Effect of Water Stress at Differentgrowth Stages on The Yield and Yield Components of Different Varieties of Okra *(Abelmoschus esculentus (L)*

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Abstract- This study was carried out at the College of education Akwanga, Nasarawa State, between January and April 2025 to investigate the effect of water stress at different growth stages on the yield and yield components of different varieties of okra (Abelmoschus esculentus (L.) Moech). The varieties used were Jambalay and Zarah. . The water stress treatments consisted of withdrawal of water for one week that is at: seedlings stage, vegetative stage, flowering stage and fruit formation stage. To determine the number of days for seeds to germinate, number of leaves before water stress, number of leaves per plant at weekly intervals, number of days to first flower bud appearance, number of flowers per plant, number of days to first fruit set.

Indexed Terms- Water stress, yield and yield components.

I. INTRODUCTION

Okra (*Abelmoschus esculentus* L.) also known as Ladys' finger belongs to the family Malvaceae and genus Abelmoschus. The origin of okra cannot be ascertained, it is assumed to have originated from South Asia, Ethopia or West Africa. The crop is cultivated in tropical, subtropical and warm climate regions around the world (Patil, Sutar, Joseph, Malik, Rao,Yadav, 2015). Okra can be grown on wide range of soils, but well drained fertile soils with adequate organic matter result to high yield. Okra is widely cultivated throughout the year in the tropics, especially Nigeria. However, India is ranked as the largest producer of okra followed by China and Nigeria (Narayanmoorthy & Devika, 2018; Kant & Singh, 2018).

Okra is mainly grown for the immature edible fruits. It is a nutritious food with many health benefits. It is rich in dietary fiber, minerals such as Sodium, Calcium, Potassium, Zinc, and Iron, Vitamins A, B, and C, antioxidants and folate. Okra seeds are rich in proteins (15-26%), the seed oil is edible (20-40%), and rich in unsaturated fatty acids like linoleic acid essential for human nutrition. The mature fruit and stems are used in the paper industry. Okra mucilage can be used as food additives (NRCNAs, 2006; Benchasri, 2012; Kumar, Kumar & Nadenlla, 2013, 2017; Gemede, Ratta, Haki, Woldegiogis, 2015; Dubey, & Mishra, 2017).The immature fruits are a rich source of fiber and minerals and economically important crop.

Philip, Sajo and Futuless (2010) stated that okra plays an important role in meeting the demand of the vegetable market. Okra is used as vegetable in different parts of the world, for example in America, okra is used in tomato soups. In Nigeria, the immature fruits are used for making soups, dried and grounded into powder for soups. Similarly, the okra leaves are been eaten as vegetables and the seeds are used for varieties of things. The straw of the okra plant is used as forage. (Kamalesh, 2016; Maciel, Finzi, Marra, Carvalha, Nogueira, 2018 & Petropoulous, 2018).

Okra is an economic crop in Nigeria for farmers because of the income generated from the sale of immature fruits, leaves, and dried fruits, which are made into diverse soup products. Okra has a high value with average retail market prices ranging between $3.45/kg in the frozen form to $7.07/kg when sold fresh (USDA ERS, 2016). In recent years, the total world area under cultivation of okra was o.43 million hectares and the production stood at 4.54 million tons. The yield of okra is low when compare to the yield of food crops. India produces 5784 thousand tons of okra. At present India is the largest producer of okra with 67.1%, (6.18 million tons) followed by Nigeria 15.4% (1.82 million tons) (FAOSTAT, 2020) and Sudan

9.3% annually. This production level of okra in Nigeria is low to meet the vegetable needs of 230 million people who use okra. Okra is relatively easy to grow and has high yields (Franklin, Suzuki, & Hongu, 2015).These attributes make okra a good crop for small producers to consider for cultivation, to improve their income and for the purpose of diversifying farming activities (Barbieri & Mahoney, 2009).

STATEMENTS OF THE PROBLEM

There is increased demand of okra during the dry season because of no rain therefore, okra production is low. At this time, there is abundance of sunshine and reduced disease incidence. But water is always very limited at this time. Consequently, some farmers are unable to irrigate regularly. The purpose of this study therefore, was to examine the possible effects of water withdrawal on the okra plant at various growth stages.

