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# Influence of Organic Manure, Natural Rocks and Putrescine on Yield and Quality of Sweet Basil (*Ocimum basilicum* L.) Grown in Sand Soil

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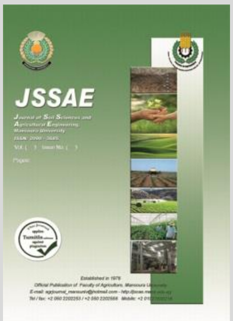

## ABSTRACT

Two field experiments were conducted in the newly reclaimed land at a Private Farm located at Village No1, west of Beni-Mazzar district, El-Minia Governorate, Egypt in two successive seasons of 2017 and 2018 to study the influence of farmyard manure, natural rocks and putrescine on growth parameters, yields, essential oil percentage and yield for sweet basil grown in sandy soil and irrigated with slightly saline water. Results showed that increasing farmyard manure up to 48 Mg $ha^{-1}$ resulted in high values of growth parameters, yields, oil percentage and yield and chemical composition of basil leaves. Using natural rocks improved all studied traits, except nitrogen concentration and pigments in basil leaves. Foliar spraying of putrescine was significantly enhanced all studied parameters, except N,P and K content. The treatment of 48 Mg $ha^{-1}$ +natural rocks +putrescine gave the highest values of basil quality and quantity of herb yield. Moreover, organic manure improved soil reaction, soil organic matter in soil after harvesting basil plants, while it increased soil salinity. Natural rocks and putrescine application did not affect all studied soil properties after harvest, except soil available P and K which increased due to natural rocks application. Results of this research confirmed that a combination of organic manure, some natural rocks and putrescine could be considered as a suitable replacement of inorganic fertilizer for improving soil properties and consequently crop yield and quality.

**Keywords:** Sweet basil, rock P, rock K, FYM, putrescine, growth parameters, yields and chemical content.

## INTRODUCTION

Basil *(Ocimum basilicum L.)* is an important medicinal properties include, antispasmodic, sedative, lowering blood pressure, lowering fever, body compatibilizer stressors and strengthening the body's natural activity and anti-inflammation (Asgharipour and Rafiei, 2011). Husain *et al* (1988) mentioned that sweet basil is a popular aromatic and medicinal plant and is well known for highly aromatic leaves uses as fresh or dried and for culinary. Phenolic compounds, flavonoids and others substances in its essential oil which have antibacterial is major impact of basil which have anti-mycotic and antioxidant activities (Nour *et al*, 2009).

The putrescine (Put) and its derivatives are the most common polyamines and it found to be implicated in plant metabolic and physiological functions (Kakkar *et al*, 2000). The beneficial of putrescine to plant response to a variety of abiotic stress, such as salinity, temperature and drought (Bouchereau *et al*, 1999). Putrescine have been shown to involved in plant growth and development processes, e.g. cell division, vascular differentiation, root initiation, shoot formation flower initiation and development, fruit ripening and senescence and embryo formation in tissue cultures (Galston and Sawhney *et al*, 1990). Many workers reported that treated basil plant with putrescine was significantly increased plant height, number of branches, fresh and dry weight/ herb, total carbohydrates, total soluble sugars, total NPK content and oil % in basil plant such as Smith (1982), Einlellig and Leather (1988) and Talaat and Balbaa (2010).

Rock P is a non-detrital sedimentary rock which contains high amounts of phosphate bearing mineral ($Ca_{10}PO_4F_2$). The efficiency of rock P as a phosphorus fertilizer depend on its particle size, chemical properties and the type of soil on which the rock P is applied (Indiati *et al*, 2002). On the other hand, potassium feldspars ($KAlSi_3O_8$) are a group of rock-forming tectosilicate minerals contain higher amount of potassium (about 9% K). Many authors stated that using rock P or feldspar were improved plant growth, such as Kifuko *et al* (2007), Ali *et al* (2012) and Basha and Hassan (2017) for rock P, and Abd El-Latif (2007), Hellal *et al* (2009) and El-Sheref (2012) for feldspar.

Taking into consideration of the deleterious effect of continuous applying of chemical fertilizer on soil properties, organic farming could consider as a suitable replacement of inorganic fertilizer for improving microbial activity, soil organic matter (Shahram and Ordookhani, 2011). Organic fertilizer, especially farmyard manure have been intensively used at the last decades to improving soil fertility and consequently growth and production of plant.

The decomposition of organic manure produce organic acids which play an important role for solubility the natural fertilizers and in turn increasing the availability of P and K from the added rocks (Hellal *et al*, 2009 and Ali *et al*, 2012).

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Many authors reported that using farmyard manure enhanced basil plant growth and production such as Geetha *et al* (2009), Hendawy *et al* (2010), Jayasri and Anuja (2010), Talaat and Bulbaa (2010), Sirousmehr *et al* (2014), El-Sayed *et al* (2015) and Bufalo *et al* (2015).

This study aimed to evaluate the effect of some natural rocks, organic manure and petruscine on sweet basil plants grown in sandy soil and irrigated with saline water and its effect on improving soil properties.

## MATERIALS AND METHODS

This study was conducted in newly reclaimed land at the Private Farm located at Village No 1, west of Beni Mazzar district, El-Minia Governorate, Egypt in two seasons of 2017 and 2018 to study the effect of using natural rocks under organic manure and putrescine application on sweet basil plant under sandy soil irrigated with slightly saline water (EC= 3.6). The experimental design was factorial in three factors in completely randomized blocks in four replicates.

**The treatments were:**

- Farmyard manure (0.0, 24 Mg g $ha^{-1}$ and 48 Mg g $ha^{-1}$).
- Natural rocks, i.e., without and 720kg $ha^{-1}$ rock P + 960 kg $ha^{-1}$ rock K.
- Putrescine (1,4 Diaminobutane dihydrochloride ), i.e., 0.0 and 10 u M putrescine.

Natural rock and organic manure were added before planting during land preparation, while putrescine treatments were applied as a foliar sprying of 10 u M putrescine solution at rate of 960 L $ha^{-1}$. The sweet basil seeds (were respect from Medicinal and Aromatic Plant Section, ARC, Egypt) were inoculated with phosphorus and silicate dissolving bacteria before planting and directly sown in nursery on 15 and 19 February in both seasons, respectively. The seedling were transferred to the field one month later. The seedlings were thinned for two plants in 45 × 22.5 cm spacing. Other recommended practice for basil production were done as in district.

A surface soil sample was taken to determine some soil physical and chemical properties for the experimental soil according to A.O.A.C. (1986) and listed in Table 1.

**Table 1. Some physical and chemical properties of the investigated soil.**

| Property | Concentration | |
|---|---|---|
| | 1st season | 2nd season |
| Particle size distribution: | | |
| Coarse sand % | 13.36 | 11.19 |
| Fine sand % | 73.19 | 75.69 |
| Silt % | 10.56 | 10.45 |
| Clay % | 2.89 | 2.67 |
| Texture grade | Sand | Sand |
| Chemical properties: | | |
| pH (1:2.5 soil-water suspension) | 7.8 | 7.9 |
| EC (soil paste) $dSm^{-1}$ | 3.1 | 3.3 |
| Organic matter % | 0.22 | 0.27 |
| $CaCO_3$ % | 4.15 | 3.19 |
| Available N $\mu gg^{-1}$ | 7.00 | 8.00 |
| Available P $\mu gg^{-1}$ | 3.00 | 4.00 |
| Available K $\mu gg^{-1}$ | 56.00 | 54.00 |

Also, some chemical composition of rock P, rock K and farmyard manure were determined according to A.O.A.C. (1986) and listed in Table 2 and Table 3.

**Table 2. Chemical analysis of natural rocks and farmyard manure.**

| Rock phosphate | | fledspar | |
|---|---|---|---|
| PH(1:2.5RP: water suspention) | 7.69 | pH(1:2.5RP: water suspention) | 7.61 |
| Total P% | 29.97 | $K_2O$ % | 10.57 |
| Available $P_2O_5$ (g $kg^{-1}$) | 17.63 | $SiO_2$ % | 64.97 |
| $SiO_2$ % | 8.97 | $Fe_2O3$ % | 0.21 |
| $Al_2O_3$ % | 0.81 | Ca % | 0.39 |
| $Fe_2O_3$ % | 1.27 | Na % | 3.47 |
| MgO % | 0.56 | $Al_2O3$ % | 18.33 |
| $CO_2$ % | 5.29 | Mg % | 0.13 |
| $CaCO_3$ % | 12.08 | | |
| $Cl^-$ % | 0.23 | | |

**Table 3. Chemical analysis of farmyard manure.**

| Farmyard manure | | |
|---|---|---|
| **property** | **1st season** | **2nd season** |
| pH (1:2.5 RP:water suspention) | 7.7 | 7.6 |
| EC | 7.6 | 7.7 |
| Organic carbon % | 34.8 | 33.5 |
| Total N % | 1.59 | 1.52 |
| Total P % | 0.35 | 0.38 |
| Total K % | 1.40 | 1.45 |
| C/N ratio | 22:1 | 22:1 |

**Data recorded:**

The sweet basil plants were harvested two times at early bloom stages in both seasons, by cutting the vegetative parts at 10 cm above the soil surface. Plant height (cm), number of branches/plant, leaf area ($cm^2$) of the fifth leaf from top, fresh weight of herb/plant (g) and dry weight of herb/plant (g) were measured, and essential oil percentage in the dry herb were determined according to Egyptian Pharmacopoeia, 1984. Also, N,P and K and some pigments, i.e., chlorophyll a, chlorophyll b and carotenoids in basil leaves at the flowering stage were determined according to A.O.A.C. (1986).

