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# Integrated Agriculture of Faba Bean Using New Modified Formula of Effective Microorganisms under New Reclaimed Areas Conditions.

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## ABSTRACT

Series of experiments were conducted in Six October farm East Oweinat - New Valley governorate during the winter season 2009/2010 (preliminary screening two filed experiments), and the successive winter seasons of 2010/2011 and 2011/2012 respectively (principal field experiments) to study the effect of the integration between new formulas of Effective Microorganisms "EM" soil amendments and foliar fertilization on *Vicia faba* L. var. Giza 40 growth and productivity. At preliminary experiments data were recorded two times during plant growth i.e. at 65 days after sowing date; plant height (cm), plant shoot and root fresh weights (g), plant shoot and root dry weights (g), $4^{th}$ leaf area ($cm^2$), total pigments (SPDA),and at harvest time, the biological and seed yields (ton/ha) and harvest index (%).While at the principal field experiment data were collected twice during plant growth i.e. at 65 days after sowing date,$4^{th}$ leaf area ($cm^2$) and total pigments (SPDA), and at harvest plant height (cm), No. of branches /plant, No. of pods /plant, seed yields (g/plant), 100 seed weight (g), biological yield (ton/ha), seed yield (ton/ha), straw yield (ton/ha). Results indicated that under severe heat and water stress conditions where there is no excess concentration of Fe either in soil or irrigation water, the combination of {EM-Bokashi + OM (1:1)} + EM-Ceramic (1 kg/ $m^3$) × $EM_{5\text{-legume plus}}$ at 45 and 60 days with 8000 ppm will be the perfect fertilization programme under these conditions. Yet, where there is excess concentration of Fe in soil or irrigation water like what existed in some oasis of Egypt, {EM-Bokashi + OM (1:1)} + EM-Ceramic (1kg/ $m^3$) × $EM_{5\text{-legume}}$ at 45 and 60 days with 8000 ppm will be the ideal fertilization programme under this conditions.

**Keywords:** Faba bean, Effective microorganisms (EM), productivity, organic and biological fertilization.

## INTRODUCTION

Faba bean, is one of the most important and strategic leguminous crops for human nutrition. It is significant for soil fertility and for intensification of the wheat based system in many countries such as Egypt, (Anonymous, 2013). Egypt ranked the first between the faba bean importing countries with 0.23-0.3 mega tons at the last five years (Anonymous ,2015). This is a result for the huge consumption, limited area for growing and its high acceptability for many biotic and abiotic stresses particularly in the new reclaimed areas (Anonymous ,2015). The average crop yields in farmers' fields were low, ranging from 3.78 tons per hectare in old lands to 3.60 tons per hectare in new lands and 3.2 tons per hectare in Upper Egypt. Most of the varieties grown by farmers were susceptible to plant diseases, insect pests, and shortage of water availability in the new reclaimed areas. Nevertheless, the negative consequences of climate change; Egypt has experienced a rise of 0.34º C per decade in mean maximum air temperature and 0.31º C per decade in mean minimum air temperature. According to the Intergovernmental Panel on Climate Change, it will probably get hotter and drier during the upcoming years (Anonymous 2015).

Organic fertilization side by side with Rhizobium inoculation was found to be very important to increase plant growth, yield, and improve seed quality and nutritional value. (El Sheikh and Elzidany, 1997), similar results were obtained by Abd El-Ati and El-Hadidy Abeer (2013) where they indicated that EM-Bokashi as an organic fertilization let to increase faba bean growth and productivity.

The term effective Microorganisms (EM) as proposed by (Higa, 1991; and Higa & Wididana, 1991a) contains selected species of microorganisms including predominant populations of lactic acid bacteria and yeasts, and smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms such as mycorrhizae. Inoculation of EM cultures to the soil/plant ecosystem can improve soil quality, plant health, growth, yield, and quality of crops. So it added for optimizing best soil and crop management practices such as crop rotations, use of organic amendments, conservation tillage, crop residue recycling, and biocontrol of pests. If used properly, $EM_1$ can significantly enhance the beneficial effects of these practices (Higa and Wididana, 1991b). Consequently, ($EM_5$) is a modification product from $EM_1$ by adding vinegar and ethyl alcohol during the fermentation process in order to have multifunction product such as foliar fertilizer and insect repellent (Higa, 2000). Wisselinka *et al*.(2002) reported that several heterofermentative lactic acid bacteria produce mannitol which is a sugar alcohol in large amounts, using fructose as an electron acceptor, whereas homo-fermentative lactic acid bacteria only produce small amounts of mannitol, therefore mannitol is produced in $EM_1$ and $EM_5$ naturally as a byproduct of the fermentation process during $EM_x$ manufacture. Consequentially, EM-ceramics are made by fermenting special montmorillonite clays with EM and then baked. This allows the microbes to remain within the pores and as a result, they exert their influences through a combination of microbial action and the physical properties of the ceramics. On the other hand, EM-Bokashi is an organic material that has been fermented with $EM_1$, molasses and water under anaerobic conditions. The resultant material is a wonderful soil improver, not only because it is nutrient rich but also because the $EM_1$ have propagated and can rapidly combines with the soil to improve the soil structure and suppress the soil born disease. It can be made from a variety of organic materials, including animal waste such as cow and horse manure or green waste (Higa, 2000). The use of these microorganisms can alleviate stresses in crop plants thus provide excellent models for understanding the stress tolerance, adaptation and response mechanisms that makes crop plants more capable to cope with climate change stresses (Wisselinka *et al*., 2002).

