M.Hemalatha *et al*, International Journal of Advances in Agricultural Science and Technology,
Vol.5 Issue.8, August- 2018, pg. 47-66 **ISSN: 2348-1358**
Impact Factor: 6.057
NAAS Rating: 3.77

Integrated Plant Nutrients Supply and Foliar Nutrition on Fruit Yield, Nutrient Uptake and Availability in Okra [*Abelmoschus esculentus* (L.) Moench] Hybrid COBhH- 4 in an Alfisol of Tamirabarani Command Area

M.Hemalatha[1]*, D.Selvi[2], D.Vasanthi[3]

[1]PG Scholar

[2]Professor, Department of Soil Science and Agricultural Chemistry, AC&RI, Killikulam - 628 252

[3]Professor, Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore - 641 003

***Corresponding Author**: hema1995murugan@gmail.com ; 9442139489

Abstract: ***The present investigation was undertaken with the main objective of evaluating the effect of IPNS and foliar nutrition on soil nutrient availability, uptake and fruit yield of okra COBhH - 4. The thirteen treatments comprising of STCR-IPNS / 100 % N through FYM in alone / in combination with Micronutrients, Moringa leaf extract and Aloe vera leaf extract and Amino acids. The highest fruit yield of 24.24 t ha^{-1} was recorded by the application of STCR - IPNS + AA + MN + ALE+ MLE (FS) followed by 100 per cent N through organics + AA + MN + ALE+ MLE (FS).The per cent yield increase over control was 135.80 and 124.71 per cent respectively for STCR-IPNS followed by FYM both in combination with amino acids + Micro nuttrients + Aloevera + Moringa Leaf Extract as foliar spray. The effect of micronutrients as foliar along with STCR-IPNS was the next best treatment. The highest BCR of 5.27 was recorded by STCR-IPNS + MN + ALE + MLE (FS) followed by 4.92 by STCR IPNS + MLE (FS) (T_{10}). Among the different treatments, STCR - IPNS + Amino Acids + Micronutrients + Aloe vera + Moringa leaf extract (FS) recorded significantly the highest soil available N (282, 290 and 236 kg ha^{-1}), soil available P (27.8, 21.9 and 19.8 kg ha^{-1}) and plant N content (2.16 , 2.35 and 2.46 %), plant P (0.24, 0.38 and 0.62 %) , plant K (1.83, 2.38 and 2.92 %) and total plant N uptake (96.39 104.75 109.67 kg ha^{-1}), total P uptake (10.47, 16.99 and 27.68 kg ha^{-1}) and total K uptake (81.59, 106.11 and 130.15 kg ha^{-1}) by okra at all the three critical growth stages. The highest content and uptake of N (2.91% and 71.23 kg ha^{-1}), P (0.32% and 7.92 kg ha^{-1}), K (2.81% and 68.80 kg ha^{-1}), Zn (91.84 mg kg^{-1} and 0.225 kg ha^{-1}), Fe (427.85 mg kg^{-1} and 1.047 kg ha^{-1}) and B (29.22 mg kg^{-1} and 0.072 kg ha^{-1}) by fruits was recorded by the treatment STCR - IPNS + Amino acids + Micronutrients + Aloevera + Moringa leaf extract (FS). At all the three stages, higher NPK availability was recorded by the same treatment (T_{12}) followed by T_{13}. The treatments which received STCR-IPNS in alone or in combination with AA/ MN/ ALE/ MLE recorded higher available K (365, 330 and 312 kg ha^{-1}) content in soil compared to 100% N through organics in alone or with similar combinations.***

Keywords: STCR – IPNS, Foliar nutrition, Nutrient Availability,Uptake, Yield of Okra, Alfisol

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Introduction

Okra (*Abelmoschus esculentus*) is an herbaceous annual plant in the family Malvaceae and an economically important vegetable crop grown in many parts of tropics and sub-tropics. In India, okra is being cultivated in an area of 5,01,000 ha with 5,7,83,000 MT production and in Tamil Nadu, the area and production of Okra are 11,000 ha and 75,400 MT respect (NHB 2016- 2017). Heavy fertilization is essential for realizing potential okra fruit yield. The demand for the crop has increased and as a result the growers started applying inorganic sources of plant nutrients. This led to inadequate and imbalanced application of nutrients and this resulted in low yield and poor quality of Okra fruits. Also, the exclusive application of inorganic fertilizers creates a deleterious effect on soil fertility due to limitation of one or more nutrients including micro nutrients and poor soil health leading to decline in productivity. Therefore, the alternative choice of the farmers for maintaining the sustainable production can be achieved by the application of nutrients through organic amentments such as farm yard manure and bio fertilizers.
The basic concept underlying the principle of Integrated Plant Nutrient Supply System (IPNS) is the maintenance and possible improvement of soil fertility for sustaining the crop productivity through the combined use of organic manure, bio- fertilizer and chemical fertilizer. Organic manures not only balances the nutrient supply but also improves the physical and chemical properties of soil. Thus, a strategy for judicious combination of both organic and inorganic sources of nutrient is the most viable option for nutrient management. Foliar fertilization with multi micronutrients to achieve balanced plant nutrition is considered to play a significant role in modern sustainable vegetable production.

Plant hormones can be used to increase yield per unit area because they influence every phase of plant growth and development (Prosecus, 2006). The aloevera leaf peeling extract and powder contain the essential nutrients and phytohormones necessary for plant growth enhancement. The minerals such as calcium, magnesium, potassium, phosphorus, iron, manganese, zinc and copper along with antioxidants are rich in Moringa leaf extract. The yields of onions, bell pepper, soya beans, sorghum, coffee, tea, chili, melon and maize crops were increased when sprayed with moringa leaf extract (Fuglie, 2000). Amino acids are well known bio stimulants with positive effects on plant growth and plant yield (Mahmood Pooryousef *et al*., 2014). Keeping this in view, the present investigation was undertaken to find out the best combination of organic and inorganic fertilizers along with plant extracts as foliar spray for obtaining the maximum fruit yield of okra enhanced nutrient availability and uptake.

Materials and Methods

The field experiment was conducted at 'D' block (Field No. D-27) of Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam, during October, 2017 - January, 2018. The experiment was laid out in RBD design with three replications. The texture of the experimental soil was sandy clay loam, neutral in reaction and was low, medium and high in available N, P and K respectively. The soil was classified as fine, loamy, isohyperthermic family of Typic Haplustalf. The soil was deficient in DTPA- Zn, Fe, B and Cu,

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

whereas sufficient in DTPA – Mn content in soil. The treatments comprised of thirteen treatment combinations of organic manure *viz.*, FYM and recommend dose of fertilizer with the treatment foliar application of micro nutrients, amino acids and different plant extracts. All the treatments were given the same dose of NPK fertilizer, but FYM was applied @ 15 t ha^{-1} to the treatments T_3, T_5, T_7, T_9, T_{11} and T_{13}. Micro nutrients namely Zn, Fe and B @ 0.5, 1.0, 0.3 per cent respectively 50 ppm and plant extracts @ 50 ppm as foliar spray were given on 25, 45 and 60 days after sowing for the respective treatments. The treatments include: T_1 - Control; T_2 - STCR-IPNS; T_3 - 100% N through FYM; T_4 -T_2 + Amino Acids (AA) -Foliar spray (FS); T_5 - T_3 + Amino Acids (FS); T_6 - T_2 + Micronutrients (MN) (FS); T_7- T_3 + Micronutrients (FS); T_8 - T_2 + Aloe vera leaf extract (ALE) (FS); T_9 - T_3 + ALE (FS); T_{10} - T_2 + Moringa leaf extract (MLE) (FS); T_{11} - T_3 + MLE (FS); T_{12} - T_2 + AA + MN + ALE+ MLE (FS); T_{13} - T_3 + AA + MN + ALE+ MLE (FS).