Surface soil samples after harvest from each plots were taken to determine some soil properties (pH, EC, O.M and soil available N,P and K) according to A.O.A.C. (1986).

Data were subject to statistical analysis according to the method described by Snedecor and Cochran (1989). The means of treatments were compared by using the L.S.D. values.

## RESULTS AND DISCUSSION

Data in Table 4 show the response of soil properties after basil harvesting to FYM, natural rocks and putrescine and their interactions. As for the main effects of organic manure, data reveal that increasing FYM up to 48 Mg ha-1 were significantly reduced soil reaction (pH), while it increased soil salinity and improved soil organic matter and soil available N, P and K. The promotive effect of FYM on soil pH be can ascribed to the acidifying effect of organic acids produced during the course of continues decomposition of applied farmyard manure ( El-Shabrawy, 2011). The improving effect of FYM on increasing soil organic carbon after harvest is mainly due to its higher content of organic carbon (Table 2) which increased with increasing the level of manure (Ali *et al*, 2012). Moreover, the increment in soil available N, P and K can explained by the content of N, P and K applied by FYM. Also, the decomposition of manure formation to mineralize forms of N, P and K would have occur, meanwhile, organic manure enhanced microorganisms activity, which in turn increased the fixation processes of atmospheric N (El-Naggar *et al*, 1998). On the other hand, the negative effect of manure on increasing soil salinity may be due the high quantities of soluble salts contained in FYM (Wong *et al*, 1999). These results are in harmony with those obtained by Abd El-Lattif (2012) and Ali *et al* (2012) for soil pH, EC and soil organic matter, and Anwar *et al* (2005), Mann *et al* (2006) and El-Shabrawy (2011) for soil available N, P and K.

Concerning the main effect of natural rocks, data in Table 4 clearly show that using rock P in combined with rock K was significantly increased soil available P and K in soil after basil plant harvested, while soil pH, soil EC, soil organic matter and soil available N did not affect. The increment in soil available P and K caused by natural rocks application may be due to rock phosphate and rock feldspar considered a source of P and K through it mineralization in soil by microbial activity (Gowda *et al*, 2011). Similar results were obtained by Hellal *et al* (2009) and Ali *et al* (2012).

With respect to putrescine, data in Table 4 indicated that all studied soil properties after basil plant harvesting did not affect by putrescine application in both seasons. These results are in line with those obtained by Sarhan (2012) who reported that putrescine application did not affect soil properties after harvest barley plants grown in sandy soil and irrigated with saline water.

As for the interaction between any of two studied factors or among three factors, data clearly showed that soil properties not responded to the interactions between factors, which means that each factor was acting independently. In general, the best values of pH, O.M, soil available N, P and K were obtained under 48 Mg ha-1 FYM. Whereas, the highest values of soil available P and K were exhibited under the treatment of 48 Mg ha-1 FYM + rock P and feldspar.

**Table 4. The main effect of FYM, natural rocks and putrescine and their interactions on some soil properties after harvest sweet basil.**

| **FYM (Mg g ha$^{-1}$) (A)** | **pH** | | **EC dsm$^{-1}$** | | **O.M %** | | **N ( µ gg-1)** | | **P ( µ gg-1)** | | **K (µ gg-1)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1st season** | **2nd season** | **1st season** | **2nd season** | **1st season** | **2nd season** | **1st season** | **2nd season** | **1st season** | **2nd season** | **1st season** | **2nd season** |
| 0.0 | 7.83 | 7.92 | 3.13 | 3.34 | 0.24 | 0.27 | 8.12 | 8.17 | 3.70 | 4.64 | 53.14 | 54.04 |
| 24 | 7.79 | 7.84 | 3.43 | 3.57 | 0.29 | 0.32 | 8.43 | 8.83 | 5.93 | 6.70 | 63.65 | 64.27 |
| 48 | 7.75 | 7.81 | 3.65 | 3.71 | 0.33 | 0.36 | 8.70 | 9.13 | 7.71 | 8.41 | 72.74 | 73.13 |
| L.S.D. at 0.05 A | 0.02 | 0.02 | 0.11 | 0.12 | 0.02 | 0.02 | 0.13 | 0.14 | 0.35 | 0.37 | 3.15 | 3.36 |
| Natural rocks (Kg ha$^{-1}$) (B) | pH | | EC dsm$^{-1}$ | | O.M % | | N ( µ gg-1) | | P ( µ gg-1) | | K ( µ gg-1) | |
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| - | 7.78 | 7.85 | 3.40 | 3.54 | 0.28 | 0.31 | 8.42 | 9.30 | 5.36 | 6.14 | 60.90 | 61.67 |
| + | 7.79 | 7.85 | 3.40 | 3.54 | 0.29 | 0.31 | 8.42 | 9.38 | 6.20 | 7.02 | 65.44 | 65.96 |
| L.S.D. at 0.05 B | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | 0.37 | 0.39 | 1.03 | 1.14 |
| Putrescine (C) | pH | | EC | | O.M | | N ( µ gg-1) | | P ( µ gg-1) | | K ( µ gg-1) | |
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| - | 7.79 | 7.85 | 3.40 | 3.53 | 0.28 | 0.31 | 8.42 | 9.30 | 5.76 | 6.58 | 63.17 | 63.81 |
| + | 7.79 | 7.86 | 3.40 | 3.54 | 0.29 | 0.31 | 8.42 | 9.38 | 5.80 | 6.59 | 63.18 | 63.83 |
| L.S.D. at 0.05 C | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |

| Interaction | | | pH | | EC | | O.M | | N ( µ gg-1) | | P ( µ gg-1) | | K ( µ gg-1) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| 0.0 | - | - | 7.82 | 7.91 | 3.12 | 3.33 | 0.24 | 0.26 | 8.11 | 8.15 | 3.21 | 4.12 | 51.16 | 52.22 |
| | | + | 7.83 | 7.92 | 3.13 | 3.34 | 0.24 | 0.27 | 8.13 | 8.17 | 3.25 | 4.12 | 51.11 | 52.26 |
| | + | - | 7.83 | 7.91 | 3.12 | 3.33 | 0.24 | 0.26 | 8.13 | 8.17 | 4.16 | 5.13 | 55.13 | 55.86 |
| | | + | 7.84 | 7.92 | 3.13 | 3.34 | 0.25 | 0.27 | 8.12 | 8.17 | 4.17 | 5.17 | 55.15 | 55.82 |
| 24 | - | - | 7.78 | 7.83 | 3.42 | 3.56 | 0.28 | 0.31 | 8.42 | 8.82 | 5.76 | 6.31 | 61.22 | 61.92 |
| | | + | 7.78 | 7.83 | 3.43 | 3.57 | 0.29 | 0.31 | 8.43 | 8.84 | 5.79 | 6.33 | 61.23 | 61.89 |
| | + | - | 7.79 | 7.84 | 3.42 | 3.57 | 0.28 | 0.32 | 8.43 | 8.83 | 6.05 | 7.08 | 66.05 | 66.61 |
| | | + | 7.79 | 7.84 | 3.43 | 3.56 | 0.29 | 0.32 | 8.44 | 8.84 | 6.11 | 7.09 | 66.08 | 66.67 |
| 48 | - | - | 7.74 | 7.80 | 3.66 | 3.70 | 0.32 | 0.36 | 8.70 | 9.11 | 7.02 | 7.98 | 70.33 | 70.85 |
| | | + | 7.75 | 7.81 | 3.65 | 3.71 | 0.33 | 0.36 | 8.70 | 9.13 | 7.12 | 7.97 | 70.36 | 70.89 |
| | + | - | 7.75 | 7.80 | 3.65 | 3.71 | 0.33 | 0.35 | 8.71 | 9.14 | 8.35 | 8.83 | 75.12 | 75.37 |
| | | + | 7.74 | 7.81 | 3.65 | 3.71 | 0.34 | 0.35 | 8.70 | 9.14 | 8.34 | 8.84 | 75.13 | 75.42 |
| L.S.D. at 0.05 | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| AB | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| AC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| BC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| ABC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |

**Growth parameters:**

Data presented in Tables 5 and 6 showed that effect of organic manure, natural rocks and putrescine application and their interaction on growth parameters of sweet basil, namely, plant height, number of branches plant$^{-1}$ , herb fresh weight plant$^{-1}$ and herb dry weight plant$^{-1}$ for both cuts. As for the main effect of FYM, the results clearly indicated that increasing FYM levels up to 48 Mg ha-1 had a markedly increased on all studied growth of sweet basil plants in both seasons and cuts. The relative increasing of plant height, number of branches plant$^{-1}$, herb fresh weight plant$^{-1}$ and herb dry weight plant$^{-1}$ resulted from added 48 Mg ha-1 reached to 24.2, 40.2, 17.5 and 32.4 % increments over control for first cut in first season, respectively. Same trends were obtained for second cut and in second season. The beneficial effect of organic manure on basil growth may be due to adding organic manure to the soil encourage microorganisms activity which improved the production of auxin and growth promoting substances to root zone (Saikia and Upadhyaya, 2011). Also, microorganisms can enhance plant growth directly through the production of phytohormones (Glick, 2003).

