Clean Agritechnique Efficiency Using Compost, Halex-2 and Seaweed on Yield and Quality of Okra

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ABSTRACT

Two field experiments were conducted at the Faculty of Agriculture, (El-shatby), Alexandria University, during the summer seasons of 2017 and 2018, in order to study the effect of compost, Halex-2 and Seaweed on okra yield and quality (cv. Turkey). The effects of the treatments on the growth, yield and plant nutrient contents of shoots and fruits were determined. The results showed that using T1, T7, T8, T9, T10 and T11 enhanced significantly vegetative growth characters (plant height cm, No. leaves/plant, No. of branches/plant, leaf area index cm², shoot, root fresh and dry weights and nutritional status of plants in leaves and fruits) except T2, T3 gave the highest values in chlorophyll reading of leaves. From data it is obvious that T4 gave the lowest mean values of the given characters. Treatments contained Halex-2 and seaweed increased significantly all morphological characteristics and qualities of okra. The treatments (T7, T9, T10 and T12) lead to increase mineral contents, vitamin C and T.S.S. of fruits compared with T4 treatment. The highest values of total yield were achieved by T9 compared with T4 treatment. The use of T1, T8 and T9 were also increased mean values of the No. of fruits/plant, fruit length, fruit diameter and average fruit weight significantly compared with other treatments. This study demonstrated the possibility of producing a good yield of okra safe and healthy without any applying chemical fertilizers via integration of compost, Halex-2 and Seaweed algae as a Clean Agriculture technique.

Keywords: compost; Halex-2; seaweed and okra.

1. Introduction

Okra (Abelmoschus esculentus L.) Malavaceae family is a good source of carbohydrates, vitamin A, B, C, and rich in protein, calcium, potassium and other minerals (Akanbi et al., 2004; Adhikari and Piya 2020). High iodine content of fruits is considered useful for control of goiter disease. Crude fiber of mature dried pods and stems is utilized in paper industry. Also, okra leaves are used for preparation of anti-inflammatory medicine (Naidu et al., 2000 and Vikash et al., 2017).

Compost made from plant residues (Chukwujindu, et al., 2006 and Abbas et al., 2019). The advantages of compost fertilizer in crop production includes ready availability of materials for their preparation, gradual release of nutrients without being wasted through leaching. So effectiveness of compost depends on source and type of organic material, method of composting and compost maturity (Adebayo et al., 2013). Also, compost increased soil drainage, aeration, water holding capacity, nutrient holding capacity and being environmentally friendly has made compost application popular among farmers (Adeediran et al., 2003 and Abbas et al., 2019).

Halex-2 is consists of Nitrogen-fixing strains (Azotobactor + Azospirillum+ Klebsiella sp.) that considered as beneficial microorganisms in a viable state intended for seed, soil or root application with the objective of increasing the number of such microorganisms (Alkaff and Hassan, 2003; Vikhe 2014).

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They influence the total soil microflora, soil enzyme activity so all of them due to soil health (Dar et al., 2010 and Vikhe 2014). Certain microbial process access the extent of the availability of nutrients in a form which can be easily assimilated by the plants (Rao, 1995 and Vikhe 2014). They produce growth promoting substances and vitamins and help to maintain soil fertility and suppress the incidence of pathogen and control diseases (Bagyaraj, 2003; Sandesh et al., 2019). Inoculation with a mixture of plant growth-promoting bacteria \( (Azospirillum, Azotobacter and Klebsiella) \) as a biofertilizer is called Halex-2 had a strong impact on growth, yield components and bulb quality of onion (Yaso et al., 2007).

Seaweed algae are one of the most important marine resources in the world and are widely used as human food, animal feed and raw material for many industries. These products improve seeds germination, seedlings development, increase plant tolerance to environmental stresses (Zhang and Erivn, 2004 & 2008 and Abul Faiz Md.Jamal Uddin et al., 2019), and enhance plant growth and yield (Hong et al., 2007; Zodape et al., 2008; Khan et al., 2009; Kumari et al., 2011 and Abul Faiz Md.Jamal Uddin et al., 2019). At present, one of the most promising applications of seaweeds is their use as plant bio-stimulants. This influence is explained on the basis of containing plant growth-promoting substances such as cytokinines, auxins, gibberellins, abscisic acid, ethylene, polyamines and betaines in the algal extracts (Blunden et al., 2010; Prasad et al., 2010; Yokoya et al., 2010 and Abul Faiz Md.Jamal Uddin et al., 2019).