OBJECTIVES OF THE STUDY

The objectives of the study was to determine:

1. The effect of withdrawal of water to different varieties of okra (*Abelmoschus esculentus)* crop at seedling stage.
2. The effect of withdrawal of water to different varieties of okra at vegetative stage.
3. The effect of withdrawal of water to different varieties of okra at flowering stage.
4. The effect of withdrawal of water to different varieties of okra at fruit formation stage.

RESAERCH QUESTIONS

1. To what extent will water withdrawal affect the okra plant at the seedling stage?

2. To what extent will water withdrawal affect the okra plant at the vegetative growth stage?

3. To what extent will water withdrawal affect the okra plant at the flowering stage?

4. To what extent will water withdrawal affect the okra plant at the fruit formation stage?

HYPOTHESES

The null hypotheses was tested at 0.05 level of significance

1. There is no significant mean difference between withdrawing water at seedling stage and vegetative growth.
2. There is no significant mean difference between withdrawing water at vegetative stage and flowering.
3. There is no significant mean difference between withdrawing water at flowering stage and fruit set.

SIGNIFICANCE OF THE STUDY

The findings of this study will revealed at what growth stage does water withdrawal has more impact on the growth, yield and yield components of okra, for example: At what week does water withdrawal affects flowering of okra plant, fruit formation and number of leaves per plant?

The findings will also benefit farmers on how to irrigate okra when water supply is limited and how to plan irrigation activities.

LITERATURE REVIEW

Literature relevant to this study was reviewed and presented in themes for example: Morphology, planting periods, economic value of okra production, and nutritional quality and health benefits of Okra.

Okra belongs to the family Malvaceae and genus Abelmoschus. The plant is cultivated in tropical, subtropical and warm temperate regions around the world. Okra can be grown on wide range of soils, but well drain fertile soils with adequate organic matter result in high yield. Okra is widely cultivated throughout the year in the tropics especially Nigeria. In 2009-2010 (about 14years ago) the total world area under cultivation of okra was 0.43 million hectares and the production stood at 4.54 million tons. The current production of Okra today in Nigeria is 136 estimated at 1.82 million tonnes per year (FAOSTAT, 2020).The yield is low when compare to the yield of other food crops. India produces 5784 thousand tons of okra. At present, India is the largest producer of okra with 67.1%, followed by Nigeria, (15.4%), and Sudan (9.3%) This production level of production is low to meet the market needs of 230 million people in Nigeria, hence this paper. Okra (*Abelmoschus esculentus* L.) is a vegetable of high nutritional value and with great socio-economic importance worldwide and Nigeria most especially. Okra meets the needs of vegetable, because the immature fruits are a rich source of fibre and minerals (Kamalesh, Subrata, Asraf, Pranabesh, 2018; Maciel, Finzi, Marra, Carvalho, Nogueira, 2018; Petropoulous, 2018).

Morphology

The okra plant is a shrub with a height of 1 to 2 m. It is characterized with large leaves which range from 20 to 40 cm in length and 3 to 7 lobes each. Okra undergo cross pollination. The leaves are heart shaped and three to five lobed. The flowers are yellow with a crimson center. The fruit, or pod is hairy at the base, it tapers like a capsule 10-25 cm (4-10 inches) in length (except the dwarf varieties) that contains numerous oval dark-coloured seeds.

Planting Periods

Okra is an all-round season crop. Meaning okra can be grown year round. However, the best time to plant okra seeds in Nigeria is between April and May when the rains have started. The plant requires some climatic factors such as light, temperature and water (Tiwari, Mai, Singh & Chattopadhyay, 1998).

Economic Value of okra Production

National economic as described in literature is the production, distribution, trade, consumption of goods and services by different agents of a nation. It is about macroeconomics and also is characterized by efficiency, equity, economic freedom, economic growth and price stability. Nigeria is an open economic where buying and selling of goods and services and distribution are determined by supply and demand with little government intervention. Citizens are free to run private businesses or engage in production, distribution or rendering services and farming okra by female farmers in Nigeria is a form of production or trade which leads to income generation.