Ayten (2011) found that foliar fertilization is an excellent method to give the best yield of maize whether to add major or minor nutrients. Kocon (2010) found that broad bean yield increased by 14-15% when sprayed with urea, compared to 2.4% with ground fertilization. Sharaf *et al*., (2009) found that foliar fertilization with boron and zinc led to increase the number of pods and plant seeds. Moreover, Sainz *et al.* (2010) reported that drought and heat stress stimulated the degradation of Photosystem II (PSII) in *Lotus japonicas*. They added that heat is also induced degradation of chloroplast Cu/Zn superoxide dismutase, therefore degradation of PSII could be caused by the loss of components of chloroplast antioxidant defense systems and subsequent decreased function of PSII (Guzmán *et al*., 2016). Meanwhile Mahdy (2009) reported that foliar application of salicylic acid (SA) enhanced all the studied growth parameters and yield of *Lycopersicon esculentum*, Mill. Young *et al*., (2009) reported that Zinc, Cu, Fe and Selenium were very important for rice to growth and to give an appreciated yield under heat stress conditions. Alscher *et al*., (2002) found that the commonality of elements in the upstream sequences of Fe, Mn and Cu/Zn the superoxide dismutases (SODs) suggests a relatively recent origin for those regulatory regions of the genome of anti-oxidation defense which plays as the first line of defense against oxidation as result of heat stress.

This study aimed to develop an ecofriendly integrated management system for soil and foliar fertilization with the beneficial microorganisms “EM” on faba bean to improve its productivity under the newly reclaimed areas condition. In addition to develop two new EM specific formulas for the production of pulses. The first formula would be used under the conditions of excess of iron in soil or irrigation water, while the second will be used for the normal conditions of iron content in soil and irrigation water.

## MATERIALS AND METHODS

Series of experiments were conducted in Six October farm East Oweinat - New Valley Governorate during the winter season of 2009/2010 (preliminary two filed experiments at the same season), and the successive winter seasons of 2010/2011 and 2011/2012, respectively (principal field experiment) to study the effect of the integration between new formulas of Effective Microorganisms “EM” as soil amendments and foliar fertilization on *Vicia faba* L. var. Giza 40 growth and productivity.

Broad bean "faba bean" (*Vicia faba* L. var. Giza 40) which obtained from Agricultural Research Center (A.R.C.) , Giza , Egypt was cultivated on $10^{th}$ November in the three winter seasons at the rate of 60 kg seeds/fed. using 2-3 seeds/hill, with 25 cm apart in between, and was thinned to one plant/hill after three weeks from sowing date, following of the common agricultural practices of the region.

At the three seasons, the experimental soil was tilled two overlapping times. During soil preparation, calcium super –phosphate (15.5% $P_2O_2$) was added into the soil at the rate of 100 kg/fed. Both the nitrogen fertilizer as ammonium nitrate (33.5 % N) at the rate of 60kg/fed and the potash fertilizer as potassium sulphate (48 % $K_2O$) were added during the growth stages through the fertigation process at the rate 50 Kg/fed following the routine work schedule of the farm. Following the method described by Chapman, 1978, the physical and chemical properties of the experimental soil were presented in tables (1and 2).The chemical properties of the irrigation water were presented in Table 3. Consequently, The metrological data of East Owinat during broad bean growing seasons in 2009/2010, 2010/2011 and 2011/2012 were presented in Table 4.

**Table1. The physical and chemical properties of the experimental soil**

| Sand | Silt | Clay | Text. | pH | EC (ppm) | O.M. |
|---|---|---|---|---|---|---|
| 45.91% | 23.76% | 22.15% | Sandy Clay Loam | 8.74 | 614 | 0.58% |

**Table 2. Continue of the chemical properties of the experimental soil**

| Cations (meq/L) | | | | Anions (meq/L) | | | | Micronutrients (ppm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $Na^+$ | $K^+$ | $Ca^+$ | $Mg^{+2}$ | $Cl^-$ | $SO_4$ | $HCO_3$ | $CO_3$ | B | Fe | Cu | Mn | Zn |
| 28.4 | 1.88 | 6.8 | 3.12 | 23.4 | 5.74 | 6.5 | - | 0.47 | 71.44 | 1.78 | 3.86 | 5.82 |

**Table 3. The chemical properties of the irrigation water**

| EC (ds/m) | pH | B (ppm) | Cations ($mg\ L^{-1}$) | | | | Anions ($mg\ L^{-1}$) | | | | Fe ($mg\ L^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $Ca^+$ | $Mg^{+2}$ | $K^+$ | $Na^+$ | $Cl^-$ | $SO_4^{-2}$ | $HCO_3^-$ | $CO_3^{-2}$ | |
| 1.14 | 7.7 | 0.068 | 19.68 | 1.45 | 31.37 | 11.82 | 29.94 | 283.64 | 73.22 | - | 0.3 |

**Table 4. The metrological data of East Owinat during broad bean growing seasons in 2009/2010, 2010/2011 and 2011/2012.**

| Month | Maximum Temperature (ºC ) | | | Minimum Temperature (ºC ) | | | Mean Temperature (ºC ) | | | Mean Humidity (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2009/10 | 2010/11 | 2011/12 | 2009/10 | 2010/11 | 2011/12 | 2009/10 | 2010/11 | 2011/12 | 2009/10 | 2010/11 | 2011/12 |
| Nov. | 28.6 | 32.2 | 32.8 | 10.6 | 11.2 | 10.9 | 19.1 | 21.2 | 21.9 | 43.7 | 44.2 | 43.2 |
| Dec | 25.2 | 30.1 | 29.5 | 13.9 | 14.3 | 14.7 | 19.1 | 21.7 | 22.1 | 50.4 | 51.3 | 49.8 |
| Jan | 25.5 | 28.8 | 29.9 | 7.8 | 8.9 | 9.2 | 16.2 | 18.4 | 19.6 | 43.3 | 43.2 | 43.4 |
| Feb | 25.6 | 26.7 | 27.2 | 10.2 | 11.5 | 11.7 | 17.4 | 18.6 | 19.5 | 41.9 | 42.9 | 41.7 |
| Mar | 30.1 | 33.5 | 34.3 | 13.8 | 15.1 | 15.5 | 21.4 | 23.8 | 24.9 | 32.7 | 33.4 | 32.9 |
| Apr | 35.5 | 37.4 | 38.6 | 18.6 | 19.6 | 19.8 | 26.5 | 28.2 | 29.2 | 25.6 | 26.1 | 26.4 |

**1. The two preliminary filed experiments during 2009/2010 winter season:**

The examined formulas were arranged in the Randomized Complete Block design (RCB) in four replicates. The plot area was 10 $m^2$ (3×3.5 m) including 5 ridges at 60 cm apart in hills 25 cm distance. The recorded data were collected two times during plant growth i.e. the first at 65 days after sowing date to determine plant height (cm), plant shoot and root fresh weights (g), plant shoot and root dry weights (g), $4^{th}$ leaf area ($cm^2$), total pigments (SPDA) following John *et al*., (1988). Consequently at harvest time, the biological and seed yields (ton/ha) in addition to harvest index were evaluated.