This present study was conducted to assess the effect of compost and seaweed as organic fertilizers, halex-2 as a biofertilizer on yield and yield attributing characters of okra plant and also to investigate their effectiveness when applied instead of chemical fertilizers.

### 2. Materials and Methods

#### 2.1. Experimental location and arrangement

Two open field experiments were conducted at the experimental farm of the Faculty of Agriculture (El-Shatby), Alexandria University (Vegetable department) during summer of the two growing seasons at 20th and 24th June, 2017 and 2018, respectively with okra (cv. Turkey) seeds. The experimental soil was sampled twice at the beginning of the first growing season, 2017 and after the end of second growing season, 2018. As well as compost and water source of surface irrigation of the farm were analyzed for some physical and chemical properties according to the methods outlined in Page et al., (1982) as shown in Tables (1,2,3 and 4).

#### 2.2. Experimental materials:

Compost from plant residues was added at 7 ton/fed., total amount of compost for each treatment was applied prior to the soil about 20 days before culture. Inoculum preparation of Halex-2; consist of some species \( (Azotobacter + Azospirillum+ Klebsiella) \) sp., which cause nitrogen fixation were used in soil. Halex-2 species were obtained from the Faculty of Agriculture (El-Shatby), Alexandria University (Prof. Dr. Gamal Hassona Lab.). It was added at 1kg/fed. It was mixed with the seeds of okra for 2 hours before culture. At planting, two mixed seeds were dropped per hole and then irrigated with surface irrigation after sowing. Inoculum preparation of Seaweed algae; from commercial company of seaweed extract powder was added at 4kg/fed. It prepared before planting; it was mixed with seeds and added some of tap water for 2 hours before culture. At the planting, two mixed seeds were dropped per hole and then irrigated. Treatments were carried out in this investigation; T1-Halex-2, T2- Seaweed algae, T3- Halex-2 + Seaweed algae (Mixture), T4-50 % compost , T5-50% compost + Halex-2 , T6-50% compost + Seaweed algae, T7-50% compost + Mixture ,T8-100% compost, T9-100% compost + Halex-2 ,T10- 100% compost + Seaweed algae ,T11-100% compost + Mixture, T12-Control (recommended doses of chemical fertilizer N, P and K of Ammonium nitrate 33.5% = 400 kg/fed. + Super phosphate 15.5% = 250 kg/fed. + Potassium sulphate 48% = 200 kg/fed).

#### 2.3. Experimental design:

Two field experiments were carried out in a randomized complete blocks design with 3 replications (RCBD). Total plot area was \((4.5m \times 0.80m = 3.6m^2)\) and the distance between two hills was 70 cm, seven plants per plot. Surface irrigation was used two times weekly. Weeds were controlled by hand hoeing once a week after sowing.
Table 1: Some physical and chemical properties of the experimental surface soil before growing season 2017.

| Soil properties | Nutrients available (mg kg⁻¹) |
|----------------|--------------------------------|
| Particle distribution: | KCl – extractable (N) 7.4 mg/kg |
| Sand | 52.49% |
| Silt | 12.00% |
| Clay | 38.48% |
| Texture class | NaHCO₃ – extractable (P) 550 mg/kg |
| Sandy clay loam | Soluble cations (meq / L) |
| pH (1:1) | 8.5 Ca²⁺ 0.82 |
| EC (dS m⁻¹) (1:1) | 0.9 Mg²⁺ 0.41 |
| Total CaCO₃ | 28 Na⁺ 7.5 |

Organic matter = 0.83 %

Table 2: Some physical and chemical properties of the experimental surface soil after the end of second growing season 2018.

| Treatments | Soil properties | Available mg/kg |
|------------|----------------|---------------|
|            | 1:2 water extract |               |
|            | pH | EC dc/m | O.M% | O.C% | N | P | K |
| T1 | 8.2 | 1.3 | 0.38 | 0.22 | 7.7 | 37 | 875 |
| T2 | 8.2 | 0.6 | 2.70 | 1.57 | 4.0 | 32 | 850 |
| T3 | 8.6 | 1.7 | 2.80 | 1.62 | 6.9 | 38.5 | 875 |
| T4 | 8.1 | 0.8 | 2.40 | 1.39 | 5.0 | 75.5 | 1125 |
| T5 | 8.1 | 1.1 | 3.20 | 1.86 | 6.4 | 62 | 1050 |
| T6 | 7.9 | 1.0 | 1.90 | 1.10 | 10.0 | 95.5 | 950 |
| T7 | 7.9 | 1.0 | 2.40 | 1.39 | 7.7 | 86 | 850 |
| T8 | 8.0 | 1.3 | 0.19 | 1.11 | 6.6 | 81 | 1050 |
| T9 | 7.8 | 2.1 | 0.95 | 0.55 | 10.5 | 75.5 | 1100 |
| T10 | 8.0 | 1.0 | 2.26 | 1.31 | 6.9 | 88.5 | 1225 |
| T11 | 8.0 | 1.4 | 2.40 | 1.39 | 6.1 | 120 | 900 |
| T12 | 7.8 | 1.1 | 1.92 | 1.11 | 6.9 | 35 | 775 |