Research reports in Nigeria have shown women economic benefits in growing Okra. For example, studies done by Ewunwe, Alufobai, and Adolue (2018) in Delta state, revealed the cost ratio of okra yield by female farmers which stands at 2.99 and a return on their investment was 2.03, indicating that okra production is viable and profitable and is cultivated mostly by women. The authors concluded that okra farming is profitable and female farmers should be encouraged by government to invest more in okra production.

Okra plant takes about 40 days to mature from planting (i.e., to flowering and fruiting), it is a vegetable that is always sort for; it can be processed by drying and preserved. The leaves are sold for use in some parts of Nigeria, therefore, farming okra by women using wood ash is a veritable business for the women. Okra is multipurpose and economic crop for farmers and marketers in Nigeria because of the income generated from the sale of immature fresh leaves, fresh and dried fruits which are made into diverse soup products (Ibitoye & Kolawole, 2022).

Nutritional Quality and Health benefits of Okra

Okra is a nutritious vegetable with many health benefits. It is rich in dietary fiber, minerals (Sodium, Calcium, Potassium, Zinc, and iron), Vitamins (A, B and C), antioxidants, and folate. Okra seed is rich in proteins (15-26%), the seed oil is edible (20-40%), and rich in unsaturated fatty acids like the linoleic acid essential for human nutrition (Olsen, 2019). The mature fruit and stems are used in the paper industry. Okra mucilage can be used as food additives (NRCNAs, 2006; Bachasri, 2012. Kumar, Kumar & Nadendla, 2013), 2017; Gemede, Ratta, Haki, Woldegiosgis, Beyene, 2015; Dubey & Mishra, 2017).

Okra leaves are excellent source of fiber and also contain vitamin A and C, Calcium, protein and iron. Okra leaves are also used to balanced digestion and internal health (Olsen, 2019). Okra is used to control cholesterol level, stabilize blood sugar by regulating the rate at which sugar is absorbed from the intestinal tract. It is good for people who feel weak or exhausted, including people suffering from depression. It is also used in treating ulcers, lung inflammation, sore throat, as well as irritable bowel. Okra is good for asthma patient (Sengkhampan, Verhoef, Schols, Sajjaanatakul & Voragen, 2009).

Empirical Studies

Ali and Bilal (2019) studied response of okra to water stress in Turkey to determine the sensitivity of okra against water stress and to also examine the plant growth, yield components, water consumption, and water use efficiency under stress conditions. The findings revealed that okra is sensitivity against water stress for fresh fruits yield and yield respond factor of 1.22 while it was found tolerant for dry fruit yield with respond factor of 0.71. They concluded therefore, that okra under water stress promotes fruit yield against vegetative growth because of its increasing harvest index. Individual water stress showed highly significant effect on growth, and yield parameters of okra high yield reduction was shown in the water stressed plants (researchgate 2024).

Ghannad, Madani and Darvishi (2014) found that irrigating okra plant every seven days influenced the intervals to flowering initiation and gave the highest yield and number of fruit per plant, and seed per pod. Irrigating of okra plants every seven days significantly increased the plant height, the number of branches and leaves, leaf area, length of fruit and number of fruit per plant. Al-Ubaydi, Al-Shakry, Al-Samara, and Al-Mohammadawy (2017) studied the effect of irrigation on growth, flowering and fruits quality of okra *Abelmoschus esculentus* (L.) Moenh in Iraq. The study revealed that irrigation every 5 days increased the number of flowers and the length of fruits, while the irrigation every 7 days influenced the fruit dry matter percentage and the interaction between the experimental factors was significant in all the studied parameters. The researchers observed that reducing the time between irrigation increased all the studied characters therefore, they suggested that irrigation every 3 days improved vegetative growth, and early flowering initiation.

MATERIALS AND METHODS

RESEARCH DESIGN

A true experimental research design was used for the study, a completely ramdomised design with 3 replications.

SAMPLE FOR THE STUDY

The experiment consisted of 2 species of okra: Jambalay and Zarah.