Moreover, adding organic manure improves soil properties that increased nutrient availability, consequently parameters were significantly increased due to added rock phosphate in combined with feldspar. The increment in the abovementioned growth parameters caused by added natural rocks reached to 5.9, 7.1, 2.5 and 6.2 % in the former order for first cut in first season, respectively when compared with no natural rocks. Same trends were obtained for second cut and for second season. This may be due to the role of application of natural rocks as a source of phosphorus and potassium which enhanced the metabolic processes and regulate water balance (Manning, 2010). These results agree with those obtained by El-Sheref (2012) and Abd El-Hafeez *et al* (2013) for rock P and Abd El-Lattif (2007) and Hellal *et al* (2009) for feldspar. Also, these results are in line with those obtained by Ali *et al* (2012) for combined rock P with feldspar.

**Table 5. The main effect of FYM, natural rocks and putrescine and their interactions on growth parameters of sweet basil.**

| FYM (Mg g ha$^{-1}$) (A) | | | Plant height (cm) | | | | No of branches/plant | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| 0.0 | | | 63.89 | 95.58 | 61.33 | 85.93 | 26.66 | 28.80 | 24.74 | 27.72 |
| 24 | | | 74.43 | 105.23 | 71.90 | 95.49 | 33.70 | 36.05 | 32.00 | 33.95 |
| 48 | | | 77.55 | 107.49 | 78.32 | 98.64 | 37.37 | 30.18 | 35.23 | 38.14 |
| L.S.D. at 0.05 A | | | 1.05 | 1.11 | 1.09 | 1.02 | 1.10 | 1.13 | 1.12 | 1.08 |
| Natural rocks (Kg ha$^{-1}$) (B) | | | Plant height | | | | No of branches/plant | | | |
| | | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | | | 70.49 | 101.23 | 68.89 | 92.04 | 31.46 | 30.62 | 29.54 | 31.98 |
| + | | | 73.43 | 104.31 | 72.15 | 94.67 | 33.69 | 32.73 | 31.78 | 34.57 |
| L.S.D. at 0.05 B | | | 1.12 | 1.25 | 1.16 | 1.13 | 1.06 | 1.05 | 1.07 | 1.02 |
| Putrescine (C) | | | Plant height | | | | No of branches/plant | | | |
| | | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | | | 71.02 | 101.68 | 69.51 | 92.41 | 31.91 | 31.09 | 30.06 | 32.71 |
| + | | | 72.90 | 103.85 | 71.53 | 94.29 | 33.25 | 32.26 | 31.26 | 33.83 |
| L.S.D. at 0.05 C | | | 0.98 | 0.85 | 0.93 | 0.85 | 0.64 | 0.57 | 0.43 | 0.40 |
| Interaction | | | Plant height | | | | No of branches/plant | | | |
| A | B | C | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| 0.0 | - | - | 60.13 | 90.19 | 57.16 | 81.31 | 24.13 | 26.31 | 22.31 | 25.11 |
| | | + | 62.90 | 94.56 | 59.63 | 83.53 | 26.01 | 28.15 | 24.19 | 27.31 |
| | + | - | 64.43 | 97.13 | 62.36 | 87.76 | 27.35 | 29.56 | 25.16 | 28.31 |
| | | + | 68.10 | 100.43 | 66.18 | 91.11 | 29.15 | 31.19 | 27.31 | 30.16 |
| 24 | - | - | 71.19 | 103.01 | 68.92 | 94.25 | 31.05 | 33.73 | 29.13 | 31.15 |
| | | + | 73.83 | 106.11 | 70.75 | 96.31 | 33.17 | 35.26 | 31.16 | 32.19 |
| | + | - | 75.51 | 104.46 | 72.17 | 94.03 | 34.43 | 36.63 | 33.16 | 35.56 |
| | | + | 77.19 | 107.35 | 75.76 | 97.35 | 36.13 | 38.56 | 34.56 | 36.91 |
| 48 | - | - | 77.19 | 107.12 | 78.25 | 98.31 | 37.12 | 30.11 | 35.26 | 38.01 |
| | | + | 77.69 | 106.36 | 78.61 | 98.52 | 37.30 | 30.17 | 35.16 | 38.11 |
| | + | - | 77.65 | 108.15 | 78.19 | 98.81 | 37.35 | 30.21 | 35.31 | 38.12 |
| | | + | 77.66 | 108.31 | 78.23 | 98.93 | 37.71 | 30.23 | 35.19 | 38.31 |
| L.S.D. at 0.05 | | | | | | | | | | |
| AB | | | 2.15 | 2.39 | 2.31 | 2.20 | 1.13 | 1.18 | 1.19 | 1.11 |
| AC | | | 2.01 | 2.16 | 2.09 | 2.11 | 1.09 | 1.16 | 1.18 | 1.11 |
| BC | | | 2.02 | 2.04 | 2.01 | 2.07 | 1.07 | 1.05 | 1.11 | 1.10 |
| ABC | | | 2.31 | 2.52 | 2.63 | 2.64 | 1.27 | 1.23 | 1.25 | 1.28 |

Concerning the effect of putrescine, the results in Tables 4 and 5 showed that pervious growth parameters of sweet basil were significantly improved as a result of putrescine application. In this concern, Einhellig and Leather (1988) reported that putrescine application had positive effect on cellular expansion, enzymatic activity, respiration and water ratio. These results agree with those obtained by Talaat and Balbaa (2010) and Zeid *et al* (2014) who stated that putrescine application improved sweet basil growth parameters.

With regard to the interaction effect, the Tables 5and 6 exhibited that the interaction between investigated factors was significant for all studied growth traits. In the presence of 48 Mg ha$^{-1}$, the natural rocks or putrescine did not alter all studied basil growth, which may be due 48 Mg ha-1 contain suitable nutrients and had well microbial activity needed for maximum growth. In general, plants treated with 24 Mg ha$^{-1}$ FYM + natural rocks + putrescine gave the highest values of all studied growth parameters in the two cuts for both seasons. which statistically equal to those obtained under 48 Mg ha$^{-1}$ FYM combined with or without feldspar and putresine, On the other hands, the plants without manuring, without rock P and feldspar and without putrescine yielded the lowest values of growth parameters. its uptake by plant (Mashali, 1997). These results are similar to those obtained by Abdou *et al* (2011) and Abd El-Salam (2014).

As for the main effect of natural rocks, the obtained results in Tables 5 and 6 reveal that the abovementioned basil growth

**Table 6. The main effect of FYM, natural rocks and putrescine and their interactions on growth parameters of sweet basil.**

| FYM (Mg g ha$^{-1}$) (A) | | | Herb fresh weight plant$^{-1}$ (g) | | | | Herb dry weight plant$^{-1}$ (g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1$^{st}$ season | | 2$^{nd}$ season | | 1$^{st}$ season | | 2$^{nd}$ season | |
| | | | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut |
| 0.0 | | | 178.45 | 203.05 | 171 | 177 | 49.3 | 54.58 | 48.48 | 53.63 |
| 24 | | | 200.05 | 220.93 | 196.1 | 198.25 | 60.43 | 63.33 | 59.08 | 62.45 |
| 48 | | | 209.7 | 232.53 | 205.3 | 205.4 | 65.28 | 70.12 | 64.53 | 68.65 |
| L.S.D. at 0.05 A | | | 3.50 | 3.66 | 3.13 | 3.08 | 1.36 | 1.42 | 1.67 | 1.09 |
| Natural rocks (Kg ha$^{-1}$) (B) | | | Herb fresh weight plant$^{-1}$ (g) | | | | Herb dry weight plant$^{-1}$ (g) | | | |
| | | | 1$^{st}$ season | | 2$^{nd}$ season | | 1$^{st}$ season | | 2$^{nd}$ season | |
| | | | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut |
| - | | | 193.62 | 216.28 | 188.17 | 191.22 | 56.58 | 60.97 | 55.65 | 59.90 |
| + | | | 198.52 | 221.38 | 193.43 | 195.88 | 60.08 | 64.38 | 59.07 | 63.25 |
| L.S.D. at 0.05 B | | | 2.57 | 2.11 | 2.36 | 2.72 | 1.15 | 1.20 | 1.21 | 1.18 |
| Putrescine (C) | | | Herb fresh weight plant$^{-1}$ (g) | | | | Herb dry weight plant$^{-1}$ (g) | | | |
| | | | 1$^{st}$ season | | 2$^{nd}$ season | | 1$^{st}$ season | | 2$^{nd}$ season | |
| | | | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut |
| - | | | 195.20 | 217.62 | 189.75 | 193.02 | 57.65 | 61.84 | 56.60 | 60.85 |
| + | | | 196.93 | 220.05 | 191.85 | 194.08 | 59.02 | 63.51 | 58.12 | 62.30 |
| L.S.D. at 0.05 C | | | 0.75 | 0.86 | 0.89 | 0.79 | 0.36 | 0.42 | 0.48 | 0.39 |
| Interaction | | | Herb fresh weight plant$^{-1}$ (g) | | | | Herb dry weight plant$^{-1}$ (g) | | | |
| A | B | C | 1$^{st}$ season | | 2$^{nd}$ season | | 1$^{st}$ season | | 2$^{nd}$ season | |
| | | | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut | 1$^{st}$ cut | 2$^{nd}$ cut |
| 0.0 | - | - | 172.3 | 196.2 | 166.3 | 171.3 | 45.3 | 50.1 | 44.1 | 49.3 |
| | | + | 176.7 | 200.5 | 169.8 | 174.5 | 47.1 | 53.6 | 46.8 | 52.8 |
| | + | - | 181.3 | 206.4 | 172.3 | 180.6 | 51.2 | 56.2 | 50.31 | 55.3 |
| | | + | 183.5 | 209.1 | 175.6 | 181.6 | 53.6 | 58.4 | 52.7 | 57.1 |
| 24 | - | - | 195.6 | 216.6 | 190.1 | 195.0 | 57.8 | 60.2 | 56.3 | 59.7 |
| | | + | 197.6 | 219.3 | 192.4 | 196.1 | 58.9 | 61.7 | 57.7 | 60.3 |
| | + | - | 202.7 | 221.7 | 199.3 | 200.3 | 61.2 | 64.3 | 60.01 | 63.5 |
| | | + | 204.3 | 226.1 | 202.6 | 201.6 | 63.8 | 67.1 | 62.3 | 66.3 |
| 48 | - | - | 209.7 | 232.5 | 205.1 | 205.3 | 65.1 | 70.11 | 64.3 | 68.7 |
| | | + | 209.8 | 232.6 | 205.3 | 205.1 | 65.3 | 70.10 | 64.7 | 68.6 |
| | + | - | 209.6 | 232.3 | 205.4 | 205.6 | 65.3 | 70.12 | 64.6 | 68.6 |
| | | + | 209.7 | 232.7 | 205.4 | 205.6 | 65.4 | 70.13 | 64.5 | 68.7 |
| L.S.D. at 0.05 | | | | | | | | | | |
| AB | | | 4.02 | 4.17 | 4.00 | 4.21 | 1.79 | 1.82 | 1.83 | 1.79 |
| AC | | | 3.55 | 3.72 | 3.70 | 3.69 | 1.47 | 1.73 | 1.70 | 1.72 |
| BC | | | 3.46 | 3.71 | 3.65 | 3.61 | 1.49 | 1.69 | 1.68 | 1.70 |
| ABC | | | 4.21 | 4.35 | 4.27 | 4.51 | 1.85 | 1.96 | 1.97 | 1.83 |