Seeds are sown at 45×30 cm spacing on October 11, 2017. Manures and fertilizers applied in the crop as per recommended dose. The organic manures were applied one week before sowing, for proper decomposition, full dose of phosphorus and potassium and half dose of nitrogen as per treatment were applied just before the sowing. The remaining half dose of nitrogen applied 30 days after sowing. Five plants were randomly tagged in each plot to record the yield. The harvested fruits were analysed for various nutrient contents and uptake values were computed. The soil samples were collected from each experimental plot at vegetative (30 DAS), flowering (70 DAS) and post harvest stages to study the effect of treatments on chemical properties. The collected soil samples were air dried, powdered with a wooden mallet, sieved through 2 mm sieve and stored in polythene bags for various analysis. A composite soil sample from 0-15 cm from the experimental field was collected before the conduct of field experiment. The five plant samples were collected at vegetative, flowering and harvest stages from each plot randomly fruit and stover samples were collected at harvest for chemical analysis. After that these samples were weighed, shade dried and then oven dried at 60^o C for 72 hrs. The weight of oven dried sample was taken to calculate the nutrient uptake on oven dry basis. The plant samples were ground in a wiley mill to pass through 20 mesh sieve, stored in butter paper covers and analysed for various nutrients. The plant samples were ground in a wiley mill to pass through 20 mesh sieve, stored in butter paper covers and analysed for various nutrients. Soil samples collected at different growth stages of bhendi were analyzed available N (Subbiah and Asija, 1956), Phosphorus (Olsen *et al*., 1954), Potassium (Jackson, 1973), and DTPA extractable Fe, Zn and B (Lindsay and Norwell, 1978) by using standard procedures. The data were subjected to statistical scrutiny (Gomez *et al*., 1984).

Results and Discussion

Okra Fruit Yield (Table 1)

The data recorded on fruit yield (t ha^{-1}) as influenced by different treatments are furnished in Table 1 and the effect was found to be significant. The bhendi fruit yield ranged from17.28 to 24.24 t ha^{-1}. The treatment (T_{12}) which received STCR - IPNS + Amino Acids + Micronutrients + Aloevera + Moringa Leaf Extract (FS) recorded

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

significantly the highest bhendi fruit yield (24.24 t ha^{-1}) followed by the treatments T_{13} (23.10 t ha^{-1}), T_6 (20.80 t ha^{-1}) and T_7 (20.45 t ha^{-1}), the latter three being comparable with each other wherein STCR-IPNS/ 100% FYM was applied with micronutrients at three times as foliar spray. Whereas, the lowest fruit yield (10.28 t ha^{-1}) was recorded by control.

The per cent yield increase over control ranged from 93.09 to 135.80 per cent. The highest per cent yield increase was recorded by T_{12} (135.80 %) followed by T_{13} (124.71), T_{10} (112.06), T_{11} (104.86) , T_6 (102.34) and T_7 (98.93) over T_1 (control). Whereas the STCR-IPNS and 100 per cent N through FYM in alone registered an increase of 93.09 and 86.77 per cent yield increase over control. The effect of moringa leaf extract was found to significant compared to aloevera leaf extract and amino acids. The effect of micro nutrients on fruit yield was the next best to T_{12}, T_{13} and $T_{10.}$ The increase in growth parameters could naturally increased the rate of photosynthesis, increased rate of assimilation of nutrients from soil through improvements in the root growth characteristics coupled with enhanced rate of photosynthesis might have reflected in yield enhancement.

It was observed that micronutrients applied alone or combination with moringa leaf extract /alovera extract/ amino acids was found significantly effective in increasing the yield of okra as compared with control. Increased yield due to micronutrients application may be attributed to enhanced photosynthesis activity and increased in production and accumulation of carbohydrates and favourable effect on vegetative growth, and retention of flowers and fruits, increased dry matter production which attributed to greater ccumulation of photosynthesis by vegetative parts and fruits of vegetable crop.

The presence of Zn activates the synthesis of tryptophan, precursor of IAA and it is responsible to stimulate plant growth. Fe plays vital role in promoting growth characters being a component of ferrodoxin, and electron transport protein and is associated with chloroplast. It helps in photosynthesis might have helped in better vegetative growth.

Boron plays an essential role in the development and growth of new cells in the plant meristem, improves the fruit quality and fruit set. It is needed by the crop plants for cell division, nucleic acid synthesis, uptake of calcium and transport of carbohydrates (Mehraj *et al.*, 2015).

Application of organics with inorganic sources resulted in enhanced fruit length, fruit girth and ultimately increased the average fruit weight of *A. Esculentus* which is in agreement with findings of Amran *et al*. (2014).

El Awady (2003) pointed out that in moringa, there is zeatin hormone in very high concentrations of between 5 mcg and 200 mcg/g of material. Fuglie (2000) confirmed that this cytokinin (CK) related hormone increases crop yields by having effect on cell division and cell elongation when sprayed as an extract from fresh moringa leaves.

Nutrients Content and Uptake by Okra
Nitrogen Content and Uptake (Table 2 & 3)

The data revealed that N content in okra plant varied from 1.22 to 2.16, 1.38 to 2.35 and 1.56 to 2.46 per cent at 30 DAS, 70 DAS and harvest respectively. The higher N content of 2.16 per cent was recorded by T_{12} followed by T_{13} (2.02%) but was significantly different with each other at 30 DAS but at later stages found to be on par among themselves and T_4 on plant N content. The lower content of plant (1.22, 1.38 and 1.56 %) was recorded in treatment T_1 at 30 DAS, 70 DAS and harvest, respectively.

The N content of okra fruit significantly varied between 2.01 and 2.91 per cent. The higher N content of fruit (2.91%) was recorded in treatment T_{12} that received STCR - IPNS + Amino Acids + Micronutrients + Aloe vera + Moringa Leaf Extract (FS) followed by T_{13} (2.84%) which was significantly at par with treatments T_4 (2.79 %) and T_5 (2.66%).

Nitrogen uptake was significantly influenced by the treatments. In general, there was an increasing trend in N uptake at all the stages of bhendi towards maturity.

The nitrogen uptake by plant ranged between 34.79 to 96.39, 39.35 to 104.75 and 44.49 to 109.67 kg ha^{-1}at 30 DAS, 70 DAS and harvest stages, respectively.

