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Growth, Fruiting, Yield and Nutritional Content of Okra Plant (*Abelmoschus Esculentus* (L.) Moench) as Influenced by Turmeric (*Curcuma Longa*) Extracts Spray

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Abstract: *The study was carried out to evaluate the effect of turmeric extract on growth and fruiting of Okra plant (Abelmoschus esculentum) at the teaching and Research Farm of Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri. The experiments were carried out in Randomized Complete Block Design. The treatments were aqueous and ethanol turmeric extract at different levels of concentration (0, 1%, 2% and 3%) replicated 3 times. The statistical result of the study indicated that aqueous turmeric extract improved the plant height, number leaf, stem girth, leaf area, and leaf area index than ethanol turmeric extract. The root and shoot dry weights were consistently improved by application of aqueous turmeric extract than ethanol extract. Analysis of nutritional status revealed that there was significant (P<0.05) improvement in reduction of moisture content of Okra pod, improvement in protein, calcium, fibre, Ash and fat content by turmeric extract application. T_3 (2%) from aqueous and ethanol extract significantly (P<0.05) produced higher yields (385.60kg/ha and 390.733kg/ha). These results thus showed that turmeric extract application of 200ml provided the better yield and nutritional status of Okra Crop.*

Keywords: *Growth, Fruiting, Okra Plant, Turmeric extract.*

INTRODUCTION

Okra (*Abelmoschus* esculentus), is a herbaceous annual plant in the family Malvaeceae which is grown for its edible seed pods. Okra plants have small erect stems that can be bristly or hairless with heart-shaped leaves. The leaves are 10–20 cm (4–8 in) long with 5–7 lobes. The plant produces flowers with five white to yellow petals which are 4–8 cm (1.6–3.1 in) in diameter. The seed pod is a capsule up to 25 cm (10 in) long, containing numerous seeds. Okra can grow 1.2–1.8 m (4–6 ft) tall and as an annual plant, survives only one growing season. Okra may also be referred to as lady's fingers and is believed to have originated in Ethiopia (Westerfield, 2008).

Okra contains proteins, carbohydrates and vitamin-C (Owolarafe & Shotonde, 2004; Gopalan *et al*., 2007; Arapitsas 2008; Dilruba *et al*., 2009), and plays a vital role in human diet (Kahlon *et al*., 2007; Saifullah & Rabbani, 2009). Consumption of young immature okra pods is important as fresh fruits, and it can be consumed in different forms (Ndunguru & Rajabu, 2004). Fruits can be boiled, fried or cooked (Akintoye *et al*., 2011).

The composition of okra pods per 100 g edible portion (81% of the product as purchased, ends trimmed) is: water 88.6 g, energy 144.00 kJ (36 kcal), protein 2.10 g, carbohydrate 8.20 g, fat 0.20 g, fibre 1.70 g, Ca 84.00 mg, P 90.00 mg, Fe 1.20 mg, ß-carotene 185.00 µg, riboflavin 0.08 mg, thiamin 0.04 mg, niacin 0.60 mg, ascorbic acid 47.00 mg (Gopalan *et al*., 2007). The composition of okra leaves per 100 g edible portion is: water 81.50 g, energy 235.00 kJ (56.00 kcal), protein 4.40 g, fat 0.60 g, carbohydrate 11.30 g, fibre 2.10 g, Ca 532.00 mg, P 70.00 mg, Fe 0.70 mg, ascorbic acid 59.00 mg, ß-carotene 385.00 µg, thiamin 0.25 mg, riboflavin 2.80 mg, niacin 0.20 mg (Varmudy, 2011). Carbohydrates are mainly present in the form of mucilage (Liu *et al*. 2005; Kumar *et al*., 2009).

Okra leaves are considered good cattle feed, but this is seldom compatible with the primary use of the plant. The leaf buds and flowers are also edible (Doijode, 2001). Moreover, okra mucilage is suitable for industrial and medicinal applications (Akinyele & Temikotan, 2007). Industrially, okra mucilage

is usually used for glace paper production and also has a confectionery use. Okra has found medical application as a plasma replacement or blood volume expander (Lengsfeld *et al*., 2004; Adetuyi *et al*., 2008; Kumar *et al*., 2010).

Yield decline is suggested to be a major problem that faces Okra growers in rain forest conditions. The main causes for poor yields are the great reduction of flowers and fruits retained on the plant as well as the great dropping of flower and fruitlets, unbalanced or malnutrition as well as unsuitable environmental conditions. Supplying the plant with their requirements from organic and mineral nutrients as well as using compounds increased the tolerance of trees to stresses is very beneficial for overcoming the yield reduction (Onuoha *et al*., 2013).