Table 3: Chemical analysis of water surface irrigation during seasons, 2017 and 2018.

| Parameter | Value | Unit |
|-----------|-------|------|
| E.C       | 4.2   | ds /m |
| Sodium (Na) | 17.44 | meq/l |
| Potassium (k) | 0.64 | meq/l |

Table 4: Chemical analysis of compost during two seasons, 2017 and 2018.

| Parameters | Sample | Unit |
|------------|--------|------|
| PH (1:10 Water extract) | 9.5 | ds/m |
| EC(1:10 Water extract) | 1.6 | |
| O.M       | 15.40 | % |
| O.C       | 8.93  | % |
| C/N       | 34.3:1 | |
| Total nutrients | | % |
| N)(Nitrogen | 0.26 | % |
| Phosphorus (P) | 0.58 | % |
| Potassium (k) | 0.40 | % |

2.4. Organic - related protection:

There were organic pesticides programme by using (Ashok) the neem oil extraction as a foliar application on leaves at plant growth stage at level: 3 cm/l for every week after 30 days from sowing and continuing for flowering stage. Then at the flowering stage was used another organic pesticide substance (Carnation oil extraction), it consists of 10 cm of carnation oil +2 litters of water + soap as a
foliar application on fruits to protect them from high temperature in the summer from (24th of August) to the end of the harvest at (24th of November) for both seasons. These two organic substances were very effective to increase the defense of the plants against every pathogenic microorganism, insects and suitable for Clean Agritechnique efficiency (CAE) without using any chemical pesticides and fertilizers.

2.5. Vegetative growth characters

Six plants were randomly dug out from each experimental unit (plot) to determine the growth characteristics (plant height (cm), No. of leaves/ plant, No. of branches/plant as well as shoot and root dry weights (g/plant), shoot fresh weight (kg/plant) and root fresh weight (g/plant), were recorded at the end of the growing seasons for leaves and roots. Total chlorophyll in green stage (SPAD); Signal Passed at Danger; which is a lightweight hand held for measuring the chlorophyll content of leaves without using a damage to plant, at green stage and leaf area index (cm²) were measured according to Roods and Blood-Worth (1964).

2.6. Plant chemical analysis

All parts of plant samples (leaves, roots and fruits) were washed by tap water then by distilled water and oven dried at 75°C for 48h to fix weights and determine dry weight. In order to measure N, P and K contents of plant leaves and fruits, samples of leaves and fruits were finely ground for chemical analysis, they were wet digested by using concentrate of H2SO4 /H2O2 according to Lowther, 1980 to estimate the percentage of phosphorus (vanaomoly-bdophosphoric method) and potassium (flam photometer) according to Jackson, 1967.Total nitrogen was measured by Nessler's using the method described by A.O.A.C. (1990), (Chapman and Pratt, 1978).Total soluble solids (TSS)% in fresh okra fruits by hand refractometer according to Chen and Mellenthin (1981) and vitamin C. (mg/100g fresh fruit weight) was determined by titration with 2, 6 dichloro phenol-indo-phenol (AOAC, 1985) and calculated as (mg/100 ml fresh juice).

2.7. Yield and its components

Yield and its components, total yield was calculated from the first picking up to the last harvesting continued to (24th of November) for 18 times of pickings. Number of fruits/plants, fruit length (cm), fruit diameter (cm) and average fruit weight (g/plant) were measured.

2.8. Statistical Analysis

Data were statistically analyzed using Costat Software (Steel and Torrie, 1980), and treatments means were compared using Duncan’s Multiple Range test at 5% level of probability.

3. Results and Discussion

The results of the soil analysis before cultivated (Table 1) showed that the soil used in the experiment was sandy clay loam texture. The amounts of available macro and micro-elements were in the range of medium availability for plant nutrition as compared with standard values (Soltanpour, 1985). This finding further signifies that the soil requires external application of nutrients for high growth and yield of the crop. On the other hand the results of the soil analysis after planting (Table 2) indicated that there are treatments which increased the amount of available macro elements above the range of the require for the plants.