The highest nitrogen uptake of 96.39 kg ha^{-1} was recorded in treatment (T_{12}) that received STCR – IPNS + Amino Acids + Micronutrients + Aloe vera + Moringa leaf extract (FS) and it was found to be significantly superior to the treatment T_{13} at 30 DAS however at 70 DAS and harvest, both the treatments were on par in their influence on N uptake. The lowest nitrogen uptake (34.79, 39.35, 44.49 kg ha^{-1}) was recorded in control at all the three stages, respectively.

The highest mean value of N uptake by okra fruit (71.25 kg ha^{-1}) was found in the treatment T_{12} followed by T_{13} (66.25 kg ha^{-1}), however the effect was significantly different. The lowest value of 20.87 kg ha^{-1} of N uptake by bhendi fruits was found in the control. The effect of STCR-IPNS/ 100% through FYM alone or with aloe vera leaf extract was found to be non- significant. However, the effect of amino acids on fruit N uptake was marked then aloe vera leaf extract/ moringa leaf extract.

Phosphorus Content and Uptake (Table 2 & 3)

Phosphorus content in okra fruit varied between 0.12 to 0.24, 0.24 to 0.38 and 0.30 to 0.62 per cent at 30 DAS, 70 DAS and harvest, respectively. The higher P content was recorded by T_{12} and T_{13} at all stages which were at a par in their influence. At 30 DAS, their effect was on par with T_5. The lower P content of bhendi was recorded in treatment T_1 at 30 DAS, 70 DAS and harvest (0.12, 0.24 and 0.30%) stages respectively.

Phosphorus content in okra fruits ranged between 0.22 and 0.32 per cent. The higher P content of fruit (0.32%) was recorded in treatment T_{12} which was at a par with treatments T_{10}, T_8, T_9, T_6, T_7 and T_8. The control recorded the lowest value of 0.22 per cent P content in fruit.

The phosphorus uptake by plant ranged between 3.28 to 10.47, 6.84 to 16.99, and 8.55 to 27.68 kg ha^{-1} at 30 DAS, 70 DAS and harvest stages respectively.

Among the different treatments, treatment T_{12} registered the highest P uptake (10.47, 16.99 and 27.68 kg ha^{-1}) at 30 DAS, 70 DAS and harvest stages, respectively closely followed by T_{13} however the effect was significantly superior at 30 DAS by $T_{12.}$ The lowest phosphorus uptake (3.28, 6.84, 8.55 kg ha^{-1}) was recorded in control at all three stages, respectively. At all stages, $T_{6,}$ $T_{7,}$ T_{10} and T_{11} were found to be significant in their effect on P uptake than $T_{8,}$ $T_{9,}$ T_4 and T_5 treatments.

The fruit uptake in different treatments ranged from 4.00 to 7.92 kg ha^{-1}. The effect of treatment was significantly superior than T_{12} followed by $T_{7,}$ T_6 and $T_{10.}$

Potassium Content and Uptake (Table 2 & 3)

It was observed that the potassium content of bhendi ranged from1.32 to 1.89, 1.98 to 2.40 and 2.12 to 2.92 per cent at 30, 70 DAS and harvest, respectively. The highest potassium content (1.89 and 2.40 %) was observed in treatment T_{13} which was at par with the treatment T_{12} (1.83%) at 30 DAS and 70 DAS respectively. At harvest stage, the treatment T_{12} recorded higher phosphorus content (2.92 %) and was found to be comparable with T_{13} (2.88%). Whereas the lowest phosphorus content (1.32, 1.98 and 2.12%) was observed in control at 30 DAS, 70 DAS and harvest, respectively.

NPK Content and Uptake

In general, there was an increasing trend in NPK content and uptake from vegetative to harvest stage of bhendi. The NPK content and uptake was significantly influenced due to various treatments at 30 DAS, 70 DAS and harvest stages. The highest N and P content and uptake values were found with the application of STCR-IPNS + AA + MN + ALE+ MLE (FS) (T_{12}) followed by the treatment $T_{13.}$ Whereas the highest K content and uptake was recorded in the treatment that received 100 per cent N through FYM + AA + MN + ALE+ MLE (FS) (T_{13}) followed by T_{12}. The total uptake of nutrients was governed by fruit yield and dry matter production as well as the content of these elements in their respective plant parts. It could also be owing to the adequate availability of nutrients for better growth and thereby ultimately resulting in an increased uptake. The application of amino acid as foliar might have increased the nutrient especially N by bhendi fruit.

The present finding is in line with the findings of who observed that application of 1.25 g amino acid increased the N (5.86%) and K (1.70%) contents in fenugreek plants. Okra fruits in the plants treated with amino acid formulation at 2.0 l ha^{-1} (4 times spray) recorded the highest N content (2.96 %), P content (0.576%), K content (2.70%) (Katharine *et al.*, 2016). Foliar application of amino acids to radish plants increased N content of shoots (Kaswan *et al.*, 2017)

Chattoo *et al.* (2009) proved that application of FYM @ 3 t + sheep manure @ 2 t + poultry manure @ 0.5 t + vermicompost @ 0.6 t + bio fertilizers @ 7 kg + RD NPK (60:30:30 kg ha^{-1}) recorded the maximum uptake of nitrogen (132.3 kg ha^{-1}).

The higher total content and uptake of macro and micro nutrients by tomato crop was reported by Saravaiya *et al.* (2014) which might be obtained due to higher accumulation of nutrients in soil by the application of chemical fertilizers as well as organic manures. The increased NPK content and uptake due to aloe vera leaf extract (El Sherif, 2017) in populus, moringa leaf extract in pepper (Hala *et al.*, 2017) supports the present finding.

The NPK content and uptake by fruit was significantly influenced by STCR-IPNS and 100% N (FYM). Tha highest NPK content was recorded in T_{12} with the integration of T_2 + AA + MN + ALE+ MLE (FS) followed by T_{13}, T_4 and T_5 (N) and others except T_1 (P and K). However, with reference to NPK uptake, the superiority of T_{12} and T_{13} treatments over others was observed. This might be due to the variation in fruit yield. The combined use of organic and inorganic nutrients might have resulted in solubilization of plant nutrients which lead to increased uptake of NPK (Naidu *et al.*, 2009; Prativa *et al.*, 2012).

An increase in the NPK uptake of nutrients by fruits due to application 43 t ha^{-1} of FYM + 50 per cent RDF was reported by Kumar *et al.* (2017) in okra and by combination of 100% RDF + FYM @ 20 t ha^{-1} in tomato (Tekale *et al.*, 2017).

Basha *et al.* (2015) repoted that spraying the plants with amino acids increased the nutrient content and uptake in radish. A similar findings was reported by Kumari *et al.* (2018).

Katharine *et al.* (2016) reported an increased NPK content and uptake by bhendi fruit by the application of amino acid @ 2 L ha^{-1}. The foliar application of micronutrients increased the content and uptake of Boron in the present finding which might be due to that boron might have taken part in active photosynthesis, its influence on flowering and fruit set which corroborates with the finding of Kadam *et al.* (2017) who reported an increased content and uptake of NPK and Boron with 75 % RDN through Tar Coated Briquettes with Boron @ 4 ka ha^{-1} fortification in okra.