Since ancient times, plant extracts were used in many ways. Recently, public health and environmental safety concerns encouraged the use of these natural products as a complete replacement of chemicals for improving growth, nutritional status of plant. Their positive action on controlling pests is very essential. The content of natural extracts such as phenolic compounds, nutrients, plant pigments and other chemical constituents seem to have synergistic effects on growth and mortality of most fungus. Out of the important plant extracts are turmeric (Okigbo and Emoghene, 2003).

Turmeric, (*Curcuma longa* L.) is a herbaceous perennial plant belonging to the *Zingiberaceous* family. Curcuma genus contains about 30 species. It originated from India and South East Asia and cultivated in the majority of tropical countries. It is obtained from the rhizome of *Curcuma longa*. It contains 2 to 9% curcuminiods which contains 60% curcumin, desmethoxycurcumin, monodemethoxycurcumin, bisdemethoxycurcumin, dihydrocurcumin and cyclocurcumin. Cucumins oxidation yield vanillin. Tumeric extract is rich in carbohydrates, (50 % starch), arabinogalacton, potassium salt, essential oils and pigments. It is known for its anti- inflammatory, anti- oxidant and anti- microbial properties. Curcumin has a free radical scavenger activity namely hydroxyl radical that is responsible to protect DNA from damage and inhibit lipid peroxidation (Alonso, 2004).

This study is initiated to examine the effect of turmeric extracts on growth and fruiting of okra.

MATERIALS AND METHODS

Location

This study was conducted in the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri. Owerri lies between the latitudes $5^{o}10'$N and $6^{o}0'$N and longitudes $6^{o}35'$E and $7^{o}0'$E with an altitude of 91.0m within the Southeast rain forest agricultural zone of Nigeria. The area maintains an average annual rainfall of 2,500 mm, mean minimum and maximum temperature of 23.5^{o}C and 32.1^{o}C respectively, with relative humidity ranging from 70-85% and the annual evapo transpiration is 1450 mm (NIMET, 2010).

Source of Materials

Materials to be used in this study were collected from Imo State University Teaching and Research Farm, while reagents to be used for extraction was also be purchased from the local market Okra seeds was sourced from NIHORT Okigwe. Other materials include, a piece of land measuring 15 m x 18 m, turmeric rhizomes, blender, weighing scale.

Preparation of Turmeric Extract

Dried turmeric was kept in a plastic zip bag at room temperature before extraction.

1. Cold solvent extraction method or maceration method (Vudhivanich & Supanuntorn, 2005).Two extracts were used in this method.

A. Extraction with ethanol- Firstly, 300g of dried turmeric was soaked in 600ml ethanol, the mixtures was then filtered using a white handkerchief or a filter paper. Finally 1L of distilled water was added to the filtrate to dilute the extract in order to obtain the different concentration which was collected and kept in a bottle at 4°C until use.

B. Extraction with water- 300g of dried turmeric was soaked in 600ml water, the mixtures was then filtered with a handkerchief or filter paper. Then 1L of distilled water was added to the filtrate to dilute the extract in order to obtain the different concentration which was collected and kept in a bottle at 4°C until use.

Experimental Design

The experiment was laid out in a Randomized Complete Block Design in a split plot fashion. The extraction methods formed the main plots while the rate/concentration of application (1%, 2% and 3%) constitutes the subplots. The setup was replicated three times.

Agronomic Practices and Treatment Application

The experimental plot was cleared and low beds was made for planting. The okra seeds were planted at a depth of 2-3 cm with spacing of 45 cm X 50cm. The rate of seed sowing was two seeds per stand. This was later thinned down to one seedling per stand at two weeks after emergence and prior to treatment application.

The treatments were applied as specified at two weeks after planting, immediately after weeding and thinning and repeated at 4, 6, 8, 10 and 12 weeks at the rate of 20 ML per plant of the different concentration. The field was kept weed free throughout the study period.

Data Collection and Analysis

The following parameters were monitored and data were collected and recorded for analysis:

Plant height (cm): The height of selected plant from each plot was taken from the base of the plant to the tip in cm and recorded. This began at 2 weeks after planting (WAP) and repeated at 4, 6, 8, 10 and 12 WAP.

Stem Girth (cm): The girth of the selected plants was taken using a veneer-caliper and was recorded. This began at 2 weeks after planting (WAP) and repeated at 4, 6, 8, 10 and 12 WAP.

Number of Leaves/Plant: The visual count of number of leaves per plant was done on the plants and recorded. This began at 2 weeks after planting (WAP) and repeated 4, 6, 8, 10 and 12 WAP.

Leaf Area (cm^2): The midrib length of 4 leaves of the selected plant was taken and calculated

Number of Fruits/Plant: Visual count of number of fruits per plant per harvest was taken and recorded. The average was be determined at the end of the study and recorded for analysis.