**A. The experiment for screening different new formulas of bio-organic soil amendments:**

The effect of new five organic soil amendments formulas with EM were examined on *V. faba* L. var. Giza 40 growth and productivity under field conditions. The examined new organic EM formulas as soil amendments were as follows; 24 $m^3$/ha. (Following the common practices in the region) of each of 1) Organic Manure (OM) {as the conventional treatment},2) EM-Bokashi ,3) EM-Bokashi + OM (1:1) , 4) EM-Bokashi +EM Ceramic (1kg/$m^3$) , 5) EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$).

**B. The experiment for screening the different bio-foliar fertilization treatments:**

Nine foliar fertilization treatments with EM including new four formulas (as will be described later) on *V. faba* L. var. Giza 40 growth and productivity were examined under field conditions. The examined EM foliar treatments were as follows; 8000 ppm (following what observed by Abd El-Ati 2014) of each of 1) (Water as control), 2) $EM_1$ at 45 days, 3) $EM_1$ at 45 and 60 days, 4) $EM_5$ at 45 days, 5) $EM_5$ at 45 and 60 days, 6) $EM_{5\text{-legume}}$ at 45 days, 7) $EM_{5\text{-legume}}$ at 45 and 60days, 8) $EM_{5\text{-legume plus}}$ at 45 days, and 9) $EM_{5\text{-legume plus}}$ at 45 and 60 days.

The common agriculture practices of the region were followed including adding 24 $m^3$/ha of animal dung as a source of organic manure.

**2. The principal field experiment during the successive winter seasons of 2010/2011 and 2011/2012 :**

The promising formulas that resulted from the preliminary experiments A and B were selected to study the effect of the interaction between new formulas of Effective Microorganisms "EM" bio-organic soil amendments and bio-foliar fertilization treatments on *Vicia faba* L. var. Giza 40 growth and productivity under field conditions during the successive winter seasons of 2010/2011 and 2011/2012 respectively as the principal experiment of the study.

The selected formulas were as follows: 1) from experiment A: (24 $m^3$/ha) from each of {EM-Bokashi}, {EM-Bokashi + OM (1:1)}, {EM-Bokashi +EM Ceramic (1kg/$m^3$)}, {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$)}. 2) From experiment B: 8000 ppm from each of {$EM_{5\text{-legume}}$ at 45 days}, {$EM_{5\text{-legume}}$ at 45 and 60 days}, {$EM_{5\text{-legume plus}}$ at 45 days}, {$EM_{5\text{-legume plus}}$ at 45 and 60 days}. The strip plot design was used in this study where the organic soil amendments occupied the horizontal plots and the foliar fertilization treatments arranged in the vertical plots with four replicates. The plot area was 10 $m^2$ (3×3.5 m) including 5 ridges at 60 cm in hills 25 cm distance. The recorded data were collected two times during plant growth i.e. the first at 65 days after sowing date $4^{th}$ leaf area ($cm^2$)using Li-3100 C leaf area meter and total pigments (SPDA) following John *et al.,* (1988), while at harvest {plant height (cm), No. of branches /plant, No. of pods /plant, seed yields (g/plant) , 100 seed weight (g), biological yield (ton/ha), seed yield (ton/ha), straw yield (ton/ha)} were evaluated.

The effective microorganisms ($EM_1$) as proposed by Higa (1991) contains selected species of microorganisms including predominant populations of lactic acid bacteria and yeasts, and smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms such as mycorrhizae. Inoculation of $EM_1$ cultures to the soil/plant ecosystem can improve soil quality, plant health, growth, yield, and quality of crops. Consequently, ($EM_5$) is a modification product from $EM_1$ that created by adding vinegar and ethyl alcohol during the fermentation process in order to have multifunction product such as foliar fertilizer and insect repellent, while EM-Ceramics is a coarse ceramic granules that has certain mish per inch (Higa, 2000), this EM-Ceramics was kindly obtained from EMRO- JAPAN, while under the national conditions ceramics granules can be obtained from domestic ceramic factories with low economic value where $EM_1$ can be used for socking the normal ceramic granules to be activated and form EM-Ceramics.

Later on, the new modification of $EM_{5\text{-legume}}$ and $EM_{5\text{-legumeplus}}$ were made by myself through different experiments for series of concentrations from each micronutrient which fermented in the classical $EM_5$; (Cu, Zn, B for $EM_{5\text{-legume}}$ while salicylic acid and Fe were added in addition to Cu, Zn and B for $EM_{5\text{-legumeplus}}$) to select the most proper concentration of each micronutrient as an active ingredient ,also to identify the proper concentration of the two modified formulas of $EM_5$ to be applied on broad bean plants under moderate ($EM_{5\text{-legume}}$) and severe ($EM_{5\text{-legume plus}}$) heat stress conditions. The selected concentration of the micronutrients as an active material in each formula were as follows: 3000 ppm of each Cu, Zn, and 0.1 ppm of B for ($EM_{5\text{-legume}}$), while 3000 ppm of each Cu, Zn, Fe , 0.1 ppm of B and 0.02 mmole of salicylic acid for ($EM_{5\text{-legume plus}}$), meanwhile foliar application with water was the control treatment. The examined foliar formulas were sprayed into broad bean plants in the concentrations (8000 ppm) either once at 45 or twice at 45 and 60 days from sowing date.