**Herb yields:**

Data in Table 7 represent the effect of FYM, natural rocks and putrescine applications and their interactions on sweet basil yields, in terms of fresh herb yield ha$^{-1}$ and dry herb yield ha$^{-1}$. Respecting the main effect of FYM, the results indicated that both fresh and dry herb yields were significantly increased due to increased FYM level from 0.0 up to 48 Mg ha-1 in both cuts and seasons. The increment in fresh and dry herb resulted to added 48 Mg ha-1 reached to 17.5 and 32.5% in first cut for first season when compared with no manuring, respectively. The positive effect of FYM application on sweet basil yield could be explained by its effect of basil growth parameters as mentioned before (Table 5 and 6). These results are in line with those obtained by many authors who stated that organic fertilization improved herb fresh and dry yields of sweet basil such as Abdou *et al* (2011), Singh *et al* (2014) and El-Naggar *et al* (2015).

With respect to the main effect of natural rocks, data in the previous Table show that sweet basil yields were significantly responded to added rock P and rock K as a source of phosphorus and potassium fertilizers. Using natural rocks produced fresh herb exceeded that without natural rocks by about 0.48 and 0.50 Mg $h^{-1}$ in first and second cuts, respectively in first season. The corresponding increases in dry herb were 0.34 and 0.33 Mg g $h^{-1}$ in the abovementioned order. Same trends were obtained for the second season. The promotive effect of natural rocks on sweet basil yields can mainly explained by its effect on growth parameters as discussed earlier. These results are in harmony with those obtained by Ezzat *et al* (2005) and Hendawy *et al* (2010).

By means of putrescine, the results clearly show that using putrescine enhanced sweet basil yields in both seasons comparing with no putrescine. In this concern, Davis and Olson (1994) reported that putrescine may evolved in the cell division stage of plant development and not cell enlargement. Also, Zhao *et al* (2007) reported that polyamines play an important role against salinity and increases of polyamines under saline conditions seems to be self-protecting response to plants. Similar results were obtained by El-Bassiouny and Bekheta (2005) and Sarhan (2012).

**Table 7. The main effect of FYM, natural rocks and putrescine and their interactions on yields of sweet basil.**

| **FYM** | | | **Fresh herb yield $ha^{-1}$ (ton)** | | | | **Dry herb yield $ha^{-1}$ (ton)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **(Mg g $ha^{-1}$)** | | | **1st season** | | **2nd season** | | **1st season** | | **2nd season** | |
| **(A)** | | | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** |
| 0.0 | | | 17.49 | 19.90 | 16.76 | 17.35 | 4.83 | 5.35 | 4.75 | 5.26 |
| 24 | | | 19.60 | 21.65 | 19.22 | 19.43 | 5.92 | 6.21 | 5.79 | 6.12 |
| 48 | | | 20.55 | 22.79 | 20.12 | 20.13 | 6.40 | 6.87 | 6.32 | 6.73 |
| L.S.D. at 0.05 A | | | 0.61 | 0.70 | 0.66 | 0.73 | 0.31 | 0.29 | 0.33 | 0.34 |
| Natural rocks | | | Fresh herb yield $ha^{-1}$ (ton) | | | | Dry herb yield $ha^{-1}$ (ton) | | | |
| (Kg $ha^{-1}$) | | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| (B) | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | | | 18.98 | 21.20 | 18.44 | 18.74 | 5.55 | 5.98 | 5.46 | 5.87 |
| + | | | 19.46 | 21.70 | 18.96 | 19.20 | 5.89 | 6.31 | 5.79 | 6.20 |
| L.S.D. at 0.05 B | | | 0.25 | 0.26 | 0.26 | 0.25 | 0.31 | 0.27 | 0.28 | 0.25 |
| Putrescine | | | Fresh herb yield $ha^{-1}$ (ton) | | | | Dry herb yield $ha^{-1}$ (ton) | | | |
| (C) | | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | | | 19.13 | 21.33 | 18.60 | 18.92 | 5.65 | 6.06 | 5.55 | 5.96 |
| + | | | 19.30 | 21.56 | 18.80 | 19.02 | 5.78 | 6.22 | 5.70 | 6.11 |
| L.S.D. at 0.05 C | | | 0.11 | 0.14 | 0.10 | 0.11 | 0.10 | 0.11 | 0.11 | 0.10 |
| Interaction | | | Fresh herb yield $ha^{-1}$ (ton) | | | | Dry herb yield $ha^{-1}$ (ton) | | | |
| A | B | C | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| 0.0 | - | - | 16.89 | 19.23 | 16.30 | 16.79 | 4.44 | 4.91 | 4.32 | 4.83 |
| | | + | 17.32 | 19.65 | 16.64 | 17.10 | 4.62 | 5.25 | 4.59 | 5.17 |
| | + | - | 17.77 | 20.23 | 16.89 | 17.70 | 5.02 | 5.51 | 4.93 | 5.42 |
| | | + | 17.98 | 20.49 | 17.21 | 17.80 | 5.25 | 5.72 | 5.16 | 5.60 |
| 24 | - | - | 19.17 | 21.23 | 18.63 | 19.11 | 5.66 | 5.90 | 5.52 | 5.85 |
| | | + | 19.36 | 21.49 | 18.86 | 19.22 | 5.77 | 6.05 | 5.65 | 5.91 |
| | + | - | 19.86 | 21.73 | 19.53 | 19.63 | 6.00 | 6.30 | 5.88 | 6.22 |
| | | + | 20.02 | 22.16 | 19.85 | 19.76 | 6.25 | 6.58 | 6.11 | 6.50 |
| 48 | - | - | 20.55 | 22.79 | 20.10 | 20.12 | 6.38 | 6.87 | 6.30 | 6.73 |
| | | + | 20.56 | 22.79 | 20.12 | 20.10 | 6.40 | 6.87 | 6.34 | 6.72 |
| | + | - | 20.54 | 22.77 | 20.13 | 20.15 | 6.40 | 6.87 | 6.33 | 6.72 |
| | | + | 20.55 | 22.80 | 20.13 | 20.15 | 6.41 | 6.87 | 6.32 | 6.73 |
| L.S.D. at 0.05 | | | | | | | | | | |
| AB | | | 0.82 | 0.79 | 0.85 | 0.90 | 0.42 | 0.40 | 0.38 | 0.42 |
| AC | | | 0.78 | 0.75 | 0.81 | 0.87 | 0.40 | 0.36 | 0.35 | 0.41 |
| BC | | | 0.72 | 0.74 | 0.80 | 0.83 | 0.38 | 0.36 | 0.34 | 0.39 |
| ABC | | | 1.02 | 1.00 | 1.03 | 1.05 | 0.53 | 0.56 | 0.51 | 0.56 |

As for the interaction, data clearly show that sweet basil yields were significantly affected by interaction between treatments and among them, where sweet basil yields not affected by putrescine or natural rocks under the high levels of organic manure. This may be due to sweet basil plant absorb enough nutrients from the high level of FYM needed for maximum growth. The treatment of 24 Mg g $ha^{-1}$ FYM + natural rocks + foliar spraying of putrescine gave the highest fresh and dry herb of sweet basil plants in the two cuts for both seasons. Whereas, control treatments exhibited the lows sweet basil yields.