Leaf Area Index: The leaf area index of 1 selected plant from each treatment level was taken. The average was determined and recorded, this began at 2 weeks after planting and repeated at 4, 6, 8, 10, and 12 weeks after planting.

Fruit Yield (Kg/ha): The yield was measured according to the treatment and calculated using the formular,

$$\frac{\text{Fresh weight x 10,000}}{\text{Land area [Umar Musa Tanko, 2015]}}$$

Dry Weight: One plant was uprooted from each treatment level and the dry weight was determined. This began at 2 weeks after planting and repeated 4, 6, 8, 10 and 12 WAP.

Proximate Analysis: This was conducted to determine the nutritional contents as influenced by the treatments. (AOAC, 2000)

Data Collection

Data collected was subjected to statistical analysis, using the analysis of variance (ANOVA) of the SAS software 17.0 version. Means separation was done using the Least Significant Difference (LSD) method as described by Onuh and Igwemma, [2007].

RESULTS

Effect of Treatment on Plant Height

The result presented in table 1a, showed that turmeric extract increase the plant heights of the plant. Treated plots were found to have performed better than the control. However, the degree of performance was not significant compared to control especially at 2, 4, and 6 WAP. In Ethanol Extract, at 8 WAP and 10 WAP.T_3 – 200g significantly influence plant height 45.5cm compared to control 27.17cm. The same trend was noticed at 10 WAP and 12 WAP respectively.

Whereas in Table 1b, the highest mean plant heights of 43cm. 65cm and 85.17cm respectively were recorded from plot treated with 200g concentration at 8, 10, and 12 WAP which was significantly difference ($P<0.05$) from the main plant heights recorded from the untreated plots.

However, among the treated plots, it was observed that T_3 – 200g concentration influenced the plant height compared to control and other treatment level in the extraction media.

Effect of Treatment on Number of Leaves

The number of leaves was not enhanced by both ethanol and water turmeric extract application at each of the sampling periods and there was no significant difference among the treatments (Table 2a-b).

However it was observed that control at 10 WAP and 12 WAP have more umber of leaves than other treatment levels respectively in both extraction methods.

Effect of Treatment on Leaf Area (cm^2)

Application of turmeric extract influenced the leaf area at 8 WAP, 10 and 12 WAP respectively compared to control (Table 3a-b). However it was observed that T_3 – (200g concentration) enhanced Leaf area more in table 3b than in table 3a. However, the highest Leaf area was consistently obtained when T_3 (200g) of water extract was applied compared to ethanol extract as shown table 3a – b.

Effect of Treatment on Leaf Area Index (LAI)

Result from table 4a-b showed that turmeric extract from both extraction media had no significant effect on Leaf area index of plants. However, it was observed that it enhanced the Leaf area index of plant compared to control in both table 4a and b. at 2, 4, 6, 8, 10 and 12 WAP turmeric starts from ethanol influence Leaf area index compared to control. The T_3 gave the highest Leaf area index as shown in table 4a. it was observed that T_4 (300g) gave the lowest value of Leaf area index at 4, 6, 8, 10 and 12 WAP sampling periods.

In table 4b, at 4, 6, 8 and 10 WAP, turmeric extract of water application enhanced the Leaf area index. It was observed that increase concentration increases the Leaf area index with exception of T_4 (300g) which recorded lower Leaf area index at 6 WAP, 8, 10 and 12 WAP respectively.

Effect of Treatment on Stem Girth (cm)

The mean stem girth of okra plant grown in treated plots with turmeric ethanol extract was influenced by various treatment levels at sampling periods.

In table 5a, At 2, 6, 8, 10 and 12 WAP control plots consistently gave the highest number of stem girth (0.71, 5.63, 11.20, 10.57 and 11.42cm respectively) compare to treated plots as shown in table 5a.

Similarly in table 5b, the same trend was observed at 6, 8, 10 WAP for control plots compared to treated plots in turmeric water extracts application.

It was observed that in spite of control performance of stem girth was influenced more in turmeric water extract than in turmeric ethanol water extract (Table 5a and b)

Effect of Treatment on Root Length (cm)

In table 6a the trend in plots treated with turmeric ethanol extract as indicated influenced the root length at all the sampling stages compared to the control. It was observed that treated 3 recorded the highest root lengths 18.50cm, 18.33cm, 21.33cm and 30.33cm respectively at 4, 6, 8, 10 and 12 WAP compared to untreated plots. whereas the similar trend was observed in table5b. It was observed that T_4 plots in turmeric water extract enhanced root length compared to T_4 plots in turmeric ethanol extracts.

