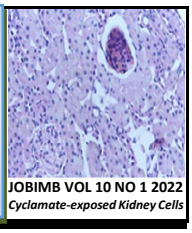
JOBIMB, 2022, Vol 10, No 1, 67-71
https://doi.org/10.54987/jobimb.v10i1.713

HIBISCUS PUBLISHER

JOURNAL OF BIOCHEMISTRY, MICROBIOLOGY AND BIOTECHNOLOGY

Website: http://journal.hibiscuspublisher.com/index.php/JOBIMB/index



Comparative Assessment of Selected Fruit Peels on Growth and Yield of Okra (*Abelmoschus esculentus* (L.) Moench)

Gbenga Olorunshola Alege[1]*, Otori Oyiza Mercy[2], Umar Haruna[3], Ilepinran Jibril Oni[3] and Dauda Danlami[1]

[1]Department of Biotechnology, Federal University Lokoja, P.M.B 1154 Lokoja, Kogi State, Nigeria.
[2]Department of Biological Sciences, Federal University Lokoja, P.M.B 1154 Lokoja, Kogi State, Nigeria.
[3]Department of Botany, Federal University Lokoja, P.M.B 1154 Lokoja, Kogi State, Nigeria.

*Corresponding author:
Gbenga Olorunshola Alege,
Department of Biotechnology,
Federal University Lokoja,
P.M.B 1154 Lokoja,
Kogi State,
Nigeria.
Email: gbenga.alege@fulokoja.edu.ng

HISTORY

Received: 12th June 2022
Received in revised form: 21st July 2022
Accepted: 27th July 2022

KEYWORDS

Fruit peels
Okra
Abelmoschus esculentus
Growth
Yield

ABSTRACT

This study was carried out to examine the effect of selected fruit peels on growth and yield of okra (*Abelmoschus esculentus*). 10g of ground fruit peels of banana, watermelon, pawpaw, pineapple, plantain, orange was applied to 7 kg of soil and left for 7 days before planting of okra seed. NPK (15:15:15) serves as positive control while groups without fertilizer served as negative control for the study. Each treatment was replicated five times in polythene bags used as pots and watered every three days. The setup was arranged in Completely Randomized Block Design (CRBD). Plant height and stem girth were measured while number of leaves were also counted from 1 to 8 Week After Planting. The numbers of days to 50% flowering, pod length and pod diameter were also recorded from 1 to 8 Week After Planting. Data pooled in this study were subjected to Analysis of variance (ANOVA) and means with statistically significant difference at $p<0.05$ were separated using Duncan Multiple Range Test. Generally, results across weeks showed statistically significant difference for plant height, number of leaves, stem girth, days to 50% flowering, number of fruit and pod length while only the diameters of fruits did not respond to different nutrient sources. Okra grown with banana and watermelon peels gave the best overall performance which indicates that they contained sufficient nutrients for optimum production of okra. This study clearly indicates that banana and watermelon fruit peels could be used singly or in combination to effectively boost yield of okra.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) *Moench*) is a member of the family Malvaceae growing as annual crop in tropic and sub-tropic [1]. The popularity of okra in Nigeria has been attributed to its high nutritional composition and great medicinal value [2]. The plant is also valued for its high protein, carbohydrate, fiber, vitamin A, B, C, Fe, Ca and P compositions [3]. Some health benefits of okra include anti-ageing effects, immunity promoting potentials, and cholesterol control abilities [4,5]. The high fiber content of okra helps to maintain blood sugar by adjusting the rate at which sugar is absorbed from the intestinal tract [6]. Besides the heart improvement potential of okra, it also improves the health of fetus during pregnancy [7]. The poor fertility status of soils coupled with issues of pests and diseases attacks constitute the major factors hindering optimum okra production [8]. Poor soil fertility condition was singled out as the major hindrance to okra production in Nigeria [9, 10]. The cause of rapid fertility deterioration of Nigerian soils was attributed to incessant cultivation, deforestation and wrong farming methods [11]. The role of fertilizer in boosting the nutrient status of soil and enhancing yield of crops cannot be overemphasized [12]. This compelled farmers to opt for synthetic fertilizer for soil improvement. The continuous uses of synthetic fertilizers have adverse effects on the environment [10]. This adverse effect coupled with the high cost and non-availability of inorganic fertilizers have forced peasant farmers to consider cheaper means of enhancing soil fertility for crop production[9, 13]. Therefore, the need to carryout research on the response of crops to cheaper and readily available organic-based fertilizers is germane. The need to evaluate the growth promoting abilities of fruit peels on crops is very important [14].