**Oil percentage and yield:**

The effects of organic manure, natural rocks and putrescine and their interactions on essential oil percentage and oil yield of sweet basil are given in Table 8. As for the main effect of organic manure, the data indicate that boot oil percentage and yield were significantly improved due to organic manure application in comparison with no manuring. Added 48 Mg ha-1 increased oil percentage and yield by about 40.0 and 84.3% over without organic manure in first cut for the first season, respectively. The corresponding increases in second cut were 38.8 and 43.5% in the abovementioned respect. Similar trends were obtained in the second season. The improving in oil percentage and yield by increasing FYM levels may be due to the biological and physiological roles of organic manure on the vegetative growth traits, prevention of nitrogen losses and improved soil chemical and physical properties (Judais and Rinaldi, 2001 and Taiwo *et al*, 2002). These results are in agreement with those obtained by Khalid *et al* (2006), El-Sanafawy (2007), Abd El-Salam (2014), Omar *et al* (2016) and El-Ziat *et al* (2018) who stated that organic manure enhanced oil percentage and oil yield for basil plants.

With regard to the main effect of natural rocks, the results clearly show that the maximum values of oil percentage and oil yield in first and second cuts for both growing seasons were recorded with application of rock P and rock K. this may be due to phosphorus is an important nutritional nutrient in metabolic processes, nucleic acids, phospholipids and co-enzyme (Hafez and Mohmoud, 2009). Besides, potassium had specific role in plants, i.e., protein synthesis, osmoregulation, photosynthetic, internal cation and anion balance and enzyme activation (Shafeek *et al*, 2005). Similar results were obtained by Hendawy *et al* 2010.

**Table 8. The main effect of FYM, natural rocks and putrescine and their interactions on essential oil percentage and oil yield of sweet basil.**

| **FYM (Mg g ha$^{-1}$) (A)** | | | **Oil percentage** | | | | **Oil yield (Kg ha$^{-1}$)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **1st season** | | **2nd season** | | **1st season** | | **2nd season** | |
| | | | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** |
| 0.0 | | | 0.45 | 0.49 | 0.44 | 0.46 | 21.96 | 26.14 | 20.77 | 24.40 |
| 24 | | | 0.55 | 0.59 | 0.54 | 0.57 | 32.77 | 36.39 | 31.18 | 34.80 |
| 48 | | | 0.63 | 0.68 | 0.61 | 0.66 | 40.47 | 46.37 | 38.73 | 44.39 |
| L.S.D. at 0.05 A | | | 0.02 | 0.02 | 0.03 | 0.02 | 0.75 | 0.78 | 0.81 | 0.82 |
| Natural rocks (Kg ha$^{-1}$) (B) | | | Oil percentage | | | | Oil yield (Kg ha$^{-1}$) | | | |
| | | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | | | 0.52 | 0.56 | 0.50 | 0.54 | 29.52 | 34.15 | 28.04 | 32.52 |
| + | | | 0.57 | 0.60 | 0.55 | 0.58 | 33.95 | 38.45 | 32.41 | 36.54 |
| L.S.D. at 0.05 B | | | 0.01 | 0.02 | 0.01 | 0.01 | 0.63 | 0.62 | 0.77 | 0.73 |
| Putrescine (C) | | | Oil percentage | | | | Oil yield (Kg ha$^{-1}$) | | | |
| | | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | | | 0.54 | 0.57 | 0.52 | 0.55 | 30.80 | 35.32 | 29.42 | 33.59 |
| + | | | 0.56 | 0.59 | 0.54 | 0.57 | 32.67 | 37.28 | 31.03 | 35.47 |
| L.S.D. at 0.05 C | | | 0.01 | 0.01 | 0.01 | 0.01 | 0.43 | 0.40 | 0.45 | 0.46 |
| Interaction | | | Oil percentage | | | | Oil yield (Kg ha$^{-1}$) | | | |
| A | B | C | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| 0.0 | - | - | 0.41 | 0.46 | 0.39 | 0.42 | 18.20 | 22.59 | 16.85 | 20.29 |
| | | + | 0.44 | 0.47 | 0.42 | 0.45 | 20.33 | 24.68 | 19.28 | 23.27 |
| | + | - | 0.47 | 0.50 | 0.46 | 0.48 | 23.59 | 27.55 | 22.68 | 26.02 |
| | | + | 0.49 | 0.52 | 0.47 | 0.50 | 25.73 | 29.74 | 24.25 | 28.00 |
| 24 | - | - | 0.51 | 0.54 | 0.50 | 0.53 | 28.87 | 31.86 | 27.60 | 31.01 |
| | | + | 0.55 | 0.58 | 0.53 | 0.56 | 31.74 | 35.09 | 29.95 | 33.10 |
| | + | - | 0.56 | 0.59 | 0.55 | 0.57 | 33.60 | 37.17 | 32.34 | 35.45 |
| | | + | 0.59 | 0.63 | 0.57 | 0.61 | 36.88 | 41.45 | 34.83 | 39.65 |
| 48 | - | - | 0.61 | 0.66 | 0.59 | 0.65 | 38.92 | 45.34 | 37.17 | 43.75 |
| | | + | 0.61 | 0.66 | 0.59 | 0.65 | 39.04 | 45.34 | 37.41 | 43.68 |
| | + | - | 0.65 | 0.69 | 0.63 | 0.67 | 41.60 | 47.40 | 39.88 | 45.02 |
| | | + | 0.66 | 0.69 | 0.64 | 0.67 | 42.31 | 47.40 | 40.45 | 45.09 |
| L.S.D. at 0.05 | | | | | | | | | | |
| AB | | | 0.03 | 0.03 | 0.04 | 0.03 | 0.91 | 0.90 | 0.92 | 0.90 |
| AC | | | 0.03 | 0.04 | 0.04 | 0.03 | 0.91 | 0.83 | 0.93 | 0.89 |
| BC | | | 0.03 | 0.03 | 0.03 | 0.03 | 0.85 | 0.87 | 0.91 | 0.81 |
| ABC | | | 0.04 | 0.05 | 0.05 | 0.04 | 0.97 | 0.98 | 0.99 | 0.93 |

Regarding the main effect of putrescine, it is obvious from data in Table 8 that foliar application of putrescine to basil plants significantly improved both essential oil percentage in the herb and oil yield. This may be due to role of putrescine in metabolic processes such as, its ability to activate protein synthesis (Serafini- Fracassini, 1991). Putrescine are low-molecular weight polycations, which are involved in the regulation of growth and stress resistance, probably by binding to negatively charged macromolecules (Smith, 1985 and Altman and Levin, 1993). These results are in line with those obtained by Abd El-Wahed and Gamal El Din (2004) and Talaat and Balbaa (2010).

Considering the interaction effect, the data indicated that, the oil percentage and oil yield were significantly affected by the interaction between treatments and among them. In general, putrescine not affected oil percentage and oil yield of basil plants under high organic manure levels. This may be due to the high positive effect of high organic dose on plant growth and microbial activity as discussed former. The treatment of 48 Mg ha-1 + natural rocks + putrescine gave the highest values of oil % and oil yield. However, the plants not treated with each of organic manure, natural rocks and putrescine yielded the lowest oil % and oil yield of basil plants.

**Chemical composition:**

The data presented in Tables 9 and 10 show the effect of organic manure, natural rocks and putrescine as well as their interactions on some chemical composition in basil leaves, i.e., N%, P%, K%, chlorophyll a, chlorophyll b and carotenoids, the data clearly showed that all studied chemical composition were significantly enhanced due to increasing FYM from 0.0 up to 48 Mg g $ha^{-1}$, which may be due to adding organic manure encourage several beneficial microorganisms that improved the production of auxin and growth promoting substances in the root zone, hence promote nutrient absorption and pigments formation (El-Merich *et al*, 1997). These results are similar to those obtained by Hemdan (2008) and Eid and Kassem (2009) for N, P and K concentration, and Abd El-Naeem (2012) and Abd El-Salam (2014) for chlorophyll a, chlorophyll b and carotenoids.

**Table 9. The main effect of FYM, natural rocks and putrescine and their interactions on N, P and K in dry herb of sweet basil.**

| **FYM (Mg g $ha^{-1}$) (A)** | **N%** | | | | **P%** | | | | **K%** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1st season** | | **2nd season** | | **1st season** | | **2nd season** | | **1st season** | | **2nd season** | |
| | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** | **1st cut** | **2nd cut** |
| 0.0 | 0.61 | 0.93 | 0.68 | 0.97 | 0.22 | 0.24 | 0.20 | 0.21 | 0.46 | 1.01 | 0.92 | 0.98 |
| 24 | 0.87 | 1.27 | 0.90 | 1.29 | 0.29 | 0.31 | 0.27 | 0.29 | 1.84 | 2.06 | 1.81 | 2.04 |
| 48 | 1.03 | 1.53 | 1.13 | 1.56 | 0.33 | 0.35 | 0.31 | 0.33 | 2.31 | 2.52 | 2.29 | 2.48 |
| L.S.D. at 0.05 A | 0.12 | 0.13 | 0.11 | 0.12 | 0.02 | 0.02 | 0.02 | 0.03 | 0.11 | 0.12 | 0.11 | 0.12 |

| Natural rocks (Kg $ha^{-1}$) (B) | N% | | | | P% | | | | K% | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st season | | 2nd season | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | 0.84 | 1.23 | 0.90 | 1.27 | 0.27 | 0.29 | 0.24 | 0.26 | 1.58 | 1.73 | 1.55 | 1.70 |
| + | 0.84 | 1.25 | 0.90 | 1.28 | 0.29 | 0.31 | 0.27 | 0.29 | 1.82 | 2.00 | 1.80 | 1.97 |
| L.S.D. at 0.05 B | N.S | N.S | N.S | N.S | 0.01 | 0.01 | 0.02 | 0.02 | 0.12 | 0.11 | 0.13 | 0.17 |