Vegetative Growth, Data in Tables (5) and (6) showed that all vegetative characters in okra (cv.Turkey) was significantly affected by applying different treatments in both seasons. Applying the treatment of T10 produced the best plant height and the treatment of T9 having the highest number of leaves while the treatment of T1 gave the highest mean number of branches. Also, the treatment of (T1, T11 and T2) resulted in largest leaf area index of okra plants in both seasons. Treatments of T2 and T3 gave the highest value of chlorophyll in leaves at both seasons. Highest fresh and dry weights for both shoots and roots produced by (T8, T3) and (T7, T3) treatments respectively. However, (T4) treatments had the lowest value for all vegetative characters in both seasons. In this investigation, the data cleared that in plant height character there wasn’t significant differences between T5, T6 and the control, also, in No. of leaves / plant character there weren’t significant differences between T1,T2,T6,T7,T10,T11 and the control.
Table 5: Effect of Compost, Halex-2 and Seaweed algae on morphological characters of okra (cv. Turkey) for two seasons 2107 and 2018.

| Treatments                        | Plant height (cm)  | No. Leaves/ Plant | No. branches/plant | Leaf area index |
|-----------------------------------|--------------------|-------------------|--------------------|-----------------|
|                                   | 2017               | 2018              | 2017               | 2018            |
| T1 140.00 f                       | 68.12 k            | 14.67 b           | 11.67 f            | 6.67 a          |
| T2 182.33 b                       | 158.21 c           | 15.00 ab          | 15.00 c            | 4.00 cd         |
| T3 154.00 e                       | 75.69 j            | 15.67 ab          | 16.67 b            | 1.67 e          |
| T4 125.00 g                       | 61.31 l            | 12.00 c           | 5.33 j             | 3.67 cd         |
| T5 172.33 cd                      | 115.35 f           | 14.67 b           | 12.67 e            | 3.00 de         |
| T6 177.33 bc                      | 128.12 e           | 14.00 bc          | 9.67 g             | 3.00 de         |
| T7 185.00 b                       | 175.80 b           | 14.67 b           | 9.67 g             | 5.00 bc         |
| T8 157.00 e                       | 84.09 i            | 17.00 a           | 18.67 a            | 1.67 e          |
| T9 167.33 d                       | 103.81 g           | 13.67 bc          | 5.67 j             | 5.67 ab         |
| T10 193.33 a                      | 195.33 a           | 14.00 bc          | 7.67 h             | 3.67 cd         |
| T11 182.00 b                      | 142.40 d           | 14.67 b           | 13.67 d            | 2.00 e          |
| T12 165.00 d                      | 93.43 h            | 14.00 bc          | 6.67 i             | 3.67 cd         |

L.S.D 7.996 1.581 1.972 0.779 1.248 0.834 0.505 0.087

Values with the same alphabetical letters, within a comparable group of means, don’t significantly differ, using L.S.D test at 0.05 level.

T1 Halex-2  T5 50% Compost + Halex-2  T9 100% Compost + Halex-2
T2 Seaweed algae  T6 50% Compost + Seaweed algae  T10 100% Compost + Seaweed algae
T3 Halex-2 + Seaweed algae (Mixture)  T7 50% Compost + Mixture  T11 100% Compost + Mixture
T4 50% compost  T8 100% compost  T12 Control (NPK)

Table 6: Effect of Compost, Halex-2 and Seaweed on morphological characters of okra (cv. Turkey) for two seasons 2107 and 2018.