The global fruit production for the year in 2018 was 124.73 million metric tons (MMT), 114.08 MMT, 84.63 MMT, 74.49 MMT, 45.22 MMT, and 25.43 MMT for citrus, bananas, apples, grapes, mangoes and pineapples respectively [15]. As a result of the health-promoting ability of fruits, consumption of fruits in raw form has increased globally. Fruit processing industries contribute significantly to the indiscriminate disposal of fruit peels [16]. Improper disposed of fruit peels is now a serious environmental issue because during the process of decomposition the peels serve as breeding site for some disease vector [14]. Fruit peels are very rich in macro and micro nutrients that are indispensable for plant [17]. Fruit peels can be applied to the soil as fertilizers to enhance fertility and enrich soil micro-biota for excellent plant growth [18]. In addition, fruit peels contain some active compounds with insecticidal and antifungal properties which help to control some plant pathogens [6]. Fruit peels offer cheap and harmless means of enhancing plant growth [19]. Therefore, processing fruit peels into fertilizer will not only help to clean up the environments but also help to convert wastes to wealth. Peels of tropical fruits such as banana, paw-paw, pineapple, mango, orange, and water melon are readily available in large quantities during their season. The application of fruit peels as fertilizer will overcome the side effects of inorganic fertilizers for optimum okra production. In spite the aforementioned growth promoting potentials of fruit peels, research on their effects on growth and yield of okra is scanty. The use of fruit peel as natural fertilizer could offer an effective, less costly and environmental friendly approach towards sustainable okra production. The main aim of the study is to examine the potentials of some selected peels of fruits in enhancing growth and yield of okra (*Abelmoschus esculentus*).

MATERIALS AND METHODS

Collection of materials

Peels of orange, banana, pineapple, watermelon, paw-paw and plantain were collected from fruit vendors in Lokoja, Kogi State, Nigeria. Inorganic fertilizer (N.P.K:15:15:15) was purchased from Agricultural Development Project (ADP), Lokoja. Seeds of improved Okra variety (V35) were obtained from National Horticultural Research Institute (NIHORT) Ibadan, Oyo State, Nigeria.

Preparation of fruit peel powders

The preparations of fruit peels powder were done according to the method outlined by [20]. The collected fruit peels were washed thoroughly in running tap water and cut into small pieces before air-drying in the Laboratory of Department of Biology, Federal University Lokoja. The well-dried peels were ground to powder by pestle and mortal. The ground peels were then sieved using 2mm mesh size and the sieved fruit powder was stored at room temperature till when needed.

Application of fruit peels powder and Inorganic fertilizer to the soil

This was carried out in the greenhouse of the Department of Biology, Federal University Lokoja. Sandy loamy soil within the depth of 0-5cm were collected and properly mixed at the research site before filling steam-sterilized soils into different polythene bags. Application of fruit peel powder was done according to the methods outlined by [14] with slight modifications. 10g of each fruit peels were applied to 7kg of soils in pots and left for 7 days before planting of okra seed into already labeled pots. Seedlings were reduced to 1 per pot after seedling establishment. 2g of NPK fertilizer was applied basally to plants in positive control group. The negative control group was without application of fruit peels or inorganic fertilizers. Each treatment was replicated ten times in polythene bags used as pots and watered every three days. The setup was arranged in Completely Randomized Block Design (CRBD).

Vegetative Morphological Parameters

Height of plants and stem girth were measure while numbers of leaves and fruits per plant were taken from ten plants for each treatment. This was done from 1 Week After Planting to 8 Week After Planting. Following harvesting of the fruits, length and girth of fruits were measured. Days to 50% flowering and numbers of fruits per plant were taken. Thereafter, the lengths and girths of fruits were measured after harvest.

Data Analysis

Data pooled in this study were subjected to Analysis of Variance (ANOVA) and means with significant differences at $P<0.05$ were separated using Duncan Multiple Range Test (DMRT). Cluster analysis was used to group the responses of okra to the nutrient sources. All analyses were carried out using SPSS Version 21 software package.