Zn Content and Uptake (Table 4)

The concentration of Zn in stover and fruit ranged from 40.54 to 67.86 mg $kg^{-1}$and 74.68 to 91.84 ppm respectively. At harvest, the maximum Zn content (67.86 mg kg^{-1}) was recorded by treatment T_{13} followed by T_{12} (65.04 mg kg^{-1}) but both are significantly different. The effect of moringa leaf extract with 100% N through FYM, micronutrients with STCR-IPNS/100% N through FYM were the next best treatments compared to remaining

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

treatments. The minimum Zn content (40.54 mg kg^{-1}) was recorded with control treatment.

In fruit, higher concentration of Zn (91.84 mg kg^{-1}) was recorded by T_{12} that received STCR - IPNS + Amino Acids + Micronutrients + Aloevera + Moringa Leaf Extract (FS) followed by T_{13} and others. While the lower concentration (74.68 mg kg^{-1}) was registered with treatment T_1.The mean value of Zn content varied from 74.68 to 91.84 mg kg^{-1}. All the treatments were found to be significantly different from each other.

Zn removal by bhendi at harvest was influenced by different treatments. Among the different treatments, T_{13} registered the highest Zn uptake (0.293 kg ha^{-1}) followed by T_{12} (290 kg ha^{-1}) at harvest. The lowest uptake was observed in T_1 (0.116 kg ha^{-1}). All the treatments were found to have tremendous influence on stover Zn uptake by bhendi.

The Zn uptake in fruit varied from 0.138 kg ha^{-1} to 0.225 kg ha^{-1}. Among the different treatments, the highest Zn uptake (0.225 kg ha^{-1}) in fruit was obtained in the treatment T_{12} followed by T_{13} (0.208 kg ha^{-1}). The lowest uptake (0.138 kg ha^{-1}) was observed in the control treatment T_1.

Fe Content and Uptake (Table 4)

The Fe content in plant at harvest ranged from 182.04 to 238.62 mg kg^{-1} at harvest. Among the different treatments, the maximum Fe content (238.62 mg kg^{-1}) was recorded by the treatment T_{13} and was at par with treatment T_{12}. The minimum Fe content (182.04 mg kg^{-1}) was observed in control treatment. The effect of STCR-IPNS/ 100% N through FYM was found to be non- significant in alone or in combination with amino acids/ moringa leaf extract/ aloe vera leaf extract.

The variation in Fe content was reported to vary from 356.80 to 430.72 mg kg^{-1}. Higher concentration of Fe (430.72 mg kg^{-1}) was with the treatment T_{13}, that received 100% N through organics + Amino Acids + Micronutrients + Aloevera + Moringa Leaf Extract (FS) closely followed by T_{12}, T_6, T_7, T_{11}, T_9 and T_{10}. The remaining treatments including control were found to be on par with each other.

The higher Fe uptake by bhendi (1.051 kg ha^{-1}) at harvest was obtained in the treatment T_{12} which was on par with T_{13} (1.029 kg ha^{-1}). The lowest uptake was observed in the treatment T_1 (0.519 kg ha^{-1}) at harvest. The effect of STCR-IPNS / 100% N through FYM was found to be comparable either in alone or in combination with micronutrients and foliar nutrition.

The higher Fe uptake in fruit (1.047 kg ha^{-1}) was recorded by T_{12} followed by T_{13} (1.005 kg ha^{-1}). T_1 recorded the lowest uptake (0.370 kg ha^{-1}). A similar trend as in stover Fe uptake was observed among the other treatments.

B Content and Uptake (Table 4)

The treatments T_{12} and T_7 recorded higher Boron content (17.38 and 16.84 mg kg^{-1}) and was at par with

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

treatment T_{13}. The B content (14.62 mg kg^{-1}) was found to be the lowest T_1 treatment at harvest.

The application of STCR - IPNS + Amino Acids + Micronutrients + Aloevera + Moringa Leaf Extract (FS) recorded significantly the higher fruit B content of 29.22 mg kg^{-1} followed by $T_{13.}$ While the lower concentration (20.75 mg kg^{-1}) was found in treatment T_1.The mean value varied from 20.75 to 29.22 mg kg^{-1}.

The higher B uptake by bhendi (0.077 kg ha^{-1}) was recorded by the treatment T_{12} followed by T_{13}. The treatment T_1 (0.042 kg ha^{-1}) at harvest recorded the lowest B uptake.

The treatments T_{12} and T_{13} were comparable in their effect on fruit B uptake and recorded higher values of 0.072 and 0.067 kg ha^{-1} respectively. The treatments $T_{8,}$ $T_{9,}$ $T_{10,}$ T_{12} and $T_{2,}$ $T_{3,}$ $T_{4,}$ T_5 were on par with each other. T_1 recorded the lowest uptake (0.022 kg ha^{-1}).

Zn, Fe and B Content and Uptake

The Fe, Zn and B content and uptake was significantly influenced by various treatments at harvest stage. The highest Fe, Zn and B contents and uptake values were recorded by the application of STCR-IPNS + AA + MN + ALE+ MLE (FS) (T_{12}) followed by the treatment T_{13} and the lowest values were observed in control treatment.

The organic manures are fairly good source of nutrients which boosted the plants to uptake progressively beneficial elements, to increase the leaf nutrient status and eventually attain optimum growth and productivity. Bio-organic fertilization is supposed to accelerate the nutrient uptake through the tested rocket plant by increasing the permeability of root membranes for electrolytes, preventing their fixation in the soil and increasing their mobility. Different part of *M. oleifera* plants have been reported to be a rich source of important minerals as Ca, Mg, K, Fe, Zn, P, S, Cu, Mn , Se and Na which can be valorized for a balanced nutrition of populations (Abdalla, 2013).

Both the application of fertilizers and organics significantly improved the micronutrients content and uptake in okra plant. FYM might have helped in the chelation of ions in soil making them available in absorbable and usable form for plant growth resulted in increased chlorophyll content in the leaves and thus photosynthetic efficiency causing perfectional influx of photosynthates to the sink. The higher Fe uptake by the crop might be due to higher concentration of iron in the FYM and higher uptake might be due to optimum dosage of chemical fertilizers, which will in turn helps in uptake of iron. STCR-IPNS might have helped in the chelation of zinc ions in soil making them available in absorbable and optimum dosage of nutrients may also be one of the reasons for increased zinc content in the plant. The dry matter production might have increased in a positive trend in higher Zn uptake by the plant.

The higher total content and uptake of macro and micro nutrients by tomato crop was reported by (Saravaiya *et al.*, 2014) which might be obtained due to higher accumulation of nutrients in soil by the application of chemical fertilizers as well as organic manures.