| Treatments                        | Total Chlorophyll in leaves (SPAD) | Shoot dry weight (g/plant) | Root dry weight (g/plant) | Shoot fresh weight (kg/plant) | Root fresh weight (g/plant) |
|-----------------------------------|-----------------------------------|-----------------------------|---------------------------|------------------------------|----------------------------|
|                                   | 2017  2018                        | 2017  2018                  | 2017  2018                | 2017  2018                   | 2017  2018                   |
| T1 50.57 abc                      | 51.03 c                           | 175.00 g                    | 165.03 i                  | 27.80 c                      | 36.03 d                      | 0.883 h                      | 209.10 d                     |
| T2 54.17 a                        | 59.00 a                           | 175.00 g                    | 153.50 j                  | 20.50 de                     | 29.17 g                      | 0.822 i                      | 170.43 g                     |
| T3 53.00 ab                       | 54.87 b                           | 240.00 b                    | 273.93 b                  | 33.00 b                      | 41.40 d                      | 1.377 b                      | 245.13 b                     |
| T4 44.20 e                        | 33.03 i                           | 155.00 h                    | 142.20 k                  | 16.00 fg                     | 21.30 k                      | 0.764 j                      | 127.27 k                     |
| T5 50.47 abc                      | 47.50 d                           | 220.00 c                    | 255.37 c                  | 12.60 g                      | 19.93 L                      | 1.280 c                      | 118.10 L                     |
| T6 40.23 f                        | 30.70 j                           | 185.00 f                    | 177.50 h                  | 23.43 d                      | 33.37 e                      | 0.953 g                      | 197.50 e                     |
| T7 46.10 de                       | 35.50 h                           | 220.00 c                    | 236.93 d                  | 39.00 a                      | 45.27 a                      | 1.195 d                      | 263.67 a                     |
| T8 37.60 fg                        | 28.50 k                           | 155.00 h                    | 130.63 L                  | 18.23 ef                     | 23.27 j                      | 0.711 k                      | 137.33 j                     |
| T9 48.17 cde                       | 38.13 g                           | 280.00 a                    | 294.97 a                  | 32.83 b                      | 38.37 c                      | 1.475 a                      | 227.80 c                     |
| T10 48.60 cd                       | 41.03 f                           | 200.00 d                    | 219.90 e                  | 20.00 def                    | 27.13 h                      | 1.107 e                      | 158.30 h                     |
| T11 35.20 g                       | 25.97 L                           | 195.00 de                   | 204.73 f                  | 19.23 def                    | 25.27 i                      | 1.101 e                      | 147.90 i                     |
| T12 49.67 bcd                      | 44.17 e                           | 190.00 ef                   | 191.97 g                  | 22.80 d                      | 30.77 f                      | 1.039 f                      | 182.93 f                     |

L.S.D 3.952 0.357 8.039 1.733 3.821 0.854 0.017 5.088

Values with the same alphabetical letters, within a comparable group of means, don’t significantly differ, using L.S.D test at 0.05 level.

T1 Halex-2  T5 50% Compost + Halex-2  T9 100% Compost + Halex-2
T2 Seaweed algae  T6 50% Compost + Seaweed algae  T10 100% Compost + Seaweed algae
T3 Halex-2 + Seaweed algae (Mixture)  T7 50% Compost + Mixture  T11 100% Compost + Mixture
T4 50% compost  T8 100% compost  T12 Control (NPK)
At the same way in total chlorophyll in green stage, it noticed that (T₁, T₂, and T₃) gave the best results compared with the control, also, from the data of shoot fresh and dry weights characters cleared that treatments (T₄ then T₅ then T₆) gave the best results of the given character, meanwhile, treatments of (T₇, T₈ and T₁₀) gave better results than the control. In addition to root fresh and dry weight the data estimated that treatments (T₁ then T₂ then T₃) gave the best results of the tested character, whereas, the treatment of (T₄) indicated the best results compared with the control for shoot dry weight character in both seasons. The favorable effect of T₁, T₂, T₃, T₇, T₈, T₉ and T₁₀ treatments on plant height, number of leaves/, plant, fresh and dry weights and leaf area index may be due to that the high concentration of nitrogen in Halex-2, seaweed algae and compost that improved physical conditions of soil, providing energy necessary for microorganisms activity and increasing the availability and uptake of nutrients, which positively reflected on these characters (Abou El-Yazied et al., 2012 and Vikash et al., 2017).

The stimulation of plant growth by using (100% compost + Halex-2) and (100% compost + Sea weed algae) may be attributed to the combined effect of compost; which contains humic acids, vitamins, amino acids and both of macro and micro nutrients, which enhanced okra growth, this finding was agreement with Trupiano et al., (2017) reported that the soil physical and chemical properties improved by the addition of any compost by increasing cations exchange capacity, soil pH, moisture content, total carbon, nitrogen and phosphorous ultimately result in plant biomass accumulation. As well as seaweed algae, which contains some growth regulators, hormones such as auxins, cytokinins and gibberellins and vitamins (Al-shakankery et al., 2014 and Abul Faiz Md.Jamal Uddin et al., 2019).

Yield and its Components, From Table (7) It is obvious that T₃ and T₅ produced the highest values of number of fruits/plant, fruit length, fruit diameter, fruit weight and total yield and there weren’t significant difference of the rest of the treatments and the control in both seasons. In this article, about No. of fruits /plant the data cleared that (T₁, T₃ and T₅) gave the highest mean values of the given character, meanwhile T₆ gave the lowest mean number of fruits /plant at both seasons.