RESULTS

Table 1 shows the result of effects of different fruit peel powders and NPK fertilizers on height of Okra (*Abelmoschus esculentus*) from 1 Week After Planting to 8 Week After Planting. The result revealed significant differences ($P<0.05$) for different nutrient sources across weeks. Okra grown without fertilizer and fruit peels (negative control) and those grown with N.P.K (positive control) produced significantly tallest plants at 1WAP while okra grown with watermelon peels produced significantly shortest plants. Banana peels produced okra that are significantly the tallest at 2WAP (18.40 cm), 3WAP (22.90 cm) and 4WAP (25.80 cm) while okra grown with watermelon peels were significantly the tallest at 5WAP, 6WAP, 7WAP and 8WAP with 36.00 cm, 52.20 cm, 70.00 cm and 81.60 cm respectively. Okra grown without fertilizers (control) produced shortest plants from 2WAP to 8WAP (**Table 1** and **Figs. 1** and **2**).

Fig. 1. Okra grown with fruit peels, NPK and controls at 4 Weeks After Planting (4WAP). Key: A= Banana peels, B= Watermelon peels, C= Pawpaw peels, D= Pineapple peels, E= Plantain peels, F= Orange peels, G= N.P.K fertilizer, H= No fertilizer and fruit peels

Fig. 2. Okra grown with fruit peels, NPK and controls at 8 Weeks After Planting (8WAP). Key: A= Banana peels, B= Watermelon peels, C= Pawpaw peels, D= Pineapple peels, E= Plantain peels, F= Orange peels, G= N.P.K fertilizer, H= No fertilizer and fruit peels.

The result of effect of different nutrient sources (banana peels, watermelon peels, pawpaw peels, pineapple peels, plantain peels, orange peels and N.P.K fertilizer on number of leaves in Okra (*Abelmoschus esculentus*) from 1WAP to 8WAP was shown in **Table 2**. The result revealed significant differences ($P<0.05$) for leaf number from 2WAP to 8WAP across nutrient sources. No significant difference ($P>0.05$) was recorded at 1 Week After Planting. Okra grown with banana peels (6.40), watermelon peels (5.80), pawpaw peels (6.00) and plantain peels (5.80) showed significant production of leaves compared to other treatments. At 3WAP and 6WAP, okra grown without fertilizers (negative control) showed statistically significant reduction in number of leaves compared to the other seven treatments. Okra grown with orange peels produced the highest significantly number of leaves compared to other treatments at 7WAP and 8WAP (**Table 2**).

Table 1. Effects of different nutrient sources on plant height in okra (*Abelmoschus esculentus*).

Nutrient Sources	Plant Height (cm)							
	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
Banana Peels	12.10^{ab}	18.40^{a}	22.90^{a}	25.80^{a}	34.30^{ab}	50.40^{a}	65.40^{ab}	77.40^{ab}
Watermelon Peels	9.46^{d}	14.40^{b}	19.50^{ab}	23.50^{ab}	36.00^{a}	52.20^{a}	70.00^{a}	81.60^{a}
Pawpaw Peels	11.82^{abc}	15.40^{ab}	18.50^{b}	21.40^{ab}	28.60^{ab}	40.90^{ab}	50.00^{ab}	62.40^{ab}
Pineapple Peels	9.76^{cd}	13.40^{b}	17.20^{b}	20.60^{b}	26.80^{bc}	38.70^{ab}	47.20^{bc}	58.80^{b}
Plantain Peels	10.30^{bcd}	14.80^{b}	19.00^{b}	22.50^{ab}	31.80^{ab}	44.30^{a}	55.00^{ab}	65.00^{ab}
Orange Peels	10.44^{abcd}	14.30^{b}	17.50^{b}	21.20^{ab}	27.60^{ab}	38.80^{ab}	48.80^{bc}	57.60^{b}
NPK (15:15:15)	12.66^{a}	15.80^{ab}	19.40^{ab}	22.40^{ab}	27.40^{ab}	38.40^{ab}	46.40^{bc}	57.80^{b}
Control (without fertilizer)	12.70^{a}	14.30^{b}	16.70^{b}	19.40^{b}	20.80^{c}	25.20^{b}	30.00^{c}	34.60^{c}
LSD Values	0.30	0.42	0.48	0.57	1.15	2.03	3.69	3.07

*Means with the same alphabets in the same column are not significantly different at 5% level of significant
WAP- Weeks After Planting

Table 2. Effects of different nutrient sources on number of leaves in okra (*Abelmoschus esculentus*).