Comparatively turmeric water extract influenced root length more than turmeric ethanol extract as shown in table 6a-b

Effect of Treatment on Root Dry Weight

The result in table 7a, shows that at 2, 6, 8, 10 and 12 WAP, the main root dry weight was highest (1.43g, 2.31, 17 and 26.42g respectively) in plot that received 200g (T_3) concentration compared to the lowest main root dry weight (0.52, 2.42, 7.00, 6.91 and 10.00g respectively) recorded from untreated plots (control)

Effect of Treatment on Shoot Dry Weight

Exogenous application of aqueous and ethanol turmeric extract enhanced the shoot dry weight of okra plant as shown in table 8a – b. in ethanol turmeric extract, application (table 8a), it was observed that,

at 2, 4, 6, 8, 10 and 12 WAP there was no significant different in the main shoot dry weight recorded from treated plots compared to the control. T_3 plots was observed to record higher shoot weights (31.91, 34.07 and 39.39 respectively) at 8, 10 and 12 WAP as indicated in table 8a compared to T_1, T_2 and T_4.

In table 8b, at 2, 4 and 6 WAP (That is early growth stage control recorded good performance compared to the treated plots although the observed difference was not significant whereas at 8, 10 and 12 WAP, T_3 plots recorded an enhanced main shoot dry weights compared to control, T_2 and T_4 treated plots.

In addition at later stage comparatively, aqueous turmeric extract enhanced shoot dry weight compared to the ethanol turmeric extract as indicated in table 8a-b

Effect of Treatment on Proximate Composition

Application of turmeric extract was observed to significantly ($p<0.05$) influenced proximate parameters as indicated in 9a and b.

Moisture Content

In ethanol turmeric extract (table 9a), moisture content was found to be higher (85.81% which was significantly different ($P<0.05$) compared to values recorded from T_2 (48.91%), T_3 (64.51%) and T_4 (61.21%)

Protein Content

Protein content was highest (2.34%) in plot treated with T_3 (200g concentration) of ethanol turmeric extract which was significantly different from the protein content recorded from T_2 (2.02), T_1 (1.70) and T_4 (1.60). whereas in aqueous T_3 significantly ($p<0.05$) influenced the protein content with highest value of 2.41 compared to lower values 1.54, 1.61 and 1.68 recorded from T_2, T_4 and T_1 respectively.

Vitamin C

The control was found to have a higher number of vitamin C relative to T_2, T_3 and T_4. The quantity of vitamin C (21.10) recorded from control plots was significantly higher from the values 14.20, 10.60 and 12.71, recorded from T_2, T_3 and T_4 respectively. In table 9b, the same trend ($T_1 > T_2 > T_4 > T_3$) was observed in aqueous turmeric extract application.

Calcium Content

Plots treated with T_2 ethanol turmeric extract contained (54.40) higher amount of calcium which was significantly ($P<0.05$) lower than 40.71 and 40.10 recorded from T_1 and T_3 plots respectively. Similarly, the same trend was observed in aqueous turmeric extract application.

Fibre Content

The fibre content was found to be significantly influenced by ethanol turmeric extract. T_3 plots recorded the highest fibre content (3.12) which was significantly difference ($P<0.05$) from the fibre content 2.32, 2.06 and 2.05 respectively recorded from plots treated with T_1, T_2 and T_4. Similarly in aqueous turmeric extract (Table 9b) T_3 plots recorded higher fibre content (3.25) which was significantly different ($P<0.05$) from fibre content (2.28, 2.98 and 3.21 respectively) recorded from T_1, T_2 and T_3.

Ash Content

Maximum Ash content (3.52) were noted from T_3 treated plants which was significantly difference to Ash content (2.80, 3.00 and 3.30 respectively) recorded from T_2, T_4 and T_1 table 9a. similarly Ash content obtained from T_3 plant treated with aqueous turmeric extract recorded highest ash content (3.66) which was significantly different from Ash content (2.89, 2.90 and 3.32 respectively) recorded from T_4, T_2 and T_1 as indicated in table 9b.

Carbohydrate

In ethanol turmeric extract application (table 9a) maximum carbohydrate content (5.67) were obtained from control which was significantly different ($P<0.05$) from the lower carbohydrate content (2.61, 3.72 and 4.67 respectively recorded from T_3, T_2 and T_4 as indicated in table 9a.

Whereas in aqueous turmeric extract (table 9b) the same trend was observed where control recorded highest carbohydrate content which was significantly different ($P<0.05$) from the carbohydrate content (3.75, 4.34 and 5.12 respectively recorded from T_4, T_3 and T_2 as shown in table 9b)

Fat Content

In table 9a, different levels of ethanol turmeric extract significantly influenced the fat content. T_2 with fat content of 0.15, T_4 (0.13) and T_3 (0.12) all shows significant different ($P<0.05$) from lower value (0.10) obtained from control

In aqueous turmeric extract (Table.9b), T_2 plots recorded higher fat content (0.55) which was significantly different, the lowest value (0.08) recorded from control while T_3 and T_4 have the same values of fat content (0.10) was significant to control.