Zn, Fe and B Content and Uptake by Bhendi Fruit

The Zn , Fe and B content and uptake by bhendi fruit was significantly influenced by various treatments. The treatments T_{12} and T_{13} were comparable in their effect on fruit Zn, Fe and Boron content and uptake in bhendi. The other treatments except T_1 were found to be on par with each other. Organic manures might have enhanced the nutrient status of okra fruit as well as at appropriate combination with inorganic fertilizer (Attarde *et al.*, 2012)**.** Moringa had the highest K ,Ca, Fe, Zn, Cu and vitamin C contents which might have increased the Fe and Zn content and uptake by okra fruits (Adekiya *et al.*, 2017)

Microbial decomposition of organic manures with simultaneous release of organic acids might have favoured the availability of micronutrients in soil and their uptake by crop. The extent of micronutrients uptake were higher at 100 per cent substitution of nitrogen through organics. This may be due to the faster decomposition of organic manures as a result of narrowing C:N ratio with the combined application of both organic and inorganic sources of nutrients. This increases the availability of cationic micronutrient concentration in soil solution, there by increasing the uptake of these micronutrients by the crop Naidu *et al.* (2009) reported the highest uptake of micronutrients with 50 per cent RDN + 50 per cent N through VC + BF + Panchagavya in chilli.

Satpute *et al.* (2013) reported that the application of $FeSO_4$+ $ZnSO_4$+ Borax significantly increased the uptake of Fe, Zn and B by okra fruits. The application of moringa extract recorded the highest Fe content and uptake in rocket plants and in chilli by FYM @ 10 t ha^{-1} (Kattimani *et al.*, 2010).

Soil Available Nutrients (Table 5)

Available Nitrogen

There was a decreasing trend in soil available N content was observed at all stages of bhendi towards maturity.

Among the different treatments, treatment T_{12} registered the highest soil available N (282, 290 and 236 kg ha^{-1}) at 30 DAS, 70 DAS and harvest stages respectively. Whereas, T_6, T_{10}, T_2, T_4 and T_8 were comparable at all the three stages. The lowest availability of soil N (188, 165 and 148 kg ha^{-1}) was observed in control at 30 DAS, 70 DAS and harvest stages respectively.

A significant decrease in the availability of macronutrients in the soil was observed with the advancement of bhendi crop growth period, irrespective of the treatments which might be due to the continuous removal of nutrients by the crop and loses due to fixation and leaching.

At all the three stages, the highest soil available nitrogen content was recorded by the application of STCR - IPNS + Amino Acids + Micronutrients + Aloevera + Moringa Leaf Extract (FS) (T_{12}) (282 kg ha^{-1}) followed by T_{13} (252 kg ha^{-1}).The higher rate of mineralization and release of N from the soil and fertilizers could have contributed to the increase in available N in the soil. The effect of $T_{6,}$ T_{10} ,T_2 , T_4 and T_8 were comparable at all stages.

The higher content of available nitrogen in soil may be due to the favorable conditions under integration of inorganic fertilizer and farm yard manuring which acts as a store house of energy for microorganism, is responsible for needed nutrient transformation besides providing favorable physical properties which help in the mineralization of soil N leading to higher available N. It was also observed that the available nitrogen content at harvest was slowly decreased obviously due to its uptake by okra crop (Salvi *et al.,* 2015).

Also the decomposition of organic matter might have increased the number and activity of micro-organisms and better involvement in regulation of organic carbon dynamics in soils and hence, the higher N availability in soil (Kumar *et al.*, 2017).

Available Phosphorus

The soil available phosphorus content ranged from 17.2 to 27.8, 16.7 to 21.9 and 12.8 to 19.8 kg ha^{-1} at 30 DAS, 70 DAS and harvest stages, respectively.

The maximum available phosphorus status of 27.8, 21.9 and 19.8 kg ha^{-1} was recorded by the treatment T_{12} that received STCR – IPNS + Amino Acids + Micronutrients + Aloevera + Moringa Leaf Extract (FS) and found superior over rest of the treatments. The lowest soil available phosphorus status (17.2, 16.7 and 12.8 kg ha^{-1}) was recorded in control at 30 DAS, 70 DAS and harvest stages, respectively.

The integration of STCR - IPNS + Amino Acids + Micronutrients + Aloevera + Moringa Leaf Extract (FS)) (T_{12}) followed by 100% N (FYM) in similar combinations recorded higher available P content in soil throughout the crop growth.

The higher content of available phosphorus in soil may be due to addition of STCR-IPNS with FYM besides being a direct source of P availability might have solubilized the native P in soil through release of various organic acids (Salvi *et al.,* 2015). These results corroborate the findings of (Naidu *et al*., 2009) with regard to availability of N, P, K significantly increased by the application of 50 per cent N through FYM +BF + Panchagavya.

Available Potassium

The NH_4OAc - K content of soil ranged from 292 to 365, 259 to 330 and 238 to 312 kg ha^{-1} at 30, 70 and harvest stages respectively. Maximum available potassium status (365, 330 and 312 kg ha^{-1}) was recorded in the treatment T_{12}, at 30 DAS, 70 DAS and harvest stages respectively. At all stages the control treatment recorded the lowest available k content in soil. The effect of T_{12} was found to be comparable with T_{10} T_8 T_6 T_4 and T_2. However,

the 100 % N through FYM treatment in alone and in combination exhibited lower values then STCR – IPNS treatments on available K content in soil.

Soil available potassium highly influenced by different organic and inorganic treatments at all the stages of bhendi crop growth. The treatments which received STCR-IPNS in alone or in combination with AA/ MN/ ALE/ MLE recorded higher available K content in soil compared to 100% N through organics in alone or with similar combinations.

The increase in the potassium availability the soil through addition of FYM/ STCR-IPNS night be due to the decomposition of organic matter accompanied by the release of appreciable quantities of CO_2 which when dissolved in water forms carbonic acid, which is capable of decomposing certain K containing primary minerals and release of nutrients in soil solution.The similar findings was reported by Kumari *et al.* (2018). The increase in K availability might be due to that shifting of equilibrium among the forms of K from relatively exchangeable K to soluble forms in the soil.

Benifit Cost Ratio (Table 1)

The cost benefit analysis for Okra as influenced by IPNS and foliar nutrition has been worked out (Table 1). The treatment which received the integrated application of STCR- IPNS + AA + MN + ALE+ MLE (FS) (T_{12}) as foliar spray recorded the highest benefit cost ratio of 5.27 which was followed by the treatment STCR-IPNS + MLE (T_{10}) with a benefit cost ratio of 4.92 and T_6 (STCR-IPNS + MN (FS) (4.66). The lowest B: C ratio was registered with the control treatment (T_1) (2.97) where neither fertilizer nor manure was added. In general, the BCR values were higher wherever STCR-IPNS was applied in combination with micronutrients/ amino acids/ aloe vera leaf extract/ moringa leaf extract. The next best treatment in terms of BCR to T_{12} was the T_{10} wherein the STCR-IPNS was integrated with moringa leaf extract (4.92) followed by T_6 *viz.*, STCR-IPNS + MN (FS) (4.66). This was in agreement Shahbaz *et al.*, (2014) with NPK and organics. In the treatments wherein STCR-IPNS was involved either alone or in combination, the FYM was applied at the rate of only 4 t ha^{-1}. On comparing the fruit yield in both the treatments, the fruit yield recorded by the treatment T_{12} is 24.24 which is only 1.14 t ha^{-1} more than the treatment T_{13} (23.1). The difference in the treatment cost made the T_{12} to perform superior than T_{13} and hence, the benefit cost ratio for the treatment T_{12} was higher than the treatment T_{13}.