Nutrient Sources	Numbers of Leaves							
	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
Banana Peels	4.00	6.40^{a}	6.40^{a}	7.60^{a}	8.40^{a}	8.80^{a}	9.80^{ab}	11.20^{ab}
Watermelon Peels	4.00	5.80^{a}	6.40^{a}	7.00^{a}	8.20^{a}	8.40^{a}	8.80b^{c}	9.20^{bc}
Pawpaw Peels	4.00	6.00^{a}	6.40^{a}	7.00^{a}	7.60^{ab}	8.80^{a}	10.00^{ab}	10.60^{ab}
Pineapple Peels	3.80	5.40^{ab}	6.20^{a}	6.40^{ab}	7.40^{ab}	8.80^{a}	9.40^{ab}	10.00^{b}
Plantain Peels	3.80	5.80^{a}	6.40^{a}	7.20^{a}	8.20^{a}	9.20^{a}	9.80^{ab}	10.80^{ab}
Orange Peels	4.00	5.40^{ab}	6.60^{a}	6.60^{ab}	7.60^{ab}	9.00^{a}	11.00^{a}	12.60^{a}
NPK (15:15:15)	3.80	5.40^{ab}	7.20^{a}	7.20^{a}	8.20^{a}	9.60^{a}	9.40^{ab}	9.60^{bc}
Control (without fertilizer)	3.60	4.40^{b}	4.80^{b}	5.40^{b}	6.40^{b}	6.60^{b}	7.40^{c}	7.40^{c}
LSD Values	NS	0.16	0.18	0.25	0.16	0.19	0.25	0.33

*Means with the same alphabets in the same column are not significantly different at 5% level of significant
WAP- Weeks After Planting

Table 3 shows the result of the effect of fruit peels and N.P.K fertilizer on stem girths of Okra (*Abelmoschus esculentus*) from 1 Week After Planting to 8 Week After Planting. The result revealed significant differences ($P<0.05$) for stem girths from 2WAP to 8WAP across nutrient sources. Stem girths did not respond significantly to nutrient source ($P>0.05$) at 1 Week After Planting. At 3WAP and 6WAP, okra grown without fertilizer (control) showed statistically significant reduction in stem girths compared to other treatments. Okra fertilized with banana peels at 4, 5 and 6 Week After Planting showed significant increase in stem girths with 2.78 cm, 3.14 cm and 3.34 cm respectively. From 2WAP to 8WAP, okra grown without application of fertilizer and fruit peels (negative control) and N.P.K (positive control) produced significantly the thinnest plants.

Table 3. Effects of different nutrient sources on stem girths in okra (*Abelmoschus esculentus*).

Nutrient Sources	Stem Girths (cm)							
	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
Banana Peels	1.10	1.66^{ab}	2.10^{a}	2.78^{a}	3.14^{a}	3.34^{a}	3.60^{a}	3.84^{a}
Watermelon Peels	1.04	1.52^{ab}	2.06^{a}	2.60^{ab}	2.98^{ab}	3.22^{ab}	3.50^{a}	3.76^{a}
Pawpaw Peels	1.22	1.60^{ab}	1.98^{a}	2.30^{ab}	2.74^{ab}	2.92^{ab}	3.16^{a}	3.34^{ab}
Pineapple Peels	1.06	1.44^{ab}	1.84^{a}	2.14^{b}	2.54^{b}	2.82^{b}	3.12^{a}	3.20^{b}
Plantain Peels	1.06	1.64^{ab}	2.12^{a}	2.62^{ab}	2.98^{ab}	3.14^{ab}	3.34^{a}	3.54^{ab}
Orange Peels	1.08	1.64^{ab}	1.88^{a}	2.24^{b}	2.66^{ab}	2.86^{ab}	3.14^{a}	3.32^{ab}
NPK(15:15:15)	1.12	1.76^{a}	1.96^{a}	2.16^{b}	2.80^{ab}	2.98^{ab}	3.18^{a}	3.36^{ab}
Control (without fertilizer)	1.02	1.38^{b}	1.46^{b}	1.60^{c}	1.80^{c}	1.98^{c}	2.16^{b}	2.14^{c}
LSD Values	NS	0.04	0.05	0.08	0.07	0.08	0.08	0.09

*Means with the same alphabets in the same column are not significantly different at 5% level of significant
WAP- Weeks After Planting