| Putrescine (C) | N% | | | | P% | | | | K% | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st season | | 2nd season | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | 0.84 | 1.24 | 0.90 | 1.27 | 0.28 | 0.30 | 0.26 | 0.28 | 1.70 | 1.85 | 1.67 | 1.83 |
| + | 0.84 | 1.25 | 0.90 | 1.27 | 0.28 | 0.30 | 0.26 | 0.28 | 1.71 | 1.87 | 1.67 | 1.83 |
| L.S.D. at 0.05 C | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |

| Interaction | | | N% | | | | P% | | | | K% | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1st season | | 2nd season | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| A | B | C | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| 0.0 | - | - | 0.62 | 0.92 | 0.67 | 0.97 | 0.20 | 0.22 | 0.18 | 0.20 | 0.79 | 0.83 | 0.75 | 0.80 |
| | | + | 0.61 | 0.94 | 0.68 | 0.96 | 0.20 | 0.22 | 0.18 | 0.20 | 0.79 | 0.84 | 0.75 | 0.80 |
| | + | - | 0.61 | 0.93 | 0.68 | 0.97 | 0.23 | 0.25 | 0.21 | 0.23 | 1.11 | 1.16 | 1.09 | 1.15 |
| | | + | 0.61 | 0.94 | 0.68 | 0.97 | 0.23 | 0.25 | 0.21 | 0.22 | 1.13 | 1.19 | 1.09 | 1.15 |
| 24 | - | - | 0.86 | 1.25 | 0.89 | 1.28 | 0.28 | 0.29 | 0.25 | 0.27 | 1.72 | 1.91 | 1.70 | 1.90 |
| | | + | 0.87 | 1.26 | 0.89 | 1.29 | 0.28 | 0.30 | 0.25 | 0.28 | 1.73 | 1.93 | 1.70 | 1.91 |
| | + | - | 0.87 | 1.27 | 0.90 | 1.29 | 0.30 | 0.32 | 0.28 | 0.30 | 1.95 | 2.20 | 1.91 | 2.18 |
| | | + | 0.88 | 1.28 | 0.91 | 1.30 | 0.30 | 0.32 | 0.28 | 0.30 | 1.96 | 2.21 | 1.92 | 2.17 |
| 48 | - | - | 1.02 | 1.51 | 1.13 | 1.56 | 0.32 | 0.34 | 0.30 | 0.32 | 2.21 | 2.41 | 2.19 | 2.38 |
| | | + | 1.03 | 1.52 | 1.12 | 1.55 | 0.32 | 0.34 | 0.30 | 0.31 | 2.22 | 2.43 | 2.18 | 2.38 |
| | + | - | 1.03 | 1.53 | 1.12 | 1.56 | 0.34 | 0.36 | 0.31 | 0.33 | 2.40 | 2.61 | 2.40 | 2.58 |
| | | + | 1.03 | 1.54 | 1.13 | 1.56 | 0.35 | 0.36 | 0.31 | 0.34 | 2.40 | 2.62 | 2.39 | 2.57 |
| L.S.D. at 0.05 | | | | | | | | | | | | | | |
| AB | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| AC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| BC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| ABC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |

**Table 10. The main effect of FYM, natural rocks and putrescine and their interactions on chlorophyll a, chlorophyll b and carotenoids of sweet basil.**

| FYM (Mg g ha$^{-1}$) (A) | Chlorophyll a, V.W | | | | Chlorophyll b, V.W | | | | Carotenoids, V.W | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st season | | 2nd season | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| 0.0 | 2.07 | 2.12 | 2.09 | 2.15 | 0.68 | 0.69 | 0.68 | 0.69 | 0.71 | 0.72 | 0.72 | 0.73 |
| 24 | 2.25 | 2.31 | 2.28 | 2.34 | 0.76 | 0.77 | 0.76 | 0.77 | 0.77 | 0.79 | 0.78 | 0.79 |
| 48 | 2.34 | 2.39 | 2.36 | 2.41 | 0.82 | 0.82 | 0.82 | 0.82 | 0.81 | 0.83 | 0.82 | 0.83 |
| L.S.D. at 0.05 A | 0.10 | 0.11 | 0.10 | 0.11 | 0.06 | 0.05 | 0.05 | 0.06 | 0.04 | 0.05 | 0.04 | 0.04 |

| Natural rocks (Kg ha$^{-1}$) (B) | Chlorophyll a, V.W | | | | Chlorophyll b, V.W | | | | Carotenoids, V.W | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st season | | 2nd season | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | 2.22 | 2.27 | 2.24 | 2.30 | 0.75 | 0.76 | 0.75 | 0.76 | 0.77 | 0.78 | 0.77 | 0.78 |
| + | 2.22 | 2.28 | 2.25 | 2.30 | 0.75 | 0.76 | 0.75 | 0.76 | 0.77 | 0.78 | 0.77 | 0.78 |
| L.S.D. at 0.05 B | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |

| Putrescine (C) | Chlorophyll a, V.W | | | | Chlorophyll b, V.W | | | | Carotenoids, V.W | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st season | | 2nd season | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| - | 2.19 | 2.25 | 2.21 | 2.27 | 0.74 | 0.74 | 0.74 | 0.75 | 0.76 | 0.77 | 0.76 | 0.77 |
| + | 2.25 | 2.30 | 2.28 | 2.33 | 0.77 | 0.77 | 0.77 | 0.77 | 0.78 | 0.79 | 0.78 | 0.79 |
| L.S.D. at 0.05 C | 0.03 | 0.03 | 0.04 | 0.04 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Interaction | | | Chlorophyll a, V.W | | | | Chlorophyll b, V.W | | | | Carotenoids, V.W | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | 1st season | | 2nd season | | 1st season | | 2nd season | | 1st season | | 2nd season | |
| | | | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| 0.0 | - | - | 2.01 | 2.08 | 2.03 | 2.09 | 0.671 | 0.674 | 0.672 | 0.676 | 0.702 | 0.713 | 0.706 | 0.717 |
| | | + | 2.11 | 2.16 | 2.13 | 2.19 | 0.693 | 0.698 | 0.694 | 0.700 | 0.725 | 0.732 | 0.729 | 0.738 |
| | + | - | 2.02 | 2.09 | 2.06 | 2.12 | 0.673 | 0.676 | 0.674 | 0.679 | 0.702 | 0.714 | 0.706 | 0.717 |
| | | + | 2.13 | 2.16 | 2.15 | 2.19 | 0.694 | 0.698 | 0.695 | 0.701 | 0.726 | 0.737 | 0.729 | 0.738 |
| 24 | - | - | 2.22 | 2.29 | 2.25 | 2.32 | 0.736 | 0.740 | 0.737 | 0.743 | 0.763 | 0.772 | 0.767 | 0.776 |
| | | + | 2.28 | 2.33 | 2.32 | 2.36 | 0.785 | 0.791 | 0.787 | 0.794 | 0.785 | 0.796 | 0.790 | 0.799 |
| | + | - | 2.22 | 2.29 | 2.24 | 2.31 | 0.737 | 0.740 | 0.739 | 0.743 | 0.764 | 0.776 | 0.769 | 0.776 |
| | | + | 2.29 | 2.34 | 2.31 | 2.36 | 0.786 | 0.792 | 0.788 | 0.793 | 0.787 | 0.797 | 0.792 | 0.803 |
| 48 | - | - | 2.32 | 2.36 | 2.35 | 2.39 | 0.811 | 0.815 | 0.812 | 0.818 | 0.803 | 0.816 | 0.808 | 0.817 |
| | | + | 2.35 | 2.40 | 2.37 | 2.43 | 0.819 | 0.822 | 0.820 | 0.824 | 0.823 | 0.835 | 0.828 | 0.836 |
| | + | - | 2.33 | 2.37 | 2.35 | 2.39 | 0.812 | 0.816 | 0.812 | 0.818 | 0.804 | 0.816 | 0.808 | 0.818 |
| | | + | 2.35 | 2.41 | 2.38 | 2.44 | 0.820 | 0.823 | 0.821 | 0.826 | 0.824 | 0.837 | 0.829 | 0.836 |
| L.S.D. at 0.05 | | | | | | | | | | | | | | |
| AB | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| AC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| BC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| ABC | | | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |

Respecting the main effect of natural rocks, data show that added rock P combined with feldspar affected only phosphorus and potassium concentration in basil leaves, while other studied traits not affected. The positive effect of rock P and feldspar on P and K concentration is mainly due to effect of natural rocks on basil growth as discussed earlier, it is a good source of phosphorus and potassium for plant (Abd El-Hafeez *et al*, 2013). These results are in line with those obtained by Youssef (2006) and El-Sheref (2012).

As for the main effect of putrescine, the obtained data clearly reveal that foliar spraying with putrescine had no significant effect on NPK and pigments in basil leaves. These results agree with those obtained by Sarhan (2012) who reported that foliar application of putrescine at rate of 10 µM putrescine had no effect on chemical composition of barley plants.

With respect to the interaction effect, the data indicated that chemical composition of basil leaves not affected by the interaction between treatments. In general, the highest values of P% and K% were obtained under the treatment of 48 Mg ha-1 + natural rocks, while highest values of plant pigments were produced under the treatment of 48 Mg ha-1 + putrescine. Moreover, the plants without manuring and without both natural rocks and putrescine exhibited the lowest values of chemical composition.