Conclusion

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

From the present study, it is clearly evident that the application of STCR-IPNS + AA +MN + ALE+ MLE (FS) (T_{12}) followed by 100 per cent N through FYM + AA +MN + ALE+ MLE (FS) (T_{13}) performed better than other treatments with respect to plant and fruit nutrient concentration, nutrient uptake, nutrient availabilty and fruit yield of Okra (COBhH– 4). The highest BCR was recorded with STCR-IPNS + AA + MN + ALE+ MLE (FS) (T_{12}) followed by the application of STCR-IPNS + Moringa leaf extract (MLE) (FS) (T_{10}). The benefit from the rupees per unit invested was maximum for the application of STCR-IPNS + AA + MN + ALE+ MLE (FS) compared to other treatments. Hence, it is concluded that the application of STCR – IPNS with micro nutrients (Zn @ 0.5 %; Fe @ 1.0 %; B @ 0.3 %) + MLE + ALE + AA as foliar spray each at 50 ppm thrice on 25, 45 and 60 DAS may be recommended to obtain maximum fruit yield with higher Benefit Cost Ratio besides sustaining the soil fertility and nutritional quality of okra (COBhH- 4).

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Table 1. IPNS and Foliar Nutrition on Yield and BCR of Okra (COBhH-4)

Treatments	Fruit Yield ($t\ ha^{-1}$)	Percent Increase Over Control	Benifit Cost Ratio
T_1 - Control	10.28	-	2.58
T_2 - STCR-IPNS	19.85	93.09	4.54
T_3 - 100% N through FYM	19.20	86.77	3.52
T_4 - T_2 + Amino Acids (AA) - Foliar spray (FS)	20.18	96.30	4.58
T_5 - T_3 + Amino Acids (FS)	19.94	93.97	3.63
T_6 - T_2 + Micronutrients (MN) (FS)	20.80	102.33	4.66
T_7 - T_3 + Micronutrients (FS)	20.45	98.93	3.69
T_8 - T_2 + Aloevera Leaf Extract (ALE) (FS)	20.26	97.08	4.59
T_9 - T_3 + ALE (FS)	20.15	96.01	3.66
T_{10} - T_2 + Moringa Leaf Extract (MLE) (FS)	21.80	112.06	4.92
T_{11} - T_3 + MLE (FS)	21.06	104.86	3.82
T_{12} - T_2 + AA +MN + ALE+ MLE (FS)	24.24	135.80	5.27
T_{13} - T_3 + AA +MN + ALE+ MLE (FS)	23.10	124.71	4.06
SEd	0.52	-	-
CD (p = 0.05)	1.09	-	-

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Table 2. IPNS and Foliar Nutrition on Macro Nutrients Content of Okra (COBhH-4)

Treatments	Nutrient Content (%)											
	N				P				K			
	30 DAS	70 DAS	Harvest		30 DAS	70 DAS	Harvest		30 DAS	70 DAS	Harvest	
			Stover	Fruit			Stover	Fruit			Stover	Fruit
T_1 - Control	1.22	1.38	1.56	2.01	0.12	0.24	0.30	0.22	1.32	1.98	2.12	2.18
T_2 - STCR-IPNS	1.70	1.96	2.20	2.26	0.22	0.30	0.42	0.28	1.52	2.20	2.58	2.45
T_3 - 100% N through FYM	1.65	2.00	2.25	2.37	0.19	0.28	0.38	0.26	1.43	2.14	2.46	2.38
T_4 - T_2 + Amino Acids (AA) - Foliar spray (FS)	1.98	2.30	2.36	2.79	0.20	0.28	0.40	0.25	1.60	2.25	2.66	2.48
T_5 - T_3 + Amino Acids (FS)	1.94	2.26	2.38	2.66	0.24	0.26	0.41	0.26	1.54	2.28	2.70	2.50
T_6 - T_2 + Micronutrients (MN) (FS)	1.80	2.18	2.29	2.42	0.22	0.30	0.44	0.28	1.53	2.26	2.64	2.56
T_7 - T_3 + Micronutrients (FS)	1.84	2.20	2.27	2.50	0.21	0.29	0.48	0.30	1.57	2.22	2.68	2.48
T_8 - T_2 + Aloevera Leaf Extract (ALE) (FS)	1.75	2.08	2.20	2.31	0.20	0.27	0.38	0.28	1.74	2.32	2.78	2.80
T_9 - T_3 + ALE (FS)	1.66	1.76	1.98	2.40	0.19	0.28	0.40	0.29	1.72	2.34	2.76	2.78
T_{10} - T_2 + Moringa Leaf Extract (MLE) (FS)	1.88	2.26	2.34	2.47	0.21	0.30	0.46	0.28	1.70	2.35	2.78	2.74
T_{11} - T_3 + MLE (FS)	1.94	2.28	2.30	2.43	0.22	0.31	0.48	0.26	1.73	2.32	2.80	2.75
T_{12} - T_2 + AA +MN + ALE+ MLE (FS)	2.16	2.35	2.46	2.91	0.24	0.38	0.62	0.32	1.83	2.38	2.92	2.81
T_{13} - T_3 + AA +MN + ALE+ MLE (FS)	2.02	2.31	2.40	2.84	0.23	0.36	0.58	0.30	1.89	2.40	2.88	2.76
SEd	0.04	0.03	0.17	0.03	0.008	0.03	0.03	0.02	0.04	0.05	0.04	0.09
CD (p = 0.05)	0.09	0.07	0.36	0.07	0.01	0.06	0.07	0.04	0.08	0.11	0.08	0.19

DAS- Day after sowing

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Table 3. IPNS and Foliar Nutrition on Macro Nutrient Uptake of Okra (COBhH-4)