The bio-organic soil amendments, as recommended by Kyan *et al*. (1999), animal manure, soil and crop residues at the ratio of 2:1:2 (w/w/w) respectively were used to prepare EM-Bokashi. $EM_1$ solution already prepared was sprayed into the dry ingredients (animal manure, soil and crop residues) and mixed well until the moisture content reached within a range of 30-40%. Mixture was heaped on a dry floor to a height of 15-20 cm and covered with a gunny bags. The temperature was maintained at 40 ± 5ºC during fermentation and was checked regularly. EM-Bokashi was ready for use after twenty days of the preparation.

The obtained data from the two seasons were subjected and prepared to the statistical analysis according to procedure outlined by Snedecor & Cochran (1980) and Sehgal (2009), while Duncan's multiple range test was used to verify the significant differences between means of treatments as described by Duncan (1955).

Weeds control was carried out after two weeks from sowing date by hand pulling and by hoeing after three weeks. However the common agricultural practices of the region for growing faba bean were applied.

# RESULTS

**1. The two preliminary filed experiments during 2009/2010 winter season:**

**A. The experiment for screening different bio-organic soil amendments new formulas**

Results in Table 5 indicate the effect of applying bio-organic soil amendments on growth characters i.e. plant height (cm), plant root and shoot fresh and dry weights (g), $4^{th}$ leaf area ($cm^2$), total pigments (SPDA) in addition to yield and its attributes i.e. the biological, seed and straw yields (ton/ha) of faba bean(*Vicia faba* L. var Giza 40) grown under East Ouinat conditions at 2009/2010 growing season. All the studied criteria were promoted significantly after applying the bio-organic soil amendments new formulas compared to the organic manure as the conventional treatment. The superior treatment was {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$)} followed by, {EM-Bokashi +EM Ceramic (1kg/$m^3$), then {EM-Bokashi + OM (1:1)}, then {EM-Bokashi} then after {Organic Manure (OM) as the conventional treatment} respectively. All the studied criteria which presented in Table 5 were used as indicators to select the most promising bio-organic formula to be used in the principal field experiment. Despite all the studied criteria seemed to be important as it indicate significant statistical differences compared to the conventional treatment, yet, seed yield seemed to be the most important one from an economic standpoint. Therefore {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$)}, {EM-Bokashi +EM Ceramic (1kg/$m^3$)} ,{EM-Bokashi + OM (1:1)}, and {EM-Bokashi} were selected to be applied in the principal field experiment that they increased the seed yield per area unit four, three, three and one times of the conventional organic fertilization respectively.

**Table. 5. Effect of bio-organic soil amendment on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions at 2009/2010 growing season.**

| Soil amendments Treatments ( $24m^3$ / ha) | 1) Plant height (cm) | 1) Plant fresh weight (g) | | 1) Plant dry weight (g) | | 1) Leaf area ($cm^2$) | 1) Total Pigm-ents (SPDA) | 2) Bio-logical yield (ton/ ha) | 2) Seed Yield (ton/ha) | 2) Harvest Index |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Shoot | Root | Shoot | Root | | | | | |
| Organic Manure (OM) (conventional) | 30.8 E | 8.1C | 4.8 E | 1.29E | 0.9 C | 3.87E | 3.1 E | 1.13E | 0.67D | 66.2 E |
| EM-Bokashi | 31.9 D | 8.13C | 6.3D | 3.2 D | 1.22 C | 4.2D | 5.8 D | 3.31D | 1.25 C | 71.6D |
| EM-Bokashi + OM (1:1) | 47.6 C | 19.5B | 10.2C | 7.6C | 4.7 B | 7.3C | 6.1 C | 5.33C | 2.18B | 88.1 C |
| EM-Bokashi +EM Ceramic (1kg/$m^3$) | 58.6 B | 19.8B | 10.7B | 8.7 B | 4.9B | 7.8B | 6.4B | 7.18B | 2.38B | 92.4 B |
| EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$) | 66.5A | 20.1A | 12.9A | 9.4 A | 5.2 A | 8.1A | 6.8A | 8.54 A | 3.14A | 102.4A |

**1) 65 days after sowing date. 2) At harvest time.**

- **Means having similar letters in the same column are not statistically differed at P≥0.05.**

**B. The experiment for screening the different bio-foliar fertilization treatments:**

Results in Table, 6 indicate the effect of different bio-foliar fertilization treatments on growth characters i.e. plant height (cm), plant root and shoots fresh and dry weights (g), $4^{th}$ leaf area ($cm^2$), total pigments (SPDA) in addition to yield and its attributes i.e. the biological, seed and straw yields (ton/ha) of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions at 2009/2010 growing season. Generally, applying the four bio-fertilizers ($EM_1$, $EM_5$, $EM_{5\text{-legume}}$ and $EM_{5\text{-legume plus}}$) on faba bean plants either once at 45 days or twice at 45 and 60 days after sowing date increased significantly all the studied criteria compared to the foliar application with water as the control treatment .The highest significant observations were obtained from $EM_{5\text{-legume plus}}$ at 45 and 60days followed by $EM_{5\text{-legume plus}}$ at 45 days, then $EM_{5\text{-legume}}$ at 45 and 60 days, then $EM_{5\text{-legume}}$ at 45 days, $EM_5$ at 45 and 60 days, and then $EM_5$ at 45 days, then $EM_1$ at 45 and 60 days then $EM_1$ at 45 days and then the foliar application with water as the control treatment respectively.

All the studied criteria which presented in Table, 6 were used as indicators to select the most effective bio-foliar fertilizer to be used on faba bean plants in the principal field experiment. Among all the studied criteria which seemed to be important as it indicate significant statistical differences compared to the control treatment, seed yield seemed to be the most important one from an economic standpoint. Therefore, $EM_{5\text{-legume}}$ at 45 days , $EM_{5\text{-legume}}$ at 45 and 60 days , $EM_{5\text{-legume plus}}$ at 45 days, and $EM_{5\text{-legume plus}}$ at 45 and 60 days were selected to be applied in the principal field experiment that they increased the seed yield per area unit seven, eight, nine and twelve times of the foliar application with water as the control treatment, respectively.