PROCEDURE

Soil (sandy loam) was collected from the botanical garden of College of Education Akwanga, Nasarawa State, Nigeria. The soil was mixed with cow dung, in the ratio of two parts of soils to one part of cow dung. The seeds of the okra varieties was obtained from Farin Gada Jos, Plateau State. The trial was carried out at the College of Education Akwanga, between the month of January and April 2025. The trial consisted of six treatment combinations of okra species and six control combinations and four stress conditions; that is stress at seedlings stage, vegetative stage, flowering stage and pod formation stage. Each treatment was replicated 3 times.

A viability test was conducted to establish the germination status of the seeds. The seeds were sown in January 14th, 2025. The water stress treatments consisted of withdrawal of water for one week at: seedlings stage, vegetative stage, flowering stage and fruit formation stage.

METHODS OF DATA COLLECTION

Data were collected through observations which included: number of days to seeds to germinate, number of leaves before water stress, number of leaves per plant at weekly intervals, number of days to first flower bud appearance, number of flowers per plant, number of days to first fruit set, number of fruits per plant, fruit weight per plant, number of seeds per fruit, number of seeds per plant, and seed weight per plant. The matured fruits were picked dried and shelled and the total seed yields were obtained. The yield from each pot was kept separately. Each pot had two plants.

METHODS OF DATA ANALYSIS

Simple percentages was used to answer research questions while analysis of variance (ANOVA) was used to test the null hypotheses.

RESULTS

NUMBER OF DAYS TO SEED GERMINATION

Table 1: Effect of Variety on Mean Number of Days to Seed Germination

Varieties	Mean
Jambalay	4.2
Zarah	4.6

Table 1 shows the mean number of days to seed germination. There was no significant difference between the varieties with respect to mean number of days to seed germination. Jambalay took longer to germinate 4.6 days compared to 4.2 days for Zarah.

LEAF NUMBER

Table 2: Effect of Variety and Sampling Dates on Mean Number of Leaves per Plant

Varieties	Weeks After Planting			
	5	7	8	9
Jambalay	7.1	3.7	3.7	2.2
Zarah	3.3	7.0	9.0	9.1
LSD0.05	2.3	1.4	2.6	2.3

Table 2 shows that Jambalay had more leaves at 5 weeks after planting than Zarah but subsequently the reverse was the case at all other sampling dates and the differences were significant at (p=0.05).

Table 3: Effect of Stress and Sampling Dates on Mean Number of Leaves per Plant

Treatment	Weeks After Planting			
	5	7	8	9
Seedling Stage	11.2	5.7	7.4	6.1
Vegetative Stage	10.2	3.0	7.2	4.2
Flowering Stage	9.1	6.8	3.3	3.7
Pod Formation Stage	10.1	5.8	8.1	2.0
LSD0.05	1.1	2.3	2.3.1	6.1

Table 3 shows the mean number of leaves per plant for two types of Okra (*Abelmoschus esculentus* L.) studied. The two varieties of Okra studied Jambalay and Zarah showed no significant difference in number of leaves per plant 4 weeks after planting. However, significant different in number of leaves occurred at flowering stage, when water stress was applied at flowering and pod formation stage at (P=0.05).

NUMBER OF LEAVES BEFORE APPLYING WATER STRESS

Table 4: Effect of Variety on Mean Number of Leaves per Plant before Applying Water Stress

Varieties	Mean
Jambalay	9.1
Zarah	10.2

Table 4 shows the mean number of leaves per plant for two types of the Okra varieties studied. Jambalay had significantly more leaves per plant than the Zarah and the difference was significant at (P=0.05).

NUMBER OF DAYS TO FIRST FLOWER BUD APPEARANCE

Table 5: Effect of Variety and Stress on Mean Number of Days to First Flower Bud Appearance

Varieties	Stress Period				
	Seedling stage	Vegetative stage	Flowering stage	Pod formation stage	LSD 0.05
Jambalay	28.6	28.4	33.8	26.9	29.4
Zarah	50.6	49.8	54.2	51.2	14.5
Mean	39.6	39.1	42.0	40.5	

LSD 0.05 (S) 1.5
LSD 0.05 (V&S) 2.1

Table 5 shows the effect of Okra variety and stress on the mean number of days to first flower bud appearance. Days to the appearance of first flower bud was significantly longer in Zarah (P=0.05) than in Jambalay. In Zarah, the longest days to the appearance of first flower bud occurred when stress was applied at the flowering stage but in Jambalay, the longest number of days to the appearance of first flower bud occurred when stress was applied at the pod formation stage.