## CONCLUSSION

It may be recommended to supply sweet basil plants grown in sandy soil and irrigated with slightly saline soil with 24 Mg ha$^{-1}$ farmyard manure + 720 Kg ha$^{-1}$ rock P + 960 Kg ha$^{-1}$ feldspar and sprayed its leaves with 10 µ M putrescine or 48 Mg ha-1 farmyard manure to produce high quality and quantity of its yield.

## REFERENCES


Abd El-Hafeez, A.M.; H.A. Awadalla and S.A. Ismail (2013). Influence of different sources and levels of nitrogen and rock phosphate addition on maize productivity and soil fertility. J. Soil Sci. and Agric. Eng., Mansoura Univ., 4(11): 1313-1328.

Abd El-Latif, M.T.M. (2007). Effect of some fertilization and antioxidant treatments on forage plants. M.Sc. Thesis, Fac. Agric., Minia Univ., Egypt.

Abd El Lattif, R.F.H. (2012). Studies of balanced fertilization of corn plant under newly reclaimed land. M.Sc. Thesis, Fac. of Agric., Benha Univ., Egypt.

Abd El-Naeem, L.M.A. (2012). Physiological studies on mint plants. Ph.D.Thesis, Fac. of Agric., Minia Univ., Egypt.

Abd El-Salam, N.M.K. (2014). Response of sweet basil plants to some agricultural treatments. Ph.D. Thesis, Fac. of Agric., Minia Univ., Egypt.

Abd El-Wahed, M.S.A. and K.M. Gamal El-Din (2004). Stimulation of growth, flowering, biochemical constituents and essential oil of chamomile plant (Chamomilla recutita L., rausch) with spermidine and stigmasterol application.Bulg. J. Plant Physiol., 30: 89-102.

Abdou, M.A.H.; M.Y.A. Abdalla; A.A. Hegazy and Z.S.A. Marzok (2011). Physiology studies on clove basil plant. J. Plant Production, Mansoura Univ.2(11): 1451-1469.

Ali, M. E.; S. A. Ismail; A. H. Abd El Hameid; O. H. EL.Hussieny and Gh. F. H. El-Sheref (2012). Effect of nature fertilizers under different levels of nitrogen and farmyard manure on the productivity of maize. Fayoum J.Agric. Res. & Dev.; 26 (1): 49-63.

Altman, A. and N. Levin (1993). Interactions of polyamines and nitrogen,nutrition in plants. Physiol. Plant., 89: 653-658.

Anwar, M.; D.D. Patra; S. Chand; K. Alpesh; A.A. Naqvi and S.P.S. Khanuja (2005). Effect of organic manures and inorganic fertilizer on growth, herb and oil yield, nutrient accumulation and oil quality of french basil. Comm. Soil Sci. and Plant Anal., 36: 1737-1746.

A.O.A.C. (1986). Official Methods of Analysis $14^{th}$ Ed. Association of Official Agricultural Chemists, Alingtan, Virginia, USA.

Asgharipour, M.R. and M. Rafiei (2011). The effect of different concentrations of humic acid on seed germination behavior and vigor of barley. Australian J. of Basic and Applied Sci., 5(12): 610-613.

Basha, A.A.A. and M.S. Hassan (2017). Evaluation of rock phosphate and potassium feldspar with biological and organic amendments and its effect on soil phosphorus and potassium availability and uptake, growth and yield of canola. International J. of plant &Soil Sci., 14(5): 1-14.

Bouchereau, A.; A. Aziz; F. Larher and M. J. Tanguy (1999). Polyamines and environmental challenges: recent development. J. of Plant Sci., 140(2): 103-125.

Bufalo, J.; C.L. Cantrell; T. Astatkie; V.D. Zheljazkov; A. Gawde and C.S.F. Boaro (2015). Organic versus conventional fertilization effects on sweet basil (*Ocimum basilicum L.*) growth in a greenhouse system. J. Industrial Crops and Products, 74: 249-254.

Davis, D.G. and P.A. Olson (1994). Effects of putrescine and inhibitors of putrescine biosynthesis on organogenesis in (Euphorbia esula L.) Reprinted with permission form: In Vitro Cellular and Developmental Biology-Plant. Published and copyright by: Society for In Vitro Biology, 30P, (2): 124-130.

Egyptian Pharmacopoeia (1984). General Organization for Governmental Printing Office, Cairo, Egypt.

Eid, M.I. and A.H.M. Kassem (2009). Effect of phosphorein and active dry yeast on *Calendulla officinalis*, L. J. Product and Dev., 14(2): 491-505.

Einhellig, F.A. and G.R. Leather (1988). Potentials for exploiting allelopathy to enhance crop production. J. Chem. Ecol., 14(10): 1829-44.

El-Bassiouny, H.M.S. and M.A. Bekheta (2005). Effect of salt stress on relative water content, lipid peroxidation, polyamines, amino acids and ethylene of two wheat cultivars. Int. J. of Agric. & Biol., 7(3): 363-368.

El- Merich, C.; M. De-Zamarozy; F. Arsene; T. Pereg; A.Paquellin and A. Kaminski (1997). Regulation NIF gene expression and nitrogen metabolism in Azospirillum. Soil Biol. and Biochem., 29(5-6): 847-852.

El-Naggar, I.M.; A.M. Hanna; E.A.Y. El-Kabbany and A.Y. El-Tawail (1998). Effect of soil moisture levels and different sources of nitrogen on physical and chemical properties of soil and maize production. Menofiya J. Agric. Res., 20: 1237-1263.

El-Naggar, A.H.M.; M.R.A. Hassan; E.H. Shaban and M.E.A. Mohamed (2015). Effect of organic and biofertilizers on growth, oil yield and chemical composition of the essential oil of Ocimum basilicum L. plants. Alex. J. Agric. Res., 60(1): 1-16.

El-Sanafawy, S.E.A. (2007). Effect of some fertilization treatments on Ocimum basilicum and Origanum majoranum. Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ., Egypt.

El-Sayed, A.A.; S.H. El-Hanafy and R.A. El-Ziat (2015). Effect of chicken manure and humic acid on herb and essential oil production of Ocimum sp. American-Eurasian J. Agric. & Environ. Sci., 15(3): 367-379.

El-Shabrawy, R. M. I. (2011). Studies on tomato plant under different fertilization system. M.Sc. Thesis, Fac. of Agric., Minia Univ., Egypt.

El-Sheref, Gh. F.H. (2012). Minimizing pollution with inorganic fertilizers through Some nutritional techniques. Ph.D. Thesis, Fac. of Agric., Benha Univ., Egypt.

El-Ziat, R.A.; H.M. Swaefy and S.E.A. Esmail (2018). The response of red rubin basil plant to organic fertilizer and humic acid versus chemical fertilizers. Middle East J. of Agric. Res., 7(3): 740-751.

Ezzat, Z.M.; K.M. Khalil and A.A. Khalil (2005). Effect of natural potassium fertilizer on yield, yield components and seed composition of lentil in old and new reclaimed lands. Egypt, J. App. Sci., 20: 80-92.

Galston, A. and R. Sawhney (1990). Polyamines in plant physiology. Plant Physiol., 94: 406-410.

Geetha, A.; P.V. Rao; D.V. Reddy and M.Shaik (2009). Effect of organic and inorganic fertilizers on macro and micro nutrient uptake, oil content, quality and herbage yield in sweet basil (*Ocimum basilicum*). Research on Crops,10(3): 740-742.

Glick, B.R. (2003). Plant growth promoting bacteria. In: Glick, B.R. and J.J. Pasternak (eds.), Molecular Biology-Principles and Applications of Recombinant DNA, pp: 436-54, ASM press, Washington DC, USA.

Gowda, A.M.; El-Taweel, A.A. and Eassa, K.B. (2011). Studies on reducing the harmful effect of saline water irrigation on picual olive trees. Minufiya J. Agric. Res., 36(3): 623-645.

Hafez, M.A. and A.R. Mahmoud (2009). Effect of natural and chemical phosphorus fertilization as individually and/or mixed on the productivity of eggplant. Res. J. Agric. & Biol. Sci., 5(4): 344-348.

Hellal, F.A.; M. Abd El-Had and A.A.M. Ragab (2009). Influence of organic amendments on nutrient availability and uptake by faba bean plants fertilized by rock phosphate and feldspar. American-Eurasian J. Agric., & Environ, Sci., 6(3): 271-279.

Hemdan, S.H.O. (2008). Effect of some organic and biofertlization treatments on anise plants. M. Sc. Thesis, Fac. Agric., Minia Univ. Egypt.

Hendawy, S.F.; E.E.A. Ezz El-Din and E.A. Omer (2010). Productivity and oil quality of Thymus vulgaris, L. under organic fertilization conditions.Ozean J. Appl. Sci., 3(2): 203-216.

Husain, A.O.P.; A. Virmani; A. Sharma; A. Kumar and L.N. Misra (1988). Major essential oil-bearing plants of India. Central Institute of Medicinal and Aromatic Plants, Lucknow, India, pp: 6-11.

Indiati, R.; U. Neri; M. Magyar and P. Csatho (2002). Effect of time, fertilizer phosphorus sources and fertilization system on phosphorus extractability of two soils from Hungary. Commun, Soil Sci. Plant Anal., 33(364): 545-560.

Jayasri, P. and S. Anuja (2010). Effect of organic nutrients on growth and essential oil content of sweet basil (Ocimum basilicum, L.). Asian J. of Horticulture, 5(1): 26-29.