**Table .6. Effect of different bio-foliar fertilization treatments on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions at 2009/2010 growing season.**

| Foliar Bio-fertilization treatments (8000 ppm) | 1) Plant height (cm) | 1) Plant fresh weight (g) | | 1) Plant dry weight (g) | | 1) Leaf area ($cm^2$) | 1) Total Pigm-ents (SPDA) | 2) Bio-logical yield (ton/ ha) | 2) Seed Yield (ton/ha) | 2) Harvest Index |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Shoot | Root | Shoot | Root | | | | | |
| Water (control) | 22.6 I | 6.81 I | 4.8 H | 0.9 G | 0.4 G | 2.87 G | 3.8 G | 0.91 I | 0.26 H | 38.3 H |
| $EM_1$ at 45 days | 33.8 H | 10.6 H | 6.3 G | 2.1 F | 2.3 F | 4.31F | 4.6 F | 2.11 H | 0.91 G | 65.4 G |
| $EM_1$ at 45 and 60 days | 36.2 G | 14.6 G | 7.1 F | 3.1 E | 3.1 E | 4.62EF | 4.6 F | 2.69 G | 1.13 F | 72.3 F |
| $EM_5$ at 45 days | 36.9 F | 15.8 F | 8.2 E | 3.4 E | 3.4 E | 4.82 E | 4.9 F | 3.55 F | 1.30 E | 77.1 E |
| $EM_5$ at 45 and 60 days | 37.4 E | 17.5 E | 8.4 E | 5.5 D | 3.8 DE | 4.96 E | 5.2 E | 3.72 E | 1.32 E | 77.5 E |
| * $EM_{5\text{-legume}}$ at 45 days | 39.7 D | 16.5 D | 9.2 D | 6.1 C | 3.9 D | 5.21 D | 5.4 D | 4.73 D | 1.82 D | 80.2 D |
| * $EM_{5\text{-legume}}$ at 45 and 60days | 40.4 C | 17.3 C | 9.7 C | 6.8 B | 4.1 C | 6.27 C | 6.9 C | 5.21 C | 2.14 C | 82.6 C |
| * $EM_{5\text{-legume plus}}$ at 45 days | 42.1 B | 17.9 B | 11.2B | 6.9 B | 4.6 B | 6.43 B | 7.8 B | 6.34 B | 2.93 B | 85.2 B |
| * $EM_{5\text{-legumeplus}}$ at 45 and 60days | 47.2 A | 18.6 A | 13.4 A | 7.2 A | 5.39 A | 6.57 A | 9.4 A | 7.63 A | 3.07 A | 96.3 A |

**1) 65 days after sowing date. 2) At harvest time. * New Modified formula**

- **Means having similar letters in the same column are not statistically differed at P≥0.05.**

**2. The principal field experiment during the successive winter seasons of 2010/2011 and 2011/2012 :**

**Effect of EM-bio-organic soil amendment on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions (combined analysis of 2010/2011 and 2011/2012 growing seasons):**

Results in Table, 7 indicate that all the studied criteria of faba bean i.e. total pigments (SPDA), 4th leaf area ($cm^2$) at 65 days after sowing date, plant height (cm), no. branches/plant, no. pods/plant, seed yield (g/plant), 100 seed weight (g), biological yield (ton/ ha), seed yield (ton/ha) and straw yield (ton/ha) at harvest time, were promoted significantly by applying the EM bio-organic soil amendments. The highest results were obtained from {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$)}, {EM-Bokashi +EM Ceramic (1kg/$m^3$)}, {EM-Bokashi + OM (1:1)} then {EM-Bokashi (control)} respectively.

**Table. 7. Effect of EM-bio-organic soil amendment on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions (combined analysis of 2010/2011 & 2011/2012 growing seasons)**

| EM- bio- organic soil amendments ( 24$m^3$ / ha) | 2) Plant height (cm) | 2) No. branches / plant | 2) No. Pods /plant | 2) Seed Yield (g/plant) | 2) 100 seed weight (g) | 2) Bio-logical yield (ton/ ha) | 2) Seed Yield (ton/ha) | 2) Straw Yield (ton/ha) | 1) Total Pigm-ents (SPDA) | 1) Leaf Area ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| EM-Bokashi(control) | 87.7 D | 3.6 D | 17.8D | 39.2D | 72.5D | 6.6D | 2.6D | 3.4D | 484.5D | 7.9D |
| EM-Bokashi + OM (1:1) | 92.3 C | 4 C | 18.2C | 40.7C | 74.2C | 7.2C | 2.8C | 3.9C | 505.4C | 8.4C |
| EM-Bokashi +EM Ceramic (1kg/$m^3$) | 101.3B | 4.4 B | 18.6B | 42.4B | 75.8B | 7.8B | 3.1B | 4.2B | 547.9B | 8.6B |
| EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$) | 106.1A | 4.6 A | 19.1A | 43.5A | 76.4A | 8.0A | 3.2A | 4.6A | 565.6A | 9.1A |

**1) 65 days after sowing date. 2) At harvest time.**

- **Means having similar letters in the same column are not statistically differed at P≥0.05.**

**Effect of foliar application with new modified EM-bio-fertilizers on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions (combined analysis of 2010/2011 & 2011/2012 growing seasons):**

Results in Table, 8 show that all the studied criteria of faba bean i.e. total pigments (SPDA), 4th leaf area ($cm^2$) at 65 days after sowing date, plant height (cm), no. branches/plant, no. pods/plant, seed yield (g/plant), 100 seed weight (g), biological yield (ton/ ha), seed yield (ton/ha) and straw yield (ton/ha) at harvest time, were promoted significantly by applying the new modified EM-bio-fertilizers. The highest observations were obtained from applying $EM_{5\text{-legume plus}}$ at 45 and 60 days followed by $EM_{5\text{-legume plus}}$ at 45 days then $EM_{5\text{-legume}}$ at 45 and 60 days then $EM_{5\text{-legume}}$ at 45 days, respectively.