Across both types of Okra, the longest period to the appearance of flower bud occurred when stress was applied at the flowering stages. In general, the differences in the first flower bud were not significantly different for the different stress periods.

NUMBER OF DAYS TO FIRST FLOWER APPEARANCE

Table 6: Effect of Variety and Stress on Mean Number of Days to First flower Appearance

Varieties	Mean
Jambalay	64.4
Zarah	115.5

Table 6 shows the mean number of days to first flower appearance. There was a great significant difference between the varieties with respect to mean number of days to first flower appearance. Zarah took longer to flower (115.5 days) compared to (64.4 days) for Jambalay.

NUMBER OF DAYS TO FIRST FRUIT SET

Table 7: Effect of Variety and Stress on Mean Number of Days to First Fruit Set

Varieties	Mean
Jambalay	43.5
Zarah	55.5

Table 7 shows the mean number of days to first fruit set. There was a significant difference between the varieties with respect to mean number of days to first fruit set. Jambalay took a shorter period to set fruits (43.5 days) compared to Zarah (55.5 days) to set fruits.

NUMBER OF PODS PER PLANT

Table 8: Effect of Variety and Stress on the Mean Number of Pods Per Plant.

Varieties	Stress Period					
	Seedling stage	Vegetative stage	Flowering stage	Pod formation stage	LSD 0.05	
Jambaly	8.3	10.1	8.0	6.9	8.3	
Zara	6.4	4.0	3.7	4.7	8.3	1.0
Mean	7.4	7.1	5.9	5.8		

LSD 0.05 (S) 1.3
LSD 0.05 V&S 2.0

Table 8 shows the mean number of pods for the various Okra types. There was a significant difference in the number of pods produced per plant by the two varieties. Jambalay okra had the highest number of pods per plant with a mean of (8.3) compared to Zarah okra with the mean of (4.7). Highest number of pods occurred in Zarah when stress was applied at the vegetative stage but Zarah. Highest number of pods per plants occurred when stress was applied at the seedling stage. Number of pods per plant were significantly reduced when stress was applied at the flowering and pod formation stages.

NUMBER OF SEEDS PER POD

Table 9: Effect of Variety and Stress on Mean Number of Seeds per Pod.

Varieties	Stress Period					
	Seedling stage	Vegetative stage	Flowering stage	Pod formation stage	LSD 0.05	
Jambalay	4.1	3.1	3.2	3.1	3.4	
Zarah	3.3	4.5	6.5	4.9	4.8	1.1
Mean	3.7	3.8	4.9	4.0		

LSD 0.05 (S) 1.4
LSD 0.05 V&S 2.0

Table 9 shows the mean number of seeds per pod for the two Okra types when stress was applied at different stages of growth. With Jambalay the highest number of seeds per plant occurred when stress was applied at the seedling stage. With Zarah the highest number of seeds was applied at the flowering stage. However, there was no significant differences in number of seeds per pod irrespective of when stress was applied (P=0.05).

100 SEED WEIGHT

Table 10: Effect of Variety and Stress on the 100-Seed Weight.

Varieties	Stress Period				
	Seedling stage	Vegetative stage	Flowering stage	Pod formation stage	LSD 0.05
Jambalay	35.5	49.0	35.5	35.5	38.4
Zarah	35.0	40.0	30.5	35.1	5.5
Mean	35.3	42.0	37.8	32.0	

LSD 0.05 (S) 7.7
LSD 0.05 V&S 10.0

Table 10 shows that one hundred seed weight was significantly influenced by both stress and variety. Jambalay had a higher seed weight than Zarah and 100-seed weight was highest for Zarah. When stress was applied at the flowering stage. This may be due to an error in the reading of the weight.