Treatments	Nutrient Uptake (kg ha^{-1})											
	N				P				K			
	30 DAS	70 DAS	Harvest		30 DAS	70 DAS	Harvest		30 DAS	70 DAS	Harvest	
			Stover	Fruit			Stover	Fruit			Stover	Fruit
T_1 - Control	34.79	39.35	44.49	20.87	3.28	6.84	8.55	2.25	37.64	56.47	60.47	22.63
T_2 - STCR-IPNS	58.60	67.56	75.83	45.31	7.58	10.34	14.48	5.68	52.39	75.83	88.93	49.13
T_3 - 100% N through FYM	53.81	65.22	73.42	45.98	6.21	9.09	12.35	4.98	46.60	69.81	80.30	46.20
T_4 - T_2 + Amino Acids (AA) - Foliar spray (FS)	71.75	83.51	85.68	56.86	7.26	10.19	14.55	5.10	58.11	81.73	96.57	50.55
T_5 - T_3 + Amino Acids (FS)	69.49	80.96	85.23	53.57	8.42	9.27	14.71	5.24	55.12	81.64	96.73	50.35
T_6 - T_2 + Micronutrients (MN) (FS)	71.98	87.20	91.60	50.84	8.58	12.04	17.66	5.81	61.20	90.35	105.58	53.78
T_7 - T_3 + Micronutrients (FS)	71.73	85.76	88.49	51.63	8.19	11.31	18.71	6.20	61.20	86.54	104.48	51.23
T_8 - T_2 + Aloevera Leaf Extract (ALE) (FS)	64.68	76.86	81.34	47.27	7.39	10.03	14.08	5.73	64.32	85.73	102.73	57.29
T_9 - T_3 + ALE (FS)	60.54	64.18	72.29	48.84	6.75	10.21	14.60	5.83	62.73	85.34	100.65	56.58
T_{10} - T_2 + Moringa Leaf Extract (MLE) (FS)	70.58	84.92	87.98	54.39	7.69	11.19	17.16	6.17	63.90	88.33	104.41	60.31
T_{11} - T_3 + MLE (FS)	72.83	85.47	86.26	51.69	8.06	11.74	17.99	5.53	65.00	87.12	104.92	58.49
T_{12} - T_2 + AA +MN + ALE+ MLE (FS)	96.39	104.75	109.67	71.23	10.47	16.99	27.68	7.92	81.59	106.11	130.15	68.80
T_{13} - T_3 + AA +MN + ALE+ MLE (FS)	87.13	99.64	103.50	66.22	9.70	15.51	25.00	7.00	81.50	103.51	124.20	64.45
SEd	2.1	2.59	4.42	1.05	0.28	1.42	1.43	0.13	2.45	3.37	3.25	1.23
CD (p = 0.05)	4.53	5.35	6.98	2.18	0.58	2.93	2.96	0.27	5.06	6.97	6.71	2.55

DAS- Day after sowing

 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Table 4. IPNS and Foliar Nutrition on Micro Nutrients Content and Uptake of Okra (COBhH-4)

Treatments	Zn				Fe				B			
	Content		Uptake		Content		Uptake		Content		Uptake	
	Stover	Fruit	Stover	Fruit	Stover	Fruit	Stover	Fruit	Stover	Fruit	Stover	Fruit
T_1 - Control	40.54	74.68	0.116	0.078	182.04	356.80	0.519	0.370	14.62	20.75	0.042	0.022
T_2 - STCR-IPNS	46.45	78.78	0.160	0.158	196.84	358.62	0.678	0.719	15.46	23.68	0.053	0.047
T_3 - 100% N through FYM	48.32	76.94	0.158	0.149	200.54	364.56	0.655	0.707	15.28	22.94	0.050	0.044
T_4 - T_2 + Amino Acids (AA) - Foliar spray (FS)	50.78	81.18	0.184	0.165	208.32	380.14	0.756	0.775	15.65	23.36	0.057	0.048
T_5 - T_3 + Amino Acids (FS)	50.34	80.94	0.180	0.163	210.08	382.76	0.753	0.771	15.48	22.82	0.056	0.046
T_6 - T_2 + Micronutrients (MN) (FS)	60.42	87.38	0.241	0.184	222.72	416.20	0.890	0.874	16.48	28.64	0.066	0.060
T_7 - T_3 + Micronutrients (FS)	58.56	86.94	0.228	0.180	224.46	412.68	0.875	0.852	16.84	26.12	0.066	0.054
T_8 - T_2 + Aloevera Leaf Extract (ALE) (FS)	54.12	79.12	0.200	0.162	211.62	384.56	0.782	0.787	15.48	24.56	0.057	0.050
T_9 - T_3 + ALE (FS)	52.36	78.08	0.191	0.159	212.44	390.28	0.775	0.794	15.54	25.06	0.057	0.051
T_{10} - T_2 + Moringa Leaf Extract (MLE) (FS)	54.38	88.10	0.205	0.194	218.54	398.30	0.822	0.877	15.90	24.90	0.060	0.055
T_{11} - T_3 + MLE (FS)	57.14	87.48	0.214	0.186	220.18	404.42	0.826	0.861	15.62	24.80	0.059	0.053
T_{12} - T_2 + AA +MN + ALE+ MLE (FS)	65.04	91.84	0.290	0.225	235.80	427.85	1.051	1.047	17.38	29.22	0.077	0.072
T_{13} - T_3 + AA +MN + ALE+ MLE (FS)	67.86	89.10	0.293	0.208	238.62	430.72	1.029	1.004	16.28	28.58	0.070	0.067
SEd	1.10	1.47	0.006	0.002	2.68	19.48	0.02	0.04	0.36	1.32	0.002	0.001
CD (p = 0.05)	2.29	0.71	0.01	0.004	5.54	40.21	0.05	0.09	0.75	0.64	0.004	0.003

DAS- Day after sowing

ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Table 5. IPNS and Foliar Nutrition on Available Nutrients of Okra (COBhH-4)

Treatments	Available Nutrient (kg ha^{-1})								
	N			P			K		
	30 DAS	70 DAS	Harvest	30 DAS	70 DAS	Harvest	30 DAS	70 DAS	Harvest
T_1 - Control	188	165	148	17.2	16.7	12.8	292	259	238
T_2 - STCR-IPNS	276	285	232	26.4	20.1	18.6	369	316	310
T_3 - 100% N through FYM	255	268	220	19.3	18.4	15.8	332	308	292
T_4 - T_2 + Amino Acids (AA) - Foliar spray (FS)	275	286	230	25.6	20.5	18.4	366	322	312
T_5 - T_3 + Amino Acids (FS)	252	265	218	19.6	18.0	15.9	337	310	293
T_6 - T_2 + Micronutrients (MN) (FS)	276	284	230	25.4	20.4	18.2	368	325	310
T_7 - T_3 + Micronutrients (FS)	260	272	224	19.4	17.6	15.8	330	305	298
T_8 - T_2 + Aloevera Leaf Extract (ALE) (FS)	275	288	235	24.9	20.7	19.0	364	320	308
T_9 - T_3 + ALE (FS)	250	261	214	19.0	17.8	15.9	328	300	282
T_{10} - T_2 + Moringa Leaf Extract (MLE) (FS)	276	286	228	25.8	20.9	19.2	360	324	310
T_{11} - T_3 + MLE (FS)	254	265	216	19.5	17.2	14.9	330	304	288
T_{12} - T_2 + AA +MN + ALE+ MLE (FS)	282	290	236	27.8	21.9	19.8	365	330	312
T_{13} - T_3 + AA +MN + ALE+ MLE (FS)	252	273	225	20.0	17.4	15.2	332	310	295
SEd	5.21	4.55	5.20	0.36	0.42	0.34	4.76	5.10	6.28
CD (p = 0.05)	10.77	9.41	10.47	0.75	0.88	0.70	9.83	10.54	12.97

DAS- Day after sowing

References

Abdalla, M. M. 2013. The potential of Moringa oleifera extract as a biostimulant in enhancing the growth, biochemical and hormonal contents in rocket (*Eruca vesicaria subsp. sativa*) plants. *International Journal of plant physiology and biochemistry*, **5(3)**: 42-49.