**Effect of the interaction between EM-bio-organic soil amendment and foliar application with new modified EM-bio-fertilizers on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions (combined analysis of 2010/2011 and 2011/2012 growing seasons):**

Results in Table,9 show that all the studied criteria of faba bean i.e. total pigments (SPDA), 4th leaf area ($cm^2$) at 65 days after sowing date, plant height (cm), no. branches/plant, no. pods/plant, seed yield (g/plant), 100 seed weight (g), biological yield (ton/ ha), seed yield (ton/ha) and straw yield (ton/ha) at harvest time, were promoted significantly by the interaction between the EM-bio- organic soil amendments and the new modified EM-foliar bio-fertilizer treatments. The highest significant observations were obtained from the interaction between {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/

m$^3$)}×$EM_{5\text{-legume plus}}$ at 45 and 60 days followed by $EM_{5\text{-legume plus}}$ at 45 days then $EM_{5\text{-legume}}$ at 45 and 60 days then $EM_{5\text{-legume}}$ at 45 days, respectively. Followed by {EM-Bokashi +EM Ceramic (1kg/m$^3$)}, {EM-Bokashi + OM (1:1)} then {EM-Bokashi (control)} respectively ×$EM_{5\text{-legume plus}}$ at 45 and 60 days followed by $EM_{5\text{-legume plus}}$ at 45 days then $EM_{5\text{-legume}}$ at 45 and 60days then $EM_{5\text{-legume}}$ at 45 days, respectively. It could be concluded that from these results, the promising ecofriendly integrated management system for soil and foliar fertilization with the beneficial microorganisms "EM" on faba bean to improve its productivity under the newly reclaimed areas condition were {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ m$^3$)} ×$EM_{5\text{-legume}}$ at 45 and 60 days.

**Table. 8. Effect of foliar application with new modified EM-bio-fertilizers on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions (combined analysis of 2010/2011 & 2011/2012 growing seasons)**

| New Modified EM-Foliar Bio-fertilizer treatments (8000 ppm) | 2) Plant height (cm) | 2) No. branches / plant | 2) No. Pods / plant | 2) Seed Yield (g/plant) | 2) 100 seed weight(g) | 2) Bio-Logical yield (ton/ ha) | 2) Seed Yield (ton/ha) | 2) Straw Yield (ton/ha) | 1) Total Pigm-ents (SPDA) | 1) Leaf Area (cm$^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| $EM_{5\text{-legume}}$ at 45 days | 64.6D | 2.2 D | 16D | 32.2D | 68.3D | 4.8D | 1.7D | 3.1D | 365.2D | 6.2D |
| $EM_{5\text{-legume}}$ at 45 and 60days | 89.3C | 3.7 C | 17.9C | 39.9C | 73.4C | 6.6C | 2.6C | 3.5C | 499.1C | 7.7C |
| $EM_{5\text{-legume plus}}$ at 45 days | 106B | 4.7B | 19.1B | 43.8B | 76.3B | 8.1B | 3.2B | 4.0B | 567.6B | 9.3B |
| $EM_{5\text{-legumeplus}}$ at 45 and 60days | 127.7A | 6.0 A | 20.7A | 49.9A | 80.9A | 10.2A | 4.0A | 5.6A | 671.9A | 10.9A |

**1) 65 days after sowing date. 2) At harvest time.**

- **Means having similar letters in the same column are not statistically differed at P≥0.05.**

**Table. 9. Effect of the interaction between EM-bio-organic soil amendment and foliar application with new modified EM-bio-fertilizers on growth characters and productivity of *Vicia faba* L. var Giza 40 grown under East Ouinat conditions (combined analysis of 2010/2011 & 2011/2012 growing seasons)**

| EM- bio-organic soil amendments ( 24m$^3$ / ha) | New Modified EM-Foliar Bio-fertilizer treatments (8000 ppm) | 2) Plant height (cm) | 2) No. branches / plant | 2) No. Pods / plant | 2) Seed Yield (g/plant) | 2) 100 seed weight (g) | 2) Bio-logical yield (ton/ ha) | 2) Seed Yield (ton/ha) | 2) Straw Yield (ton/ha) | 1) Total Pigm-ents (SPDA) | 1) Leaf Area (cm$^2$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EM-Bokashi (Control) | $EM_{5\text{-legume}}$ at 45 days | 52.1 P | 1.6 P | 15.2 O | 29.3 P | 65.9 J | 4.1 O | 1.3 N | 2.8 I | 301.9 O | 5.7 M |
| | $EM_{5\text{-legume}}$ at 45 and 60days | 56.0 O | 2.0 O | 15.6 N | 31.1 O | 67.5 I | 4.5 N | 1.5 M | 3.0 HI | 319.8 N | 6.3 M |
| | $EM_{5\text{-legume plus}}$ at 45 days | 73.2 N | 2.5 N | 16.3 M | 33.6 N | 69.6 H | 5.3 M | 2.0 L | 3.0 HI | 413.1 M | 5.9MN |
| | $EM_{5\text{-legumeplus}}$ at 45 and 60days | 76.9 M | 2.7 N | 16.9 L | 34.6 M | 70.2 H | 5.4 M | 2.0L | 3.2 GH | 426.1 L | 6.8 L |
| EM-Bokashi + OM (1:1) | $EM_{5\text{-legume}}$ at 45 days | 82.4 L | 3.2 L | 17.4 K | 37.9 L | 71.3 G | 5.9 L | 2.3 K | 3.3 G | 468.8 K | 7.1 KL |
| | $EM_{5\text{-legume}}$ at 45 and 60days | 85.9 K | 3.5 K | 17.7 J | 39.1 K | 73.7 F | 6.4 K | 2.6 J | 3.4 FG | 491.8 J | 7.5 JK |
| | $EM_{5\text{-legume plus}}$ at 45 days | 92.4 J | 3.9 J | 17.9 J | 40.7 J | 74.3EF | 6.9 J | 2.7 I | 3.6 EF | 508.2 I | 7.9 IJ |
| | $EM_{5\text{-legumeplus}}$ at 45 and 60days | 96.5 I | 4.1 I | 18.5 I | 41.8 I | 74.4EF | 7.1 I | 2.8 H | 3.6 E | 527.5 H | 8.3 HI |
| EM-Bokashi +EM Ceramic (1kg/m$^3$) | $EM_{5\text{-legume}}$ at 45 days | 98.7 H | 4.3 H | 18.7 H | 42.5 H | 74.8DE | 7.4 H | 3.0 G | 3.8 E | 539.4 G | 8.7GH |
| | $EM_{5\text{-legume}}$ at 45 and 60days | 102.2G | 4.5 G | 18.9 G | 43.0 G | 75.6 D | 7.8 G | 3.0G | 4.1 D | 545.1 G | 9.1 FG |
| | $EM_{5\text{-legume plus}}$ at 45 days | 108.7F | 4.8 F | 19.2 F | 44.0 F | 77.1 C | 8.3 F | 3.3 F | 4.2 D | 579.4 F | 9.5EF |
| | $EM_{5\text{-legumeplus}}$ at 45 and 60days | 114.2E | 5.3 E | 19.5 E | 45.7 E | 77.6 C | 8.8 E | 3.5 E | 4.3 D | 606.6 E | 9.9 DE |
| EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ m$^3$) | $EM_{5\text{-legume}}$ at 45 days | 117.6D | 5.5 D | 19.7 D | 47.2 D | 77.9 C | 9.1 D | 3.6 D | 4.3 D | 628.8 D | 10.3CD |
| | $EM_{5\text{-legume}}$ at 45 and 60days | 125.2C | 6.0 C | 20.4 C | 49.5 C | 80.1 B | 10.0 C | 4.0 C | 5.4 C | 666.7 C | 10.7C |
| | $EM_{5\text{-legume plus}}$ at 45 days | 130.9B | 6.3 B | 21.1 B | 51.1 B | 82.5 A | 10.7 B | 4.2 B | 5.8 B | 691.0 B | 11.0AB |
| | $EM_{5\text{-legumeplus}}$ at 45 and 60days | 137.0A | 6.4 A | 21.5 A | 51.8 A | 83.2 A | 10.9 A | 4.3 A | 6.7 A | 702.0 A | 11.4 A |