Effect of Treatment on Yield Components

In table 10a, influenced of ethanol turmeric extract was not significant on the mean number of fruits although it increased the number of fruit when compared to control. T_3 plots recorded a higher mean number of fruits (42), than the lower mean number fruits (23.33) recorded from control. Also, T_2 and T_4 recorded mean number of fruits (36.33 and 40.33), which are not significant to the mean number (23.33) of control plots (table 10a)

Similarly, the same trend was recorded in aqueous turmeric extract application, $T_3 > T_4 > T_2 > T_1$. These observable difference statistically was not significant ($P<0.05$)

Mean Fresh Fruit Weight

Application of turmeric extract have profound influence on the mean fresh weight of fruit relative control. In ethanol turmeric extract application (table 10a) it was observed that T_3 plots recorded maximum mean fresh weight (1055.00g) which was not significantly different ($P<0.05$) from the lowest (543.30g) recorded from control.

Other treatment levels, T_2 and T_4 were found to have mean fresh weights (889.0g and 786.70g) which are higher than fresh weight (543.30g) recorded from control.

Similarly, in aqueous turmeric extract (table 10b) it was observed that T_3 recorded the highest mean fresh weight of 940.80g which was not statistically significant to lower fresh weight (542.90g) recorded from control.

It will be noted that 2% of ethanol turmeric extract have the highest mean fresh weight compared to 2% of aqueous turmeric extract.

Yield (kg/ha)

Application of turmeric extract from the two extract significantly improved the yield of Okra plants as indicated in table (10a-b).

In ethanol turmeric extract application (10a), the maximum yield (390.733kg/ha) was recorded from plots that received $treatment_3$ (2%) which was significantly different ($P<0.05$) from yields (84.10/kg/ha, 362.60kg/ha and 302.467kg/ha respectively) recorded from control, $treatment_2$ and $treatment_4$ respectively.

In table 10b, aqueous turmeric extract significantly influenced the yield of Okra plant. Among the treatment levels T_3 (2% concentration) plots recorded higher (385.600kg/ha) yield which was significantly different ($P<0.05$) from the yields (78.733kg/ha, 214.666kg/ha and 348.433kg/ha respectively) recorded from control (0%), T_1 (1%) and T_4 (3%) plots.

DISCUSSION

It is evident from this study that application of turmeric extract influenced the performance of Okra plant. However, degree of response depends on the concentration level and extract used.

Plant height was observed to be enhanced by $treatment_3$ (2% concentration) compared to control and other treatment levels in both extract used. The higher performance of Okra plants that received turmeric extract could be attributed to chemical content of turmeric extract (pigments, antioxidant and nutrients which might encourage cell division and biosynthesis of organic food. This is in conformity with work of Noric *et al.* 2002, and Ahmed *et al.* 2013.

Ethanol and aqueous extract of turmeric was found to enhance the performance of Leaf area index, leaf area, number of root, root length compared to the plants from control plots. This enhancement could be that turmeric extract contents some growth enhancement substances, which impact more on these growth parameters than other parameters (stem girth and number of leaves). The increase in growth parameters may be due to the presence of some growth regulatory substances. Variation in the growth performance obtained might have been due to action of biochemical content in both aqueous extract and ethanol turmeric extract. This agreed with work of Ahmed *et al.*, 2013 who reported that combined and single application of extract of Roselle turmeric and seaweed at 0.2%, 0.1% and 0.2% effectively improved the Leaf area, nutrients (N, P, K and Mg, total chlorophyll and total carotenoids in leaves, yield quality of Valencia orange trees).

The root dry weight and shoot dry weight were food to be improved by application of aqueous and ethanol turmeric extract although not statistically different it could be attributed to improvement in Leaf area which increase interception of light for fixation of carbon in the matrix of the plant during biosynthesis. The highest mean root dry weight and shoot dry weight were concomitant with using the higher level of turmeric extract (T_3 especially) which improved the growth parameters than other treatment levels. Such increment might be due to that turmeric extract is a biostimulant, which provide Okra with micro and macro nutrients which increase the chlorophyll production by boosting the photosynthesis process, thereby stimulating vegetative growth. This agreed with work of some authors (Parohit, 2000; Okigbo and emoghene, 2003, Chawdhury *et al.* 2007; Bhdwaji *et al.* 2010; Abd El-Rahman and El-Masry, 2012; Ahmed *et al.* 2013 and Mohammed and Mohammed, 2013) who found that plant extracts enhance growth, nutritional status, yield and fruit quality of fruit crops.