DISCUSSION AND CONCLUSION

Both stress and variety (Okra types) had significant effects on the outcome of the study. In Jambalay there was a long delay in the appearance of flower bud when stress was applied at the flowering stage. Similar effect was also observed with Zarah suggesting that stress at the reproductive stage was very critical to the formation of flowers. This finding is consistent with the report of Mackey and Eaves, 1962.

The effect of stress on number of pods had minimal effect when stress was applied at the seedling and vegetative stages in both types. The effect of stress on seed yield was least when stress was applied at the seedling stage. Application of stress at other stages of growth produced similar effect on the number of seeds per plant.

Based on the results, the researcher concluded that Okra types when stressed at the flowering and pod formation stages it does adversely affects number of pods per plant. Number of seeds per plant were not significantly different irrespective of the stage of growth of the crop at which stress was applied.

SUGGESTION

Application of stress at any period of growth affected the number of seeds per plant adversely. It is advisable therefore, to ensure adequate irrigation during flowering and pod formation stages of growth of this crop for maximum pod formation.

REFERENCES

[1] Ali, & Bilal, C. (2019). Response of okra to water stress. Mustafa Kemal University Journal of Agricultural Sciences 24: 313-319. eISSN: 2667-7733 http://dergipark.org/mkutbd

[2] Al-Ubaydi, R. M., Al-Shakry, E. F., Al-Samara, M. A., & Al-Mohammadawy, S. M. (2017) Effect of irrigation on growth, flowering and fruits quality of okra Abelmoschus esculentus (L.) Monech). African Journal of Agricultural Resaerch 12(23), 2036-2040. Doi:10.5897/AJAR/http://www.academicjournals.org

[3] Barbieri, C. & Mahoney, E. (2009). Why diversification an attractive adjustment strategy? Journal of Rural Studies 25: 58-66

[4] Benchasri, S. (2012). Okra (Abelmoschus esculentus (L.) Moench) as a valuable vegetable of the world. Ratarstvo Povrtarstvo 49:105-112. 10.5937/ratpov49-1172 (CrossRef) (Google Scholar)

[5] Dubey, P., Mishra, S. (2017). A review on: Diabetes and okra (Abelmoschus esculentus (L.) Moench). Journal of Medicinal plant Studies. 5:23-26

[6] FAOSTAT, (2020). Food and Agricultural Organization Statistics.

https://www.fao.org/faostat/en/#data/QCL (Google Scholar)

[7] Franklin, M. A., Suzuki, A., Hongu, H., (2015). Okra AZ1649. The University of Arizona Cooperative Extension Service 73-78

[8] Gemede, H. F., Ratta, N., Haki, G. D., Woldegiorgis, A. Z., & Beyene, F. (2015). Nutritional quality and health benefits of okra (Abelmoschus esculentus (L.) Moench). A review of Journal of Food Process Technology 6:2. 10.4172/2157-7110.1000458 (Crossref) (Google Scholar)

[9] Ghannad, M., Madani, H., Darvishi, H. H. (2014). Effect of different sowing times, irrigation intervals and sowing methods on okra (Abelmoschus esculentus L. Monech) International Journal of Farm Allied Sciences. 3(6)683-689

[10] Greiner, T. (1894). Value of wood ashes and their uses

[11] Ibitoye, D.O. & Kolawale, A.O. (2022). Farmers' Appraisal on Okra (Albemoschus esgulentus L.) Production and Phenotypic Characterization: A synergistic Approach for Improvement. 10.3389/fpls/787577. ncbi.nlm.nih.gov

[12] Jha, Y., Subramanian, R. B. (2016). Physiology and antioxidant enzymes for alleviating salinity stress by potassium-mobilizing bacteria. In: Meena, B. R., Verma, J. P., Meena, R. S. (ed) Potassium Solubilizing Micro-organisms for Sustainable Agriculture 149-162. Springer, New Delhi, India

[13] Kamalesh, P., Sabrata, D., Asraf, A. K., Pranabesh, C. (2016). Phytochemical investigation and hypoglycemic effect of okra (Abelmoschus esgulentus). Research Journal of Pharmacy and Technology (9), 162-164