**1)65 days after sowing date. 2) At harvest time.**

- **Means having similar letters in the same column are not statistically differed at P≥0.05.**

## DISCUSSION

Agenda 21 which is a product of the Earth Summit (UN Conference on Environment and Development) that held in Rio de Janeiro, Brazil, in 1992, is a universal action plan for sustainable development. This agenda imbedded three main conventions i.e. Climate Change, Biodiversity and Desertification (Anonymous, 1992). Despite these three conventions seemed to be separate yet, it has a wide thematic area in between. Global Warming inducing heat stress is one of these climatic factors that link between climate change (drought), biodiversity loss and hence desertification including pollution that derived from the intensive use of agrochemicals particularly in harsh environments such as newly reclaimed areas. The essential need for alternative practices that ensure the environmental safety and sustainability has become a must nowadays particularly in new reclaimed areas where the environment is still virgin (Higa, 1991). Organic farming is one of the environmental technologies that embedded several practices including organic and biological fertilization in order to provide the fertility and the resistance for several abiotic stresses such as heat stress and drought with environmental conservation. Thus, EM technology including EM-Bokashi is a perfect example for this concept (Higaand Parr,1994).Incorporation of organic amendments into the soil is one of those technologies that leads to land degradation neutrality (one of its indicators is increase of land productivity) in harsh environments as in newly reclaimed areas; where both heat stress and drought are dominant and chemical fertilization seemed to be a risky gamble (Abd El-Ati and El-Hadidy Abeer, 2013). Yet, under heat stress conditions, the decay rate of complete fermented organic amendments is very fast accompanied with high and fast loss of its nitrogen content into the atmosphere. Therefore, under heat and drought stress conditions EM-Bokashi which is an incomplete fermented organic material could be an effective organic fertilizer in nature farming crop production under stressful conditions (Kyan *et al*., 1999); because it provides several benefits to the growers as an environmental friendly method of cultivation. Moreover, as bio-organic manures that contain many plant nutrients (nitrogen, phosphorus, potassium and many other essential nutrients) , besides it increases infiltration of water and enhances retention of nutrients, reduces wind and water erosion and promotes growth of beneficial organisms that help plants to resist environmental stresses (Ross, 2008). Consequently, EM-Ceramics can provide safe habitat for the soil beneficial micro flora within its available mesh that existed in its structure. In addition, to increase the soil water holding capacity through absorb the water that available in the soil with the dissolved micronutrient and slow release to the plant to promote plant stress tolerance and enhance plant-soil water relationships (Ryals and Ward, 1994; Higa, 2000 and Prodinger *et al*., 2016). This could clarify the superior results that have been achieved by the application of {EM-Bokashi + Organic Manure (1:1) + EM-Ceramic (1 kg/ $m^3$)}.