Nutritional status was found to be significantly improved by turmeric extract. It was observed that, 2% level impacted positively on protein content, fibre, fat, calcium content of Okra plant relative to moisture content, vitamin C content and carbohydrate. The improvement on the nutritional content could be due to nutrient content of turmeric extract such as N., P, K, Ca and Mg and vitamins, which protect DNA damage in the plant. These results are in harmony with those obtained by Chawdhury *et al.* 2007, Karim and Rahim 2008, Ahmed *et al.* 2014.

Yield could be considered to be the mirror of all growth features. Comparing the effect of different levels of spraying treatments on yield and yield component, the results indicate that, in spite of no significant difference were detected among control treatment and aqueous, and ethanol extract, on number of fruits and fresh weight, it was clear that turmeric extract (both ethanol and aqueous) at 2% tested concentration significantly increased yield compared to those of untreated plots. These increase in the number of fruits, fresh weights and significant increase in the yield could be attributed to the presence of nutrients (such as calcium, phosphorus, potassium and magnesium) Vitamins, some growth regulators in turmeric extract. The use of such materials on Okra plant will improve the physiological and nutritional statues of the Okra plants and increase the yield and fruit quality. This is in harmony with Ahmed *et al.* (2013 and Hageb *et al.*, 2005) on citrus, Hafez *et al.* (2013) on Olive, and Hanafy, *et al.* (2012) on plant extract.

CONCLUSION

From the above results it could be concluded that using turmeric extract (both ethanol and aqueous extract) at T3 (2% concentration) had clear effects on vegetative growth, nutritional status, yield and yield components.

It was noted that aqueous turmeric extract have greater impact on the growth parameters measured compared to ethanol turmeric extract. Therefore, within the limit of this study, 2% extract concentration (T_3) of both extract could be safely recommended as natural bio stimulant application for improving fruiting of okra plants.

Table 1. *Effect of Treatment on Plant Height (cm)*

Table 1a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	5.93^{a}	7.90^{a}	15.50^{a}	27.17^{b}	36.33^{b}	50.87^{b}
T_2	6.50^{a}	10.83^{a}	15.33^{a}	31.83^{ab}	45.00^{ab}	62.63^{ab}
T_3	6.33^{a}	10.83^{a}	22.53^{a}	45.50^{a}	62.00^{a}	84.50^{a}
T_4	5.50^{a}	9.73^{a}	18.83^{a}	34.17^{ab}	48.33^{ab}	71.00^{ab}
L.S.D	2.20	4.31	8.54	14.26	19.20	24.32

Table 1b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	6.07[a]	7.53[a]	15.77[a]	27.23[b]	37.67[b]	57.00[b]
T_2	5.50[a]	9.00[a]	17.00[a]	27.50[b]	40.17[b]	61.23[ab]
T_3	5.17[a]	9367[a]	20.50[a]	43.00[a]	65.00[a]	85.17[a]
T_4	4.73[a]	8.83[a]	16.17[a]	30.00[ab]	41.00[ab]	65.00[ab]
L.S.D	3.36	4.00	8.57	15.00	24.22	24.25

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 2. *Effect of Treatments on Number of Leaves*

Table 2a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	5.00[a]	8.00[b]	10.33[a]	16.00[a]	37.00[a]	52.33[a]
T_2	4.33[a]	9.67[a]	16.00[a]	19.00[a]	26.67[a]	47.67[a]
T_3	5.67[a]	9.67[a]	12.00[ab]	18.33[a]	31.33[a]	36.67[a]
T_4	5.00[a]	8.33[ab]	9.67[a]	14.67[a]	24.67[a]	35.67[a]
L.S.D	1.40	1.40	5.12	13.40	24.71	32.04

Table 2b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	4.67[a]	8.33[a]	10.67[a]	16.00[a]	37.67[a]	46.33[a]
T_2	5.00[a]	8.00[a]	10.33[a]	16.00[a]	25.00[a]	39.33[a]
T_3	5.33[a]	9.00[a]	10.67[a]	19.00[a]	26.67[a]	46.00[a]
T_4	5.00[a]	8.33[a]	10.00[a]	19.00[a]	29.67[a]	42.67[a]
L.S.D	1.10	1.66	4.04	16.44	37.80	35.80

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 3. *Effect of Treatments on Leaf Area (cm^2)*

Table 3a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	27.10[a]	121.17[a]	282.67[a]	336.58[a]	413.92[a]	402.00[a]
T_2	23.00[a]	131.73[a]	239.68[ab]	404.17[a]	427.17[a]	440.58[a]
T_3	22.00[a]	130.42[a]	190.38b[c]	383.08[a]	423.33[a]	434.83[a]
T_4	18.00[a]	92.68[a]	154.00[c]	294.98[a]	317.92[a]	383.08[a]
L.S.D	16.00	70.00	54.78	135.71	120.71	102.48