Table 7: Effect of Compost, Halex-2 and Seaweed on yield and yield components of okra (cv. Turkey) for two seasons 2017 and 2018.

| Treatments | No. of fruits/plants | fruit length (cm) | fruit diameter (cm) | fruit weight (g/plant) | Total yield (Ton /fed) |
|------------|----------------------|------------------|---------------------|------------------------|-----------------------|
|            | 2017     | 2018     | 2017     | 2018     | 2017     | 2018     | 2017     | 2018     | 2017     | 2018     |          |
| T₁         | 4.00 a   | 6.00 a   | 4.27 g   | 4.20 L   | 2.03 c   | 1.77 g   | 6.07 f   | 10.30 k  | 1.182 f  | 0.996 h  |
| T₂         | 2.00 bc  | 4.67 bc  | 6.10 ab  | 6.30 d   | 2.00 c   | 1.67 h   | 16.60 b  | 18.47 c  | 1.435 b  | 1.513 b  |
| T₃         | 1.67 c   | 4.00 cd  | 6.27 ab  | 6.70 c   | 2.13 bc  | 1.87 f   | 18.77 a  | 19.87 b  | 1.133 g  | 0.976 i  |
| T₄         | 2.00 bc  | 4.33 cd  | 5.37 cd  | 5.10 h   | 2.27 abc  | 2.27 c   | 5.00 g   | 9.43 L   | 1.235 e  | 1.053 g  |
| T₅         | 1.67 c   | 3.67 de  | 4.40 ef  | 4.63 j   | 1.90 c   | 1.47 j   | 11.70 d  | 14.87 f  | 1.295 c  | 1.218 e  |
| T₆         | 1.67 c   | 3.00 e   | 4.37 ef  | 4.43 k   | 2.20 bc  | 2.17 d   | 8.57 e   | 11.80 i  | 1.321 c  | 1.408 c  |
| T₇         | 2.00 bc  | 4.33cd   | 5.87 ab  | 6.00 e   | 2.40 ab  | 2.47 b   | 14.37 c  | 15.96 e  | 1.263 d  | 1.133 f  |
| T₈         | 2.67 b   | 5.33 ab  | 6.50 a   | 7.43 a   | 2.57 a   | 2.67 a   | 7.30 ef  | 11.10 j  | 0.976 i  | 0.864 k  |
| T₉         | 4.00 a   | 5.67 a   | 6.40 a   | 7.01 b   | 2.00 c   | 1.57 i   | 19.93 a  | 21.33 a  | 1.467 a  | 1.627 a  |
| T₁₀        | 2.00 bc  | 4.67 bc  | 5.67 be  | 5.43 g   | 1.93 c   | 1.37 k   | 14.57 c  | 17.17 d  | 1.072 h  | 0.922 j  |
| T₁₁        | 2.00 bc  | 4.00 cd  | 5.00 de  | 4.80 i   | 2.20 bc  | 2.07 e   | 11.27 d  | 12.87 h  | 0.725 j  | 0.809 L  |
| T₁₂        | 2.67 b   | 5.33 ab  | 5.93 ab  | 5.70 f   | 1.93 c   | 1.27 L   | 11.47 d  | 13.87 g  | 1.293 c  | 1.308 d  |
| L.S.D.     | 0.803    | 0.737    | 0.607    | 0.072    | 0.323    | 0.088    | 1.587    | 0.122    | 0.027    | 0.003    |

Values with the same alphabetical letters, within a comparable group of means, don’t significant differ, using L.S.D test at 0.05 level.

T₁ Halex-2  T₅ 50% compost + Halex-2  T₉ 100% compost + Halex-2
T₂ Seaweed algae  T₆ 50% compost + Seaweed algae  T₁₀ 100% compost + Seaweed algae
T₃ Halex-2 + Seaweed algae (Mixture)  T₇ 50% compost + Mixture  T₁₁ 100% compost + Mixture
T₄ 50 % compost  T₈ 100% compost  T₁₂ Control(NPK)

Also, in fruit length character, the treatments (T₂, T₃) gave better results than the control in both seasons. At the same trend in fruit diameter character, the treatments (T₃, T₄, T₆ and T₁₁) gave better results than the control in two seasons. At the same way in fruit weight character, it noticed that treatments (T₁ and T₉) gave the best results compared with the control. In addition to the data of total yield character cleared...
that treatments (T₆, T₂ and T₀) gave the best results compared with the control. Whereas, the lowest value for the total yield character produced from T₁₁ treatment. The performance of higher number of fruits/plant, fruit length, fruit diameter, fruit weight and total yield from treatments (T₁, T₂, T₃, T₄ and T₈) may be due to their higher nutritional contents, particularly K, Ca, Mg, S and Fe in seaweed extract (Abul Faiz Md. Jamal Uddin et al., 2019) and N in Halex-2 (Alkaif and Hassan, 2003 and Vikash et al., 2017). These elements value can encourage vegetative growth, total chlorophyll and photosynthetic rate, which enhance flowering and fruiting leading to increase in early fruit maturity. These results agree with previous studies (Sandesh et al., 2019). They showed that applying of biofertilizer and seaweed extract and organic treatments like compost increased total yields compared with using chemical fertilizers. The recorded maximum yield at (100% COM + Halex-2) and Seaweed algae treatments might be attributed towards higher porosity, aeration, water holding capacity and presence of humic-like materials and other plant growth-influencing substances (such as plant growth hormones) produced by micro-organisms during composting (Arancon et al., 2004 and Adhikari and Piya 2020).