The influence of fruit peels and N.P.K fertilizer on days to 50% flowering and pod attributes in Okra *Abelmoschus esculentus*) is shown in **Table 4** and **Fig. 3**. Plants grown with N.P.K (positive control) and fruit peels flowered earlier than the negative control group. Okra grown with banana peels significantly outperformed ($P<0.05$) other treatments in terms of number of pods (5.80), pod length (12.22 cm) and pod breadth (9.50 cm) while okra grown without addition of fertilizers (negative control) significantly produced the least number of pods (2.60), pod length (6.77 cm) and pod breadth (6.70 cm). **Fig. 4** shows relationships among nutrient sources for the expression of morphological vegetative and yield attributes in Okra. Cluster analysis grouped the eight treatments into two categories with cluster I am comprising of only the control group. Cluster II comprised of two sub-clusters with sub-cluster A comprising of okra grown with banana and watermelon peels alone while sub-cluster B comprised of groups grown with other peel (orange, pawpaw, pineapple and plantain) and N.P.K fertilizer.

Table 4. Effects of different nutrient sources on yield of okra (*Abelmoschus esculentus*).

Nutrient Sources	Days to 50% Flowering	Numbers of Fruits	Pod Length (cm)	Pod Breadth (cm)
Banana Peels	58.80^{b}	5.80^{a}	12.33^{a}	9.50^{a}
Watermelon Peels	55.80^{b}	2.80^{bc}	7.00^{d}	7.53^{c}
Pawpaw Peels	61.20^{b}	3.80^{bc}	8.73^{c}	7.50^{c}
Pineapple Peels	69.80^{b}	4.00^{bc}	9.63^{b}	9.17^{ab}
Plantain Peels	64.60^{b}	4.40^{b}	8.40^{c}	8.53^{cd}
Orange Peels	63.00^{b}	5.80^{a}	10.47^{b}	8.07^{d}
NPK	65.20^{b}	3.20^{bc}	9.60^{b}	8.97^{bc}
Control (without fertilizer)	96.00^{a}	2.60^{c}	6.77^{d}	6.70^{f}
LSD Values	16.07	1.32	1.79	0.95

*Means with the same alphabets in the same column are not significantly different at 5% level of significant

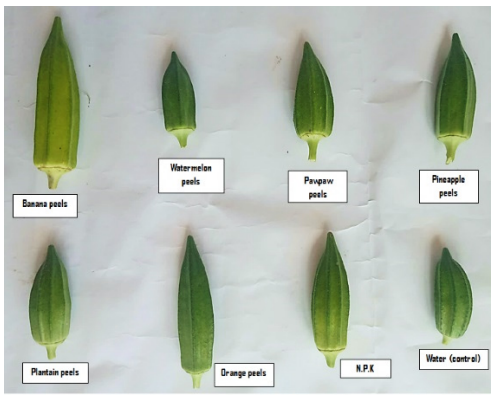


Fig. 3. Fruits of Okra grown with different fruit peels, N.P.K fertilizer and control.

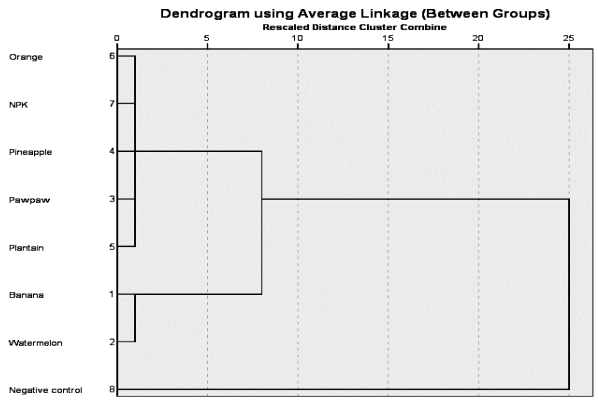


Fig. 4. Relationships among the different nutrient sources in terms of growth and yield performance of okra.

DISCUSSION

Availability of adequate amount of nutrients in soil is required for optimum growth and yield of crops [20]. The non-significant response of the plants across the treatments for numbers of leaves and stem girth coupled the significant increase in height of plants grown with N.P.K and negative control (without fertilizer and fruit peels) compared to those grown with fruit peels at 1WAP suggests that nutrients in fruit peels may not be made available to the plants immediately. This finding is in agreement with the report of [14] who reported significant performance of plants grown with orange and banana fruit peel powder after 2 Weeks After Planting (2WAP).