Table 3b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	27.07[a]	124.37[a]	282.97[a]	356.58[a]	412.48[a]	402.58[a]
T_2	23.41[a]	110.00[a]	226.00[a]	311.00[a]	342.83[a]	442.58[a]
T_3	27.55[a]	103.92[a]	201.58[a]	380.00[a]	418.33[a]	469.33[a]
T_4	23.22[a]	83.58[a]	224.50[a]	351.25[a]	389.58[a]	442.50[a]
L.S.D	8.50	100.31	145.05	149.04	152.54	193.81

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 4. *Effect of Treatments on Leaf Area Index*

Table 4a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	5.43[b]	9.20[a]	23.00[a]	35.00[a]	36.00[a]	44.00[a]
T_2	7.33[a]	8.50[a]	24.00[a]	41.00[a]	39.00[a]	46.00[a]
T_3	6.10[ab]	14.00[a]	28.00[a]	36.00[a]	37.00[a]	46.20[a]
T_4	6.30[ab]	15.00[a]	23.03[a]	35.50[a]	34.00[a]	41.00[a]
L.S.D	1.71	6.24	15.00	10.22	13.00	17.00

Table 4b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	5.40[a]	9.07[a]	22.57[a]	33.73[a]	36.33[a]	41.67[a]
T_2	5.63[a]	13.00[a]	20.17[a]	33.67[a]	35.33[a]	39.67[a]
T_3	6.23[a]	8.83[a]	28.57[a]	35.00[a]	38.00[a]	48.00[a]

T_4	4.83[a]	11.00[a]	25.00[a]	34.67[a]	36.00[a]	43.00[a]
L.S.D	2.01	7.77	15.00	14.30	11.93	17.73

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 5. *Effect of Treatments on Stem Girth (cm)*

Table 5a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	0.71[a]	3.22[a]	5.63[a]	11.20[a]	10.57[a]	11.42[a]
T_2	0.83[a]	3.65[a]	5.88[a]	8.92[a]	6.28[a]	7.00[a]
T_3	0.42[a]	3.50[a]	5.35[a]	6.07[a]	8.83[a]	9.08[a]
T_4	0.50[a]	3.43[a]	4.17[a]	8.03[a]	5.25[a]	5.53[a]
L.S.D	0.37	0.95	1.43	3.00	3.30	3.34

Table 5b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	0.68[a]	3.40[a]	7.53[a]	10.50[a]	12.27[a]	11.35[a]
T_2	1.40[a]	5.12[a]	6.21[a]	10.67[a]	8.00[a]	12.00[a]
T_3	1.63[a]	4.34[a]	6.51[a]	10.33[a]	9.67[a]	16.00[a]
T_4	1.52[a]	3.75[a]	6.42[a]	10.00[a]	8.33[a]	10.33[a]
L.S.D	0.72	1.10	1.66	4.00	5.12	8.54

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 6. *Effect of Treatments on Root Length (cm)*

Table 6a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	4.64[a]	18.33[a]	18.33[a]	14.83[a]	16.33[a]	23.33[a]
T_2	2.34[a]	12.67[b]	20.67[a]	14.50[a]	16.00[a]	26.00[a]
T_3	3.08[a]	16.67[ab]	18.50[a]	18.33[a]	21.33[a]	30.33[a]
T_4	3.36[a]	16.33[ab]	24.83[a]	17.83[a]	17.00[a]	30.33[a]
L.S.D	2.45	5.26	11.00	9.70	12.10	11.80

Table 6b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	4.87[a]	18.53[a]	18.27[ab]	14.83[a]	16.67[a]	27.00[a]
T_2	2.70[b]	12.17[b]	13.17[b]	18.83[a]	25.00[a]	31.00[a]
T_3	2.96[a]	14.33[ab]	15.33[b]	18.83[a]	24.00[a]	30.17[a]
T_4	5.71[a]	13.50a[b]	22.33[a]	23.00[a]	24.00[a]	31.83[a]
L.S.D	2.35	5.70	6.45	11.00	13.29	13.83

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 7. *Effect of Treatments on Root Dry Weight*

Table 7a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	0.89[a]	0.52[b]	2.42[a]	7.00[a]	6.91[a]	10.00[a]
T_2	0.32[a]	0.54[b]	3.71[a]	10.27[a]	8.20[a]	13.32[a]
T_3	0.84[a]	1.43[a]	2.40[a]	20.31[a]	17.00[a]	26.42[a]
T_4	0.68[a]	1.21[ab]	3.40[a]	15.09[a]	10.50[a]	18.20[a]
L.S.D	0.35	0.80	3.10	28.03	15.10	20.00