Adekiya, A., Agbede, T., Aboyeji, C., Dunsin, O., & Ugbe, J. (2017). Green manures and NPK fertilizer effects on soil properties, growth, yield, mineral and vitamin C composition of okra (Abelmoschus esculentus (L.) Moench). *Journal of the Saudi Society of Agricultural Sciences*.

Amran, H. A., Prasad, V. M., & S.Saravanan. (2014). Effect of FYM on growth, yield and fruits quality of okra (*Abelmoschus esculentus* L. Moench). *IOSR J. of Agriculture and Veterinary Science, 7*(3), 07-12.

Attarde, S., Narkhede, S., Patil, R., & Ingle, S. (2012). Effect of organic and inorganic fertilizers on the growth and nutrient content of Abelmoschus esculentus (okra crop). *International Journal of Current Research, 4*(10), 137-140.

Basha, D., & El-Aila, H. (2015). Response of foliar spraying with amino acids and integrated use of nitrogen fertilizer on Radish (Raphanus sativus L.) plant. *International Journal of ChemTech Research, 8*(11), 135-140.

Chattoo, M. A., Ahmad, N., J.A.Wani, Najar, G. R., Vala, J., & Faheema, S. (2009). Effect of organic manures and inorganic fertilizers on nutrient uptake in Okra (Abelmoschus esculentus (L.) Moench). *Environ. Ecol, 27*(4), 1455-1457.

El Awady, A. (2003). Bachelor Thesis. Cairo University, Cairo, Egypt.

El Sherif, F. (2017). Aloe vera Leaf Extract as a Potential Growth Enhancer for Populus Trees Grown Under in vitro Conditions. *American Journal of Plant Biology, 2*(4), 101-105.

Fuglie, L. (2000). New uses of Moringa studied in Nicaragua. *ECHO Development Notes, 68*, 1-25.

Gomez, K. A., Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*: John Wiley & Sons.

Hala, H., & Nabila, A. E. (2017). Effect of Moringa oleifera Leaf Extract (MLE) on Pepper Seed Germination, Seedlings Improvement, Growth, Fruit Yield and its Quality. *Middle East J, 6*(2), 448-463.

Jackson, M. L. 1973. Soil Chemical Analysis. *Prentic Hall (India) Pvt. Ltd. New Delhi*.

Kadam, D., Kasture, M., Dodake, S., Dhopavkar, R., & Dademal, A. (2017). Effect of boron and Konkan Annapurna briquettes on yield, nitrogen use efficiency and nutrient uptake by okra (Abelmoschus esculentus (L.). *International Journal of Chemical Studies 3*(5), 214-217.

Kaswan, P., Yadav, P., Jakhar, R., Kumawat, A., & Kumar, H. (2017). Effect of Different Varieties and FYM Levels on Yield and Quality of Onion (Allium cepa L.) in Arid Western Rajasthan, India. *Int. J. Curr. Microbiol. App. Sci, 6*(6), 497-503.

Katharine, S., Mariappan, G., Radhika, K., & Hemalatha, S. (2016). Influence of amino acid formulation on okra and brinjal. *Asian Journal of Soil Science, 11*(1), 115-119.

Kattimani, S. K., & Shashidhara, G. (2010). Integrated nutrient management in chilli genotypes. *Karnataka Journal of Agricultural Sciences, 19*(3).

Kumari, M., & Tripathi, D. (2018). Influence of integrated nutrient management on yield and uptake of tomato (solanum lycopersicum l.) and availability of nutrients in soil under mid hill conditions of Himachal Pradesh.

Kumar, V., Saikia, J., & Nath, D. (2017). Effect of integrated nutrient management on growth, yield, and quality of okra (Abelmoschus esculentus (L). Moench) cv. Arka Anamika. *IJCS, 5*(5), 2001-2003.

Lindsay, W. L., & Norvell, W. A. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper1. *Soil science society of America journal, 42*(3), 421-428.

Mahmood Pooryousef and Khoshnood Alizadeh. 2014. Effect of foliar application of free amino acids on alfalfa performance under rainfed conditions. *Research.crops*, **15(1)**: 254-258.

Mehraj, H., Taufique, T., Mandal, M., Sikder, R., & Uddin, A. J. (2015). Foliar Feeding of Micronutrient Mixtures on Growth and Yield of Okra (Abelmoschus esculentus). *American-Eurasian J Agric. & Environ. Sci, 15*(11), 2124-2129.

Naidu, D. K., Radder, B., Patil, P., Hebsur, N., & Alagundagi, S. (2009). Effect of integrated nutrient management on nutrient uptake and residual fertility of chilli (Cv. byadgi dabbi) in a vertisol. *Karnataka Journal of Agricultural Sciences, 22*(2), 306-309.

National Horticultural Board. 2016-18. Area and Production of Horticultural Board. http://nhb.gov.in/statistics/Publication/Horticulture.

Olson, S. R. (1954). *Estimation of available phosphorus in soils by extraction with sodium bicarbonate*: US Government Printing Office.

Prativa, K., & Bhattarai, B. (2012). Effect of integrated nutrient management on the growth, yield and soil nutrient status in tomato. *Nepal Journal of Science and Technology, 12*, 23-28.

Prosecus, P. 2006. Biosynthesis - Plant Hormones and Growth and Regulators: Chemistry and Biology. *Biosynth Ag.Co.*, Switzerland.

Salvi, V., Minal, S., Bhure, S., & Khanvilkar, M. (2015). Effect of integrated nutrient management on soil fertility and yield of okra in coastal region of Maharashtra. *Asian Journal of Soil Science, 10*(2), 201-209.

Satpute, N., Suryawanshi, L., Waghmare, J., & Jagtap, P. (2013). Response of summer okra (cv. Phule Utkarsha) to iron, zinc and boron in inceptisol. *Asian Journal of Horticulture, 8*(2), 541-546.

Saravaiya, S., Wakchaure, S., Jadhav, P., Tekale, G., Patil, N., and S. Dekhane. 2014. Effect of foliar application of micronutrients in tomato (*Lycopersicon esculentum* Mill.) cv. GUJARAT TOMATO-2. *Asian Journal of Horticulture*, **9(2)**: 297-300.

Shahbaz, M., Akhtar, M. J., Ahmed, W., and A. Wakeel. 2014. Integrated effect of different N-fertilizer rates and bioslurry application on growth and N-use efficiency of okra (*Hibiscus esculentus* L.). *Turkish Journal of Agriculture and Forestry*, **38(3)**: 311-319.

Subbiah, B. (1956). A rapid procedure for the determination of available nitrogen in soils. *Curr Sci*, *25*, 259-260.

Tekale, G., Saravaiya, S., Jadhav, P., Tekale, C., & Patel, R. (2017). Integrated Nutrient Management (INM) on Nutrient Availability, Uptake and Yield of Tomato (Lycopersicon esculentum Mill.) cv."Gujrat Tomato-2". *Int. J. Curr. Microbiol. App. Sci*, *6*(5), 864-874.