Chemical composition, data presented in Table (8) indicated that both of T₀ and T₁₀, significantly, produced higher value of nitrogen content in leaves of okra at both seasons. Also, it noticed from the data that (T₂, T₃, T₇) gave better results than the control treatment. These results may be due to the support of higher value of nitrogen in all of Halex-2, Seaweed and 100% compost were very rich in NPK contents because of the effect of Halex-2 are living nitrogen-fixing bacteria such as (Azotobacter and Azospirillum sp.). They also have the ability to fix nitrogen and to release certain phytohormones, i.e. GA3, IAA and cytokinins (Vikhe 2014; Adhikari and Piya 2020) which could stimulate plant growth and increase the availability of nutrients for plant roots.

Table 8: Effect of Compost, Halex-2 and Seaweed on leaves nutrient contents of okra (cv. Turkey) for two seasons 2107 and 2018.

| Treatments | N % | P % | K % | V.C. % in fresh fruits(mg/g) |
|------------|-----|-----|-----|-----------------------------|
|            | 2017 | 2018 | 2017 | 2018 | 2017 | 2018 | 2018 |
| T₁         | 0.40 c | 1.27 ef | 0.17 c | 1.03 c | 10.00 abc | 9.13 d | 0.60 cd |
| T₂         | 0.63 b | 1.77 c | 0.17 c | 0.94 d | 10.07 abc | 9.70 c | 0.63 bcd |
| T₃         | 0.47 bc | 1.57 d | 0.13 c | 0.87 e | 7.10 fg | 5.90 j | 0.77 abc |
| T₄         | 0.37 c | 1.17 f | 0.10 c | 0.75 f | 6.87 fg | 5.40 k | 0.90 a |
| T₅         | 0.57 bc | 1.57 d | 0.33 b | 1.15 b | 6.17 g | 4.90 L | 0.87 ab |
| T₆         | 0.40 c | 1.20 f | 0.10 c | 0.66 g | 10.17 ab | 10.43 b | 0.57 cd |
| T₇         | 0.50 bc | 1.53 d | 0.60 a | 1.22 a | 9.20 cd | 7.77 f | 0.87 ab |
| T₈         | 0.67 b | 1.93 b | 0.40 e | 0.56 h | 7.80 ef | 6.23 i | 0.47 d |
| T₉         | 0.93 a | 2.17 a | 0.10 c | 0.46 i | 9.67 bc | 8.40 e | 0.77 abc |
| T₁₀        | 0.93 a | 1.97 b | 0.13 c | 0.35 j | 8.07 e | 6.77 h | 0.67 abcd |
| T₁₁        | 0.37 c | 1.00 g | 0.10 c | 0.25 k | 8.67 de | 7.37 g | 0.57 cd |
| T₁₂        | 0.47 bc | 1.37 e | 0.13 c | 0.16 L | 10.77 a | 11.23 a | 0.63 bcd |
| L.S.D.     | 0.193 | 0.114 | 0.097 | 0.097 | 0.050 | 0.939 | 0.329 | 0.215 |

Values with the same alphabetical letters, within a comparable group of means, don’t significant differ, using L.S.D test at 0.05 level.

