bud (3cm) of the pepper plants to be decapitated was cut off from the plant top, using a pair of secateurs at 2, 4, 6 and 8 WAP intervals while the control plants were not decapitated.

2.4 Yield and Yield Components

Fruits harvested were counted per plant. Fruit circumference (cm) was determined by placing a tape around the middle portion of the fruit using measuring tape and the circumference recorded. Fruit length (cm) was determined by placing a meter rule at the proximal to the distant ends of the fruit and the length was recorded. Fresh fruit yield was determined by weighing the fruit on a plot using a P1203 Mettler Toledo electronic weighing balance (grams).

2.5 Data Collection and Analysis

Five plants were randomly selected, tagged, and used for data collection. Data collected were plant height (cm), leaf area (cm^2), number of branches at 2, 4, 6, and 8 weeks after transplanting (WAT), stem girth (cm) at 2, 4 and 6 WAT, and cumulative fruit yield (g) (Brown et al., 1967). Plant height was measured using a measuring tape at 2, 4, 6 and 8 weeks after transplanting (WAT). Number of branches were carefully counted on each plant. Leaf area (cm^2) was determined using a correction factor (Salaus et al., 2008; Singh et al., 2011) as follows.

$$LA = 64 \times LW \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation\ 3$$

Where:

L=length of the leaf
W-width of the leaf

Stem girth was determined by wrapping a measuring tape around, and in the plane perpendicular to the axis of the plant trunk. Harvesting of the pepper was done after the fruit attended its physiological maturity stage from 8 weeks after transplanting. Pepper fruits were handpicked into a basket. Data generated were subjected to analysis of variance and means were compared using the Fischer's least significant difference at 5% probability level (Gomez & Gomez, 1984).

3.0 Results and Discussion

3.1 Soil Physico-chemical Properties

The result of soil physico-chemical properties are presented in Table 3.1. Results showed that the soil was loamy sand in texture. The soil was acidic, with a pH value of 5.50 and 5.60, at a soil depth of 0-15 and 15-30 cm, respectively. The soil had an electrical conductivity of 0.072 dsm^{-1} and 0.053 dsm^{-1}. Organic matter recorded values of 1.02 and 0.98%, while total nitrogen recorded values of 0.07 and 0.05% with 0-15 cm and 15-30 cm depth, respectively. Available phosphorus recorded values of 44.33 mg/kg and 46.70 mg/kg with 0-15 cm and 15-30 cm. This values were below the critical value of 50.0 mg/kg reported by (FAO, 2014). Ca had values of 2.55 and 2.01 cmol kg^{-1}, Mg had values of 1.6 and 1.5 cmol kg^{-1}, Na had values of 0.05 and 0.06 cmol kg^{-1}, K had values of 0.11 and 0.12 cmol kg^{-1}, while exchangeable acidity had values of 2.60 and 4.95 cmol kg^{-1} in 0-15 and 15-30 cm depth, respectively. ECEC recorded values of 7.13 and 10.05 cmol kg^{-1}, base saturation of 65.70 and 51.70% in 0-15 and 15-30 cm depth, respectively. From all indications, the soil was low in soil fertility and required the application of fertilizer to improve its fertility status.

3.2 Plant Height as Influenced by Time of Decapitation of Pepper

Plant height varied significantly at 2, 4, 6, and 8 WAT (Table 3.2). At 2 WAT, the plant decapitated at 10 DAT was the shortest plant (14.32 cm) At the same time, the control had a (25.60 cm) plant height and was not statistically different ($P > 0.05$) when compared to plant heights recorded in decapitation at 40 DAT (24.80 cm). At 4 WAT, the result showed a significant difference when plant heights recorded in the control, 30, and 40 DAT were compared with plant height recorded in treatment of 20 DAT (23.16 cm). At 6 WAT, control, 40, and 10 DAT were the tallest plants (64.40, 64.11 and 41.25 cm), while the shortest plants were recorded with 30 and 20 DAT (39.06 and 36.15 cm). At 8 WAT, control had the tallest plant (68.75 cm) , while shortest plant (45.62 cm) was recorded at 30 DAT decapitation.