Banana fruit peels produced significant increase in height of okra at 2WAP, 3WAP and 4WAP while growing okra with watermelon peels brought about significantly increase in height at 5WAP, 6WAP, 7WAP and 8WAP. This indicates that nutrients in banana peels are made available to the plants at early stages of growth while nutrients in watermelon peels are made available at later stages. This finding is in agreement with the report of [14] who attributed the growth enhancing potentials of banana fruit peel to its high potassium (K) contents which helps in creating new cells, which are then organized into plant tissues.

Similarly, the significant increase in numbers of leaves recorded up to 6WAP for plants grown with banana and watermelon fruit peels suggests the suitability of these two peels for use as organic fertilizer for optimum okra production. In this study, the enhanced leave production of okra grown with orange fruit peels at later stages of growth (6 to 8 WAP) may be attributed to the delay in flowering compared to okra enhanced with banana and watermelon fruit peels. The significant increase in stem girth of okra grown with all the fruit peels compared to control further suggests that fruit peels contain sufficient amount of nutrients to support growth of okra. Banana fruit peels produced plants with the widest stems from 3WAP compared with other treatments. This finding singled out banana fruit peel as a suitable bio-organic for enhancing growth of okra. This finding also corroborates the report of [21] that banana peels can be formulated into fertilizers to enhance plant growth. [18] recommended the use of fruit peels as promising substitute to the popular inorganic fertilizer for enhanced production of crops.

In this study, application of fruit peels significantly shortens days to flowering in okra. This finding is consistent with that of [22] who recorded more days to flowering in negative control plots compared to okra grown with orange and banana fruit peels. Application of banana fruit peels influenced all the yield attributes considered in this study (number of pod, pod length and width). This finding is in agreement with the reported of [14] that application of mixture of orange and banana fruit peel powders significantly shorten the days to 50% flowering but in contrary to our finding did not influence the number of fruits per plant in okra. The yield promoting potentials of banana and orange fruit peels according to [23] could be attributed to presence of sufficient macro and micronutrients in them.

CONCLUSION

Although banana fruit peels performed better than watermelon fruit peels, findings in this study indicates that watermelon fruit peels can also be used as substitute to banana fruit peels for excellent okra production. The potentials of pawpaw, pineapple, plantain and orange fruit peels in enhancing vegetative growth and yield attributes in okra are comparable with the performance of plant growth with N.P.K fertilizer (positive control) which suggest that any of the fruit peels can be used to enhance yield of okra when banana and watermelon fruit peels are not available. Combining banana and watermelon fruit peels will be a positive step toward improved okra production considering the poor fruit enhancing potentials of watermelon fruit peels on okra. This study clearly indicated the opportunities available for converting waste to wealth. This is revealed by the significant growth and yield enhancing ability of banana fruit peels for sustainable production of okra. Watermelon fruit peels can also be used as substitute to banana fruit peels for okra production when the latter is not available. The use of banana and watermelon fruit peels in combination may help to enhance yield of okra.

REFERENCES

1. Das A, Yadav RK, Choudhary H, Lata S, Singh S, Kumar C, Kumari S, Boopalakrishnan G, Bhardwaj R, Talukdar A. Population structure, gene flow and genetic diversity analyses based on agro-morphological traits and microsatellite markers within cultivated and wild germplasms of okra (*Abelmoschus esculentus* (L.) Moench). Genet Res Crop Evol. 2022;771-791.
2. Gurve VR, Pugalendhi L, Karthikeyan G, Gnanam R, Kalaiyarasi R. Assessment of genetic variability and character association in yield related traits and yellow vein mosaic virus disease resistance in Okra (*Abelmoschus esculentus L. Moench*). Madras Agr J. 2022;108:10-12.
3. Sachan S, Sing D, Kasera S, Mishra SK, Tripathi Y, Mishra V. Singh RK. Intergrated Nutrient Management (INM) in okra (*Abelmoschus esculentus* (L.) Monech) for better growth and high yield. J Pharm Phytochem. 2017;6(5):1854-1856.
4. Dubey P, Mishra S. Effect of okra seed in reduction of cholesterol. J Ent Zoo Stud. 2017,5(4):94-97.
5. Ibeawuchi II, Obiefuna JC, Ofoh MC. Effects of row spacing on yield and yield components of okra (*Abelmoschus esculentus*) and mixture groundnut (*Arachis hypogaea*). J Agro. 2005:304-307.
6. Singh MD, Chirag G, Prakash PO, Mohan MH, Prakash G, Vishwajith O. Nano fertilizers is a new way to increase nutrients use efficiency in crop production. Int J Agri Sci. 2017;9(7):3831-3833.
7. Gemede HF, Ratta N, Haki G.D, Beyene F, Woldegiorgis, AZ. Nutritional quality and health benefits of okra (*Abelmoschus esculentus*): a review. Am J Food Sci Nut. 2015:2(1).
8. Nyande A, George MS, Kassoh FA, Bah AM. Growth and yield response of okra (*Abelmoschus esculentus*) to varying rates of different sources of organic soil amendments at Njala, Moyamba District, Southern Sierra Leone. Afr J Agric Res. 2022;17(8):1144-1154.
9. Makinde AI, Oyekale KO, Daramola DS. Growth and yield of okra (*Abelmoschus esculentus L. moench*) as influenced by fertilizer application under different cropping systems. Agric Socio-Eco J. 2022;22(1):29-36.