On the same trend, the highest phosphorus in leaves significantly obtained from T₇ and T₉ treatments, while, there is non-significant difference among all other treatments in the first season and the control treatment. Seaweed extract treatments increased fruit content of phosphorus which may be due to the high content of phosphorus in seaweed commercial source used in this investigation, these are in agreement with (Al-shakankery et al., 2014). For potassium content in okra leaves, Table (8) indicated that in both seasons, the highest value obtained from using treatment T₁₂ followed by (T₆ and T₇) meanwhile, the lowest value obtained from T₄ treatment. High potassium content in leaves may be due
to the use of chemical fertilizer (NPK) directly this finding is in agreement with (Esther and Otobong, 2018; Dademal et al.,2004). On the other hand T4, T5, T6, T10 and T12 gave the highest mean values of vitamin C content in fruits. Also, it declared that there were n’t significant differences between (T1, T2, T6,T11) and the control treatment. On the same trend T5, T6, T11 and T12 produced the largest values of total soluble solid in okra fruits. These finds in are in accordance with (Colo et al., 2014) who reported that a biofertilizer (Halex- 2) was found as the best combination which gave the maximum marketable yield and increase TSS and sprouted bulbs in onion, so the use of Halex- 2 could replace one-third of the chemical N fertilizer used and, consequently, improve the economics of onion production. This result due to the synthesis of IAA, siderophores and P-solubilizing activity of B. subtilis and A. chroococcum in Halex-2.

Regarding, N, P and K concentrations in okra fruits: Data presented in table (9) showed that T2 and T7 increased N content in fruits. This finding is in agreement with (Dademal et al.,2004) who reported that the nitrogen content in the organic fertilizers has been known to enhance leaf production, flowering and root formation which will lead to higher metabolic activities and consequently higher fresh fruit yield in okra. On the same way application of T1, T3, T6, T9 and T11 in the first season gave the highest mean values of P content in fruits compared with other treatments. Similar results have been obtained from T5 then T2 gave the highest mean values of K content in fruits but T10 and T11 produced better results than the control at both seasons. These findings may be attributed to using Halex-2, Seaweed algae and compost treatments that improve soil activity of microorganisms and provide the roots of the plants with potassium and other elements those are in accordance with (Alkaff and Hassan, 2003 and Vikash et al., 2017), they reported that Halex-2 which contain combinations of microorganisms that provide plants with mineral elements.

Table 9: Effect of Compost, Halex-2 and Seaweed on fruits nutrient contents of okra cv. Turkey for two seasons 2107 and 2018.

| Treatments            | N %     | 2017 | 2018  | P %     | 2017 | 2018  | K %     | 2017 | 2018  | T.S.S |
|-----------------------|---------|------|-------|---------|------|-------|---------|------|-------|-------|
| T1                    | 0.67 d  | 0.63 a| 0.87 b| 10.67 fg| 11.30 j| 1.50 d|
| T2                    | 1.87 a  | 2.33 a| 0.20 cd| 0.33 cd| 18.67 ab| 20.40 b| 2.17 b|
| T3                    | 0.63 de | 1.33 g| 0.63 a | 0.83 b | 14.77 cde| 15.20 f | 1.77 cd|
| T4                    | 1.07 c  | 1.87 c| 0.33 b | 0.27 de| 11.50 f | 12.20 i | 1.77 cd|
| T5                    | 0.60 de | 1.20 h| 0.40 b | 0.20 e | 14.20 c | 13.06 h | 2.77 a|
| T6                    | 0.57 de | 1.13 h| 0.60 a | 0.43 c | 14.93 cde| 16.30 e | 2.77 a|
| T7                    | 1.90 a  | 2.07 b| 0.17 d | 0.27 de| 9.30 fg | 10.60 k | 1.50 d|
| T8                    | 0.80 cd | 1.63 e| 0.10 d | 0.17 e | 8.87 g | 9.80 L | 2.27 b|
| T9                    | 1.47 b  | 1.87 c| 0.30 bc| 1.03 a | 19.90 a | 21.93 a | 2.07 bc|
| T10                   | 0.30 e  | 1.00 i| 0.40 b | 0.27 ef| 17.00 bc| 18.87 c | 2.00 bc|
| T11                   | 1.10 c  | 1.73 d| 0.53 a | 0.37 cd| 16.67 bcd| 17.60 d | 2.70 a|
| T12                   | 0.67 d  | 1.43 f| 0.63 a | 0.33 cd| 14.60 de| 14.00 g | 2.70 a|
| L.S.D.                | 0.325   | 0.092| 0.116 | 0.097  | 2.099 | 0.286  | 0.287 |

Values with the same alphabetical letters, within a comparable group of means, don’t significant differ, using L.S.D test at 0.05 level.

4. Conclusion

From previous results, it could be suggested that using Halex-2, commercial seaweed extract in addition to compost are considered suitable applications to improve vegetative growth and yield of okra plants. The best treatment was T9 which gave the maximum yield at two seasons. Also, There is an advice to the farmers in this investigation cleared that there are some combinations of organic fertilizers gave better results or equal to the control treatment (NPK), so we can replace these combinations with
the chemical fertilizers without affected the yield to protect our environment and our soil and maximize our yield.

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