[14] Kumar, A., Kumar, P., & Nadenlla, R. (2013). A review on: Abelmoschus esculentus (L.) Moench). (Okra). International research Journal of Pharmaceutical Applied Sciences 3:129-132. (Google Scholar)

[15] Kant, K., Singh, J.P. (2020). Resources use efficiency in okrs in Meerut district of Western Uttar Pradesh. Journal of Pharmacognosy and Phytochemistry (9), 2114-2116

[16] Maciel, G. M., Finzi, R. R., Marra, A. W. C., Carvalha, F. J., Nogueira, A. P. O. (2018). Agronomic potential and selection of okra hybrids to obtain potential genitors. Horticultura Brasileira (36), 112-117

[17] Meena, V. S., Bahadur, I., Maurya, B. R., & Kumar, A
Meena, R. K., Meena, S. K., & Verma, J.P. (2016). Patassium solubilizing microorganism in evergreen agriculture: In Meena, B. R., Verma, J. P., Meena, R. S. (ed) Potassium Solubilizing Micro-organisms for Sustainable Agriculture 120. Springer, New Delhi, India

[18] Mishra, H. P. & Pandey, R. G. (1987). Effect of N and K on the seed production of okra (Abelmoschus esgulentus L.) Mill, J in calcareous soil. Indian Journal of Agronomy, 32(4), 425-427

[19] Mitchel, J. D. D. (1970). Potassium uptake by potatoes. Journal of Agricultural Science 74 (3) 495-500

[20] Narayanamoorthy, A., Davika, N. (2018) Economic and resource impacts of drip method of irrigation on okra cultivation: An analysis of field survey data. Journal of Land and Rural Studies (6), 15-33

[21] NRCNAS, (2000). "Okra" Lost crops of Africa: Vol II: Vegetables. Lost Crops of Africa. 2. Washington, D.C.: National Academics Press Google Scholar

[22] Omovbude, S., & Udensi, E. A. (2018). Response of okra (Abelmoschus esgulentus (L.). Moench) and weeds to plant spacing and weeding regime in a humid forest agro-ecology of South-Eastern Nigeria. Journal of Applied Science International 18; 1-13

[23] Olsen, N. (2019). Benefits and uses of Okra. https://www.medicalnewstoday.com
Patil, P., Sutar, S., Joseph, J. K., Malik, S., Rao, S., Yadav, S. (2015). A systematic review of the genus (Malvaceae). Rheedea 1:14-30. (Google Scholar)

[24] Petropouslos, S., Fernandes, A., Barros, L., Ferrera, I. C. (2018). Chemical composition, nutritional value and antioxidant properties of Mediterranean okra genotypes in relation to harvest stage. Food Chemistry 242: 466-474

[25] Philip, C. B., Sajo, A. A., & Futuless, K. N. (2010). Effect of spacing and NPK fertilizer on the yield and yield components of okra (Abelmoschus esgulentus L.). In Mubi Adamawa State Nigeria, Nigeria Journal of Agronomic. 9:131-134

[26] Sengkhampam, N., Verhoef, R., Schols, H. A., Sajjaanatakul, T., & Voragen, A. G. J. (2009). Characterization of cell wall polysaccharides from okra (Abelmoschus esgulentus (L.) Moench) Carbohydrates Research 344, 1824-1832

[27] Strassburger, A. S., Peil, R. M. N., Schwengber, J.E., Medeiros, C. A. B., Martins, D. D. S., Silva, J. E. (2010). Crescimento e produtividade de cultivares de montangueiro de “dianeutro” em diferentes densidades de plantio em sistema de cultivo orgânico, Bragantia (69), 623-630

[28] Tiwari, K. N. & Gavin, S. (2014). Potassium deficiency symptoms in vegetables crops. Potassium-de Wikipedia https://en.wikipedia.org

[29] USDA (2016). Okra average retail price per pound and per cup equivalent. USDA Economic Research Service

[30] Zahedi, H. (2016). Growth promoting effect of potassium, solubilizing microorganism on some crops species. In: Meena, B. R., Verma, J. P., Meena, R. S. (ed) Potassium Solubilizing Micro-organisms for Sustainable Agriculture 31-32. Springer, New Delhi, India