Table 7b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	0.43[b]	0.53[a]	2.43[a]	7.01[a]	6.83[a]	9.87[b]
T_2	0.80[a]	1.31[a]	1.86[a]	17.93[a]	14.75[a]	21.90[ab]
T_3	0.29[bc]	0.54[a]	1.70[a]	17.71[a]	17.17[a]	28.37[a]
T_4	0.40[b]	0.75[a]	3.77[a]	13.20[a]	14.43[a]	22.23[ab]
L.S.D	0.31	1.27	3.26	17.77	13.41	17.54

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 8. *Effect of Treatments on Shoot Dry Weight*

Table 8a. *(Ethanol Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	0.95[a]	1.27[a]	4.00[a]	10.59[a]	12.05[a]	16.04[a]
T_2	0.67[a]	1.11[a]	6.10[a]	15.67[a]	16.57[a]	19.74[a]
T_3	1.29[a]	2.20[a]	4.51[a]	31.91[a]	34.07[a]	39.39[a]
T_4	1.13[a]	2.00[a]	5.51[a]	20.99[a]	21.80[a]	25.27[a]
L.S.D	0.80	1.40	5.10	36.40	36.10	37.00

Table 8b. *(Aqueous Turmeric Extract)*

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
T_1	1.06[a]	1.01[a]	3.80[a]	10.56[a]	12.08[a]	15.87[a]
T_2	1.11[a]	1.82[a]	3.29[a]	26.93[a]	29.43[a]	38.04[a]
T_3	0.54[a]	1.01[a]	2.59[a]	27.58[a]	31.12[a]	40.74[a]
T_4	0.81[a]	1.53[a]	5.97[a]	22.98[a]	28.90[a]	38.75[a]
L.S.D	0.56	1.23	5.03	26.65	24.42	25.74

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

TABLE 9. *Effect of Treatments on Proximate Composition*

Table 9a. *(Ethanol Turmeric Extract)*

Treatments	M.C	Protein	Vit. C	Calcium	Fibre	Ash	Total fat	Carbohy-drate
T_1	85.81[a]	1.70[c]	21.10[a]	40.71[c]	2.32[b]	3.30[b]	0.10[c]	5.67[a]
T_2	48.91[d]	2.02[b]	14.20[b]	54.40[a]	2.06[c]	2.80[d]	0.15[a]	3.72[c]
T_3	64.51[b]	2.34[a]	10.60[d]	40.10[d]	3.12[a]	3.52[a]	0.12b[c]	2.61[d]
T_4	61.21[c]	1.60[d]	12.71[c]	50.10[b]	2.05[c]	3.00[c]	0.13a[b]	4.67[b]
L.S.D	0.04	0.07	0.03	0.52	0.10	0.10	0.02	0.03

Table 9b. *(Aqueous Turmeric Extract)*

Treatments	M.C	Protein	Vit. C	Calcium	Fibre	Ash	Total fat	Carbohy-drate
T_1	85.85[a]	1.68[b]	21.05[a]	41.23[d]	2.28[d]	3.32[b]	0.08[b]	5.64[a]
T_2	57.10[d]	1.54[d]	18.10[b]	50.42[a]	2.98[c]	2.90[c]	0.55[a]	5.12[b]
T_3	78.02[b]	2.41[a]	13.04[d]	42.50[c]	3.66[a]	3.66[a]	0.10[b]	4.34[c]
T_4	62.40[c]	1.61[c]	13.52[c]	49.12[b]	2.89[c]	2.89[c]	0.10[b]	3.75[d]
L.S.D	0.05	0.02	0.05	0.14	0.02	0.03	0.10	0.03

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

Table 10. *Effect of Treatments on Yield and Yield Components*

Table 10a. *(Ethanol Turmeric Extract)*

Treatments	Number of fruit	Mean fresh weight	Yield (kg/ha)
T_1	23.33[a]	543.30[a]	84.100[a]
T_2	36.33[a]	889.00[a]	362.600a[b]
T_3	42.00[a]	1055.00[a]	390.733[a]
T_4	40.33[a]	786.70[a]	302.467[b]
L.S.D	27.02	890.14	294.26

Table 10b. (Aqueous Turmeric Extract)

Treatments	Number of fruit	Mean fresh weight	Yield (kg/ha)
T_1	23.33[a]	542.90[a]	78.733[b]
T_2	28.33[a]	579.70[a]	214.666[ab]
T_3	44.67[a]	940.80[a]	385.600[a]
T_4	34.67[a]	771.10[a]	348.433[ab]
L.S.D	24.17	711.92	271.496

Means in the same column, having the same letter according to LSD are not significant (P<0.05).

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