3.3 Number of Branches Per Plant as Influenced by Time of Pepper Decapitation

A number of branches per plant as influenced by the time of pepper decapitation is shown in Table (3.3). The result showed significant differences at 4, 6 and 8 WAT. Pepper decapitated at 10 DAT had the highest number of branches (4.30, 8.14, and 16.40) at 4, 6, and 8 WAT, respectively, at LSD ($P < 0.05$). Pepper decapitated at 30 WAT produced approximately 5 and 11 branches at 6 and 8 WAT, respectively. The least number of branches per plant was recorded at 6 WAT (4.10) and 8 WAT (8.87)

3.4 Leaf Area of Pepper as Influenced by Time of Decapitation

The leaf area of pepper as influenced by the time of decapitation, shown in Table 3.4. The result showed no significant difference in leaf area at 2, 4, 6, and 8 WAT (Table 3.4). The leaf area recorded at 2, 4, 6, and 8 WAT ranged from 18.69 to $34.5cm^2$ across treatments. Treatments of 10 and 20 DAT appeared to produce the largest leaf area at all times of measurements. Treatment of 10 DAT at 2, 4, 6 and 8 WAT, recorded 20.30, 31.50, 34.20 and $34.11cm^2$ respectively.

Table 3.1: Physico-chemical properties of the soil before planting

Soil properties	Soil depth (cm)	
	0-15	**15-30**
Sand %	76.5	78.00
Silt (%)	9.30	7.80
Clay (%)	14.20	14.20
Textural class	Loamy sand	Loamy sand
pH (H_20)	5.50	5.60
EC (dsm^{-1})	0.072	0.053
Organic matter (%)	1.02	0.98
Total nitrogen (%)	0.07	0.05
Available phosphorus (mg kg^{1})	44.33	46.70
Exchangeable Ca ($cmolkg^{-1}$)	2.55	2.01
Exchangeable Mg ($cmolkg^{-1}$)	1.6	1.5
Exchangeable Na ($cmolkg^{-1}$)	0.05	0.06
Exchangeable K ($cmolkg^{-1}$)	0.11	0.12
Exchangeable Acidity ($cmolkg^{-1}$)	2.60	4.95
ECEC ($cmolkg^{-1}$)	7.13	10.05
Base saturation ($cmolkg^{-1}$)	65.7	51.70

Table 3.2: Plant height (cm) as influenced by time of decapitation of pepper

	Weeks after transplanting			
Treatment	**2**	**4**	**6**	**8**
Control	25.60	33.91	64.40	68.95
10 DAT	14.32	26.52	41.25	56.01
20 DAT	24.70	23.16	39.06	50.33
30 DAT	25.01	40.30	36.15	45.62
40 DAT	24.80	40.22	64.11	60.13
LSD (P<0.05)	3.11	4.09	4.22	4.50

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Table 3.3: Number of branches per plant as influenced by time of pepper decapitation

	Weeks after transplanting			
Treatment	**2**	**4**	**6**	**8**
Control	0.00	1.21	4.40	9.02
10 DAT	0.00	4.30	8.14	16.40
20 DAT	0.00	1.05	5.22	12.77
30 DAT	0.00	1.22	4.50	10.59
40 DAT	0.00	1.09	4.10	8.87
LSD (P<0.05)	NA	1.05	2.10	2.51

NS = Not available (no branches were produced at 2 WAT)

Table 3.4: Leaf Area (cm^2) of pepper as influenced by time of decapitation

	Weeks after transplanting			
Treatment	**2**	**4**	**6**	**8**
Control	18.69	30.90	33.80	32.16
10 DAT	20.30	31.50	34.20	34.11
20 DAT	21.01	32.11	34.51	33.10
30 DAT	19.84	30.44	33.40	32.12
40 DAT	20.80	31.70	33.15	32.59
LSD (P<0.05)	NS	NS	NS	NS

NS = Not significant

3.5 Stem Girth

Stem girth as influenced by the time of decapitation of pepper is presented in Table 4.5. The result showed no significant differences ($P < 0.05$) between treatments. The stem girth in control at 2, 4, 6, and 8 WAT recorded values of 0.91, 1.32, 1.39, and 1.64 cm, respectively. The stem girth in 10 DAT decapitation at 2, 4, 6, and 8 WAT recorded values of 0.9, 1.51,1.53, and 1.75 cm, respectively. Stem girth recorded in the treatment of 40 DAT decapitation at 2, 4, 6, and 8 WAT were 0.90, 1.41, 1.47, and 1.72 cm^2, respectively.