Judais, V. and S. Rinaldi (2001). Organic fertilizers in melon: the dynamic of nitrogen. PHM Revue Horticole. 431: 17-20 (C.F. Hort. Abst., 72(7): 63-85).

Kakkar, R.K.; P.K. Nagar; P.S. Ahuja and V.K. Rai (2000). Polyamines and plant morphogenesis. Boil. Plant., 43: 1-11.

Khalid, Kh. A.; S.F. Hendawy and E. El-Gezawy (2006). Ocimum basilicum, L. production under organic farming. Res. J. of Agric. and Bio. Sci., 2(1): 25-32.

Kifuko, M.N.; C.O. Othieno; J.R. Okalebo; L.N. Kimenye; K.W. Ndung´u and A.K. Kipkoech (2007). Effect of combining organic residues with minjingu phosphate rock on sorption and availability of phosphorus and maize production in acid soils of Western Kenya. Excremental Agriculture, 43:1, 51-66.

Mann, K.K.; B.S. Brar and N.S. Dhillon (2006). Influence of long-term use of farmyard manure and inorganic fertilizers on nutrient availability in typic ustochrpt. Indian J. of Agric. Sci., 76(8): 477-480.

Manning, D.A.C. (2010). Mineral sources of potassium for plant nutrition. A review article. Agronomy for Sustainable Develop. 30:208-294.

Mashali, A.M. (1997). FAO global network on integrated soil management for sustainable use of salt affected soils. Proceedings of International Symposium on Sustainable Management of Salt Affected Soils in the Arid Ecosystem. 21-26 September, Cairo, Egypt, 31-51.

Nour, A.H.; S.A. Elhussein; N.A. Osman; N.E. Ahmed; A.A. Abduelrahman and M.M. Yusoff (2009). Antibacterial activity of the essential oils of Sudanese accessions of basil (*Ocimum basilicum* L.). J. Appl. Sci., 9: 4161-4167.

Omar, E.A.; M.S. Hussein; A.R. Osman; E. Sewedan; A.I. Elgohary and A.M. Salman (2016). Response of basil essential oil to cultivation date and organic fertilization. Int. J. Pharm Tech Res., 9(5): 86-98.

Saikia, L.R. and S. Upadhyaya (2011). Antioxidant activity, phenols and flavonoid content of A. racemosus, Willd. a medicinal plant grown using different organic manures. Res. J. Pharm. Biol. Chem. Sci., 2(2): 457-463.

Sarhan, M.G.R. (2012). Some agricultural practices for improving barley yield grown in the newly reclaimed land irrigated with saline water. Ph.D. Thesis, Fac. of Agric., Minia Univ., Egypt.

Serafini-Fracassini, D. (1991). Cell cycle-dependent changes in plant polyamine metabolism. I: Slocum RD, Flores HE(ed) Biochemistry and Physiology of Polyamines in Plants. CRC Press, Boca Raton, FL, pp: 159-171.

Shafeek, M.R.; O.A.H. El-Zeiny and M.E. Ahmed (2005). Effect of natural phosphate and potassium fertilizer on growth, yield and seed composition of pea plant in new reclaimed soil. Asian J. Plant Sci., 4(6): 608-612.

Shahram, S. and K. Ordookhani (2011). Organic and bio-fertilizers as a good substitute for inorganic fertilizers in medicinal plants farming. Australian J. Basic-Appl. Sci., 5:1330-1333.

Singh, K.; S. Chand and M. Yaseen (2014). Integrated nutrient management in indian basil (Ocimum basilicum). Industrial crops and products, 55: 225-229.

Sirousmehr, A.; J. Arbabi and M.R. Asgharipour (2014). Effect of drought levels and organic manures on yield, essential oil content and some morphological characteristics of sweet basil (*Ocimum basilicum*). Advances in Environmental Biology, 8(4): 880-885.

Smith, T.A. (1982). The function and metabolism of polyamines in higher plants. In: Wareing P.F.(ed). Plant Growth Substances. Academic Press, New York, pp: 683.

Smith, T.A. (1985). Polyamines. Annu., Rev., Plant Physiol., 36: 117-43.

Snedecor, G.W. and W.G. Cochran (1989). Statistical Methods. $6^{th}$ (Ed.), The Iowa State Univ. Press, Ames., Iowa. U.S.A.

Taiwo, L.B.; J.A. Adediran; O.A. Ashaye; O. Odofin and A.J. Oyadoyin (2002). Organic okra (Abolmoschus esculentus): its growth, yield and organoleptic properties. Nutrition and Food Science, 32(415): 180-183. (Hort. Abst., 72(12): 10918).

Talaat, I.M. and L.K. Balbaa (2010). Physiological response of sweet basil plants (Ocimum basilicum L.) to putrescine and trans-cinnamic acid. American-Eurasian. J. Agric. & Environ. Sci., 8(4): 438-445.

Wong, J.W.C.; K.K. Ma; K.M. Fang and C. Cheung (1999). Utilization of a manure compost for organic farming in Hong Kong. Bioresource Technology, 67 (1): 43-46.

Youssef. I.A.. (2006). Evalution of effects of some natural organic and inorganic materials on plant growth and soil properties. M.Sci. Thesis, Fac. of Agric., Minia Univ., Egypt.

Zeid, F.A.; E.A. Omer; A.Y. Amin and Sh.A.H. Hanafy (2014). Effect of putrescine salicylic acid on ajwain plant (*Trachyspermum Ammi*) at vegetative stage grown under drought stress. International J. of Agric. Sci. and Res., 4(6): 61-80.

Zhao, F.; C.P. Song; J. He and H. Zhu (2007). Polyamines improve $K^+/Na^+$ homeostasis in barley seedlings by regulating root ion channel activities. Plant Physiology, 145(3): 1061-1072.

## تأثير السماد العضوي والاسمدة الطبيعية والبتروسين علي محصول وجودة نبات الريحان النامي في أرض رملية

**غادة فتح الله حافظ الشريف ، حامد علي عوض الله و جيهان عبدالرؤف محمد**
**معهد بحوث الأراضى والمياه والبيئه -مركز البحوث الزراعية بالجيزة- مصر**

أقيمت تجربتان حقليتان في الأراضي الجديدة بمزرعة خاصة بمنطقة القرية الاولي غرب مدينة بني مزار، محافظة المنيا، جمهورية مصر العربية لدراسة تأثير أضافة الأسمدة العضوية ( صفر، 24 ، 48 طن/هكتار سماد بلدي) ، الأسمدة الطبيعية ( صفر ، خلط 720 كجم/هكتار صخر فوسفات مع 960 كجم/ هكتار فلسبار) ، مادة البتروسين ( صفر ، رش بتروسين بمعدل 10 ميكرومول) علي صفات النمو الخضري (طول النبات ، عدد الأفرع للنبات ، الوزن الطازج والجاف للنبات) والمحصول الطازج والجاف للهكتار ، ونسبه ومحصول الزيت ، ومحتوي الأوراق من النيتروجين والفوسفور والبوتاسيوم والكلورفيل أ والكلورفيل ب والكاروتينويدات وكذلك علي بعض خواص التربة بعد الحصاد (الحموضة والملوحة ونسبة المادة العضوية وصلاحية النيتروجين والفوسفور والبوتاسيوم). ويمكن تلخيص أهم النتائج المتحصل عليها كمايلي: - أدي زيادة التسميد العضوي حتي 48 طن/ هكتار الي زيادة في أرتفاع النبات ، عدد الأفرع/النبات والوزن الطازج والجاف للنبات في كل حشه والوزن الطازج والجف بالطن/هكتار ونسبة ومحصول الزيوت الطيارة والمكونات الكيميائية للورقة (تركيز النيتروجين والفوسفور والبوتاسيوم والمحتوي من والكلورفيل أ والكلورفيل ب والكاروتينويدات. - أدي إضافة أسمدة الصخور الطبيعية الي زيادة في كل الصفات السابقة الذكر ماعدا محتوي النيتروجين والصبغات في الأوراق. - أدي رش نبات الريحان بمادة البتروسين الي زيادة معنوية الصفات المدروسة ماعدا محتوي الاوراق من النيتروجين والفوسفور والبوتاسيوم. - أدت معاملة 24 طن/هكتار سماد بلدي + 720 كجم صخر فوسفات/هكتار + 960 كجم فلسبار/هكتار + رش بمادة البتروسين أو 48 طن سماد بلدي للهكتار إلي أعلي قيم لمحصول الريحان كما ونوعا. - أدي إضافة السماد البلدي الي تحسين حموضه التربة ونسبة المادة العضوية وصلاحية النيتروجين والفوسفور والبوتاسيوم بعد الحصاد. بينما زادت ملوحة التربة بإضافة السماد لعضوي. - لم يؤثر إضافة الأسمدة الطبيعية ورش مادة البتروسين علي خوص التربة بعد الحصاد ، ماعدا الفوسفور والبوتاسيوم الميسر بعد الحصاد الذي زاد بإضافة الأسمدة الطبيعية. ومن نتائج البحث يمكن التوصيه بتسميد نبات الريحان بالسماد البلدي بمعدل 48 طن/هكتار مع إضافة 720 كجم/هكتار صخر فوسفات مختلط مع 960 كجم/هكتار فلسبار ورش النبات بمادة البتروسين بمعدل 10 ميكرومول للحصول علي أعلي إنتاجية كما ونوعا.