Heat stress and the subsequent water stress which is prevalent under newly reclaimed areas conditions affects the plant metabolism in many aspects; it affects the active and negative transport of water from soil to plant and within the plant parts, the stomata closer and conductance, corrupt the photosynthesis rate, and boost the respiration rate to enforce the plant to end juvenility and reach maturity thus end its life cycle (Edwards *et al*., 1998 and Orcutt and Nilsen, 2000). As report (Sainz *et al.* 2010), drought and heat stress stimulated the degradation of Photosystem II (PSII) in *Lotus japonicas* L. They added that heat is also induced degradation of chloroplast Cu/Zn superoxide dismutase, therefore degradation of PSII could be caused by the loss of components of chloroplast antioxidant defense systems and subsequent decreased function of PSII. Similarly, Maksymiec (1997) reported that Cu is an indispensable component of oxidative enzymes or of particular structural component of cells. At elevated concentrations, Cu can act strongly on chromatin, the photosynthetic apparatus, growth and senescence processes, while regarding Boron, Metwally *et al.* (2014) reported that B is an essential element for soil micro-biomes and enzyme activities but in a very low concentration, beside it plays as an osmo-regulator in plant cells under stressful conditions. Regarding Fe; Brear *et al*., (2013) reported that it is an essential micro-element for rhizobium to success the sympatric nodulations in legumes particularly under stressful conditions. Also Fariduddin *et al*.,(2003) described the role of salicylic acid in inducing the tolerance for multiple biotic and abiotic stress and influencing net the photosynthetic rate, carboxylation efficiency, nitrate reductase activity and seed yield in stressed plants like *Brassica juncea* L. These can easily ensure that farmers cannot depend only on soil amendments programs but foliar application with a very specific formulas is a must in order to get an appreciate growth and yield, and this can simply justifies the superior results that obtained from foliar application with $EM_{5\text{-legume plus}}$ at 45 and 60 days. Similarly the interaction {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ $m^3$)} ×$EM_{5\text{-legume plus}}$ at 45 and 60 days. It also understood that foliar application of both $EM_1$ and $EM_5$ would act like a bio-fertilizing agent that can carry the micronutrients into the plant parts through the plant pits and the semi-closed stomata during the stress occurrence. Out of the for its linear stereoscopic shape of the ethyl alcohol that existed in its composition yet $EM_5$ is more capable for its higher content of Ethyl Alcohol that is originally one of its components and that dominate the linear stereoscopic shape of the bio product (Higa, 2000).

## CONCLUSION

Under newly reclaimed lands conditions climate change consequences are dominant. Consequently, several biotic and abiotic stress are existed yet; heat stress and drought are the most serious ones. Therefore, farmers cannot depend on chemical fertilization, which will be a very risky gambling. EM as a Bio-organic technology can provide an ecofriendly solution to this dilemma through integrated fertilization programs that depend on the environmental conditions. Under severe heat and water stress conditions where there is no Fe high concentration in soil or irrigation water, the combination of {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ m3)} × $EM_{5\text{-legume plus}}$ at 45 and 60days will be the perfect fertilization programme under these conditions. Yet, where there are excess concentration of Fe in soil or irrigation like what existed in some oasis in Egypt, {EM-Bokashi + OM (1:1) + EM-Ceramic (1 kg/ m3)} × $EM_{5\text{-legume}}$ at 45 and 60days will be the ideal fertilization programme.

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## "الزراعة المتكاملة للفول البلدي بإستخدام مستحضر جديد معدل من الكائنات الحية الدقيقة النافعة تحت ظروف الأراضي حديثة الإستصلاح "

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أجريت سلسلة من التجارب في مزرعة السادس من أكتوبر بشرق العوينات - محافظة الوادي الجديد خلال موسم الشتاء 2010/2009 (تجارب استطلاعية)، ثم المواسم الشتوية 2011/2010 و2012/2011 على التوالي (التجربة الرئيسية) لدراسة تأثير التكامل بين التسميد الأرضي والورقي بصيغ جديدة من مستحضر الكائنات الحية الدقيقة الفعالة "EM" على نمو وإنتاجية الفول البلدي صنف جيزة 40. تم أستخدام تصميم القطاعات كاملة العشوائية في أربعة مكررات خلال التجارب الأولية ، حيث تم في التجربة الأولي: استطلاع تأثير خمسة إضافات عضوية للتربة كمعاملات تسميد عضوي هي كالتالي :طبقا للممارسات الزراعية المتبعة في المنطقة إضافة 24( م$^3$ / للهكتار) من كل من 1) السماد العضوي (معاملة مقارنه) ، 2) بوكاشي الكائنات الحية الدقيقة- 3) بوكاشي الكائنات الحية الدقيقة + السماد العضوي - 4) بوكاشي الكائنات الحية الدقيقة + سيراميك الكائنات الحية الدقيقة (اكجم/ م3) –5) بوكاشي الكائنات الحية الدقيقة + السماد العضوي (1:1) +سيراميك الكائنات الحية الدقيقة (اكجم/ م$^3$). تم في التجربة الثانية: استطلاع تأثير تسعة تركيبات جديدة من الكائنات الحية الدقيقة كسماد ورقي بتركيز 8000 جزء في المليون كانت كالتالي : 1) الماء (مقارنه) –2) الرش بالـ $EM_1$ عند عمر 45 يوم - 3) الرش بالـ $EM_1$ عند عمر 45، 60 يوم - 4) الرش بالـ $EM_5$عند عمر 45 يوم 5) الرش بالـ $EM_5$عند عمر 45 و 60 يوم - 6) الرش بالـ $EM_{5-legume}$عند عمر 45 يوم - 7) الرش بـ $EM_{5-legume}$ عند عمر 45 و 60 يوم - 8) الرشبالـ $EM_{5-legume\ plus}$ عند عمر 45 يوم- 9)الرش بـ $EM_{5-legume}$ عند عمر 45 و 60 يوم. وقد تم تسجيل البيانات التالية مرتين أثناء نمو النباتات الأولي بعد 65 يوما من تاريخ الزراعة: ارتفاع النبات (سم)، الوزن الغض و الوزن الجاف لكل من الساق والجذر (جم)، مساحة الورقة (سم$^2$) ، الصبغات الكلية ، بينما سجلت البيانات التالية وقت الحصاد: المحصول البيولوجي ومحصول البذور (طن / هكتار) ودليل الحصاد (٪).تم اختيار أفضل أربعة معاملات من التجربة الأولي و أفضل أربعة معاملات من التجربة الثانية لتوضع تحت الدراسة في التجربة الرئيسية لموسمين متتاليين، حيث تم استخدام تصميم الشرائح المتعامدة في أربعة مكررات ،وقد تم تسجيل البيانات التالية مرتين خلال نمو النبات كالاتي: بعد 65 يوما من تاريخ الزراعة، مساحة الورقة الرابعة (سم$^2$) والصبغات الكلية ، بينما سجلت البيانات التالية وقت الحصاد: ارتفاع النبات (سم)، عدد الفروع / نبات، عدد القرون /نبات، محصول البذور (جم / نبات)، وزن 100 بذرة (جم)، المحصول البيولوجي (طن / هكتار)، محصول البذور (طن / هكتار)، محصول القش (طن /هكتار). عموما