3.6 Yield and Yield Components of Pepper

The number of fruits per plant, fruit circumference (cm), fruit length (cm), and fruit yield as influenced by the time of decapitation of pepper is shown in Table 3.6. Results showed that the number of fruits per plant was observed to be higher in 10 DAT (41.30) of decapitation, followed by the number fruits per plant recorded in 20 DAT (34.45). While the least number of fruit were recorded in 40 DAT decapitation. Fruit circumference as influenced by time of decapitation, shown in Table 3.6, revealed that there were no significant differences ($p > 0.05$) between treatments. Fruit circumference was between 3.-3.9 cm across treatments. Results for fruit length revealed that there were no significant differences ($p > 0.\ 05$) between treatments. Fruit length ranged from 5.75 cm (in the 40 DAT) to 6.25 cm (in the control). Fresh fruit yield, between decapitation treatments differed significantly ($p > 0.05$) (Table 3.6). Treatment of 10 DAT decapitation produced a significantly higher fresh fruit yield (19.24 t/ha) followed by the treatment of 20 DAT decapitation (15.73 t/ha). Fresh fruit yield recorded in the control (12.30 t/ha) and 40 DAT (10.72 t/ha) were the lowest.

Table 3.5: Stem girth (cm) as influenced by decapitation

	Weeks after transplanting			
Treatment	**2**	**4**	**6**	**8**
Control	0.91	1.36	1.39	1.64
10 DAT	0.90	1.51	1.53	1.75
20 DAT	0.91	1.42	1.49	1.74
30 DAT	0.93	1.43	1.48	1.70
40 DAT	0.90	1.41	1.47	1.72
LSD (P<0.05)	NS	NS	NS	NS

NS = Not significant

Table 3.6: Yield and yield components of pepper influenced by time of decapitation (weeks after transplanting)

Treatment	No of fruits/plant	Fruit circumference (cm)	Fruit length (cm)	Fresh fruit yield (t/ha)
Control	25.60	3.98	6.25	12.30
10 DAT	41.30	3.11	5.86	19.24
20 DAT	34.45	3.19	5.90	15.73
30 DAT	30.30	3.10	5.81	13.80
40 DAT	23.11	3.08	5.75	10.72
LSD (P<0.05)	4.07	NS	NS	2.81

NS = Not Significant

3.7 Discussion

Results from this study showed that decapitation influenced chili pepper growth and yield. Early decapitation produced significantly higher number of branches per plant and fruit yield despite the low soil nutrient and organic matter content at the 0-15 and 15-30 cm soil depth. The increased yield in the early decapitation could be attributed to more lateral buds in the decapitated plants compared to the control. The result agreed with the finding of Salaus et al. (2008) that apical debugging and branch pruning was the most important contributor to higher yield of fruits. Kabir (2014) reported that apical bud pinching or nipping is a well-known practice of breaking apical dominance that encourages lateral growth, thereby increasing the potential of the fruiting area. Early decapitation increased yield compared to delayed decapitation, this was in line with report by Williams (1997), that pruning tomato plants during the early stages of growth produced significantly higher fruit yield than late pruning; the low yield recorded in late pruning was attributed to stock during flower initiation or heading.

In soybean, removing the apex during the early flowering stage increased yield by 10-15 % according to Andrea et al. (2006). In groundnut, the number of seed sets per plant was increased by 24% when the apical dominant shoot of the plant was removed (Andrea et al., 2006). Brown et al. (1967), who studied the effect of ethno-agricultural practice on the production of marketable fresh fruits and seed production for 12 okra cultivars under two cropping seasons also reported that decapitation affected the yield of okra.

Similar findings was also reported with fluted pumpkin in a tillage trial. Idowu (2017) studied the effect of tillage practices and decapitation methods on the fluted pumpkin (*Telfairia occidentalis*) grown in an inland swamp land in the dry season. The report revealed that decapitation techniques and tillage practices adopted in the study affected biomass re-growth and the development of fluted pumpkin (*Telfairia occidentalis*).

4. Conclusion

Based on the findings of this study, the following conclusions were drawn: that decapitation at 10 DAT produced a significantly higher number of branches, number of fresh fruit, and fresh fruit yield. Delayed decapitation until 40 DAT had the least number of fruits per plant and fresh fruit yield. Therefore, early decapitation on pepper will initiate a higher fruit yield. Based on the research findings, pepper farmers should be encouraged to decapitate pepper plants at 10 DAT for higher fresh fruit yield.

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