10. Unagwu BO, Ayogu RU, Osadebe VO. Soil Chemical Properties and Yield Response of Okra (Abelmoschus Esculentus L) to Different Organic Fertilizer Sources. J Agric Ext. 2021; 25(2): 66-74.
11. Alege GO, Yakubu MO, Egilla DT, Igata DF, Aliyu UI, Dauda D. Growth and yield response of sesame (*Sesamum indicum* L.) to bitter leaf (*Vernonia amygdalina* Del.) leaf, stem and root aqueous extracts. Fudma J Sci. 2021;5(4):150-156.
12. Akinmutimi AL, Akinlade NM. Ukpai S. Comparative effects of organic and inorganic fertilizer sources on growth, yield and nutrient content of okra in an ultisol in Southeastern Nigeria. IOSR J Agric Vet Sci. 2021;14(3):1-11.
13. Ajayi EO, Adeoye IB, Shittu OA. Economic analysis of intercropping okra with legumes. J Agric Sci. 2017;62(2):193-202.
14. Dayarathna SGARM, Karunarathna B. Effects of different fruit peel powders as natural fertilizers on growth of Okra (*Abelmoschus esculentus* L.). J Agric Sci - Sri Lanka. 2012;16(1):67-79.
15. Sagar NA, Pareek S, Sharma S, Yahia EM, Lobo MG. Fruit and vegetable waste: Bioactive compounds, their extraction, and possible utilization. Com Rev Food Sci Food Safety. 2018;17(3):512-531.
16. Jariwala HJ, Syed HS. Study on use of fruit peels powder as a fertilizer. Nat Conf Rec Adv in Env Sci Eng Tech. 2016;4:1-3.
17. Ibrahim UK, Kamarrudin N, Suzihaque MUH, Hashib SA. Local fruit wastes as a potential source of natural antioxidant: an overview. IOP Conf Ser: Mat Sci Eng. 2016;206:1-3.
18. Sakpere AMA, Bankole M, Oyekola OB, Akinyemi OS, Akosile OR, Adegboye OA, Akinropo MS, Obisesan IA. Effect of different *Moringa oleifera* extracts and fruit peels on the growth of *Solanum scabrum.* Int J Bio Sci. 2018;12(4):1543-1549.
19. Bakry AB, Ibrahim FM, Abdallah MMS, Bassiouny HMS. Effect of banana peel extract or tryptophan on growth, yield and some biochemical aspects of quinoa plants under water deficit. Int J Pharm Res. 2016;9(8):276-287.
20. Mercy S, Mubsira BS, Jenifer I. Application of different fruit peels formulations as a natural fertilizer for plant growth. Int J Sci Tech Res. 2004;3(1):300-307.
21. Qader H. Influence combination of fruits peel and fertilizer methods on growth and yield of Chickpea (*Cicer areitinum*) L. Plants. ZANCO J Pure App Sci. 2019;31(3):45-51.
22. Anhwange BA, Ugye BA, Nyiaatagher TD. Chemical composition of *Musa sapientum* (banana) peels. Elect J Env. 2009; 8(6):437-442.
23. Pathak PD, Mandavgane SA Kulkarni B D. Fruit peel waste: characterization and its potential uses. Cur Sci. 2017;113(3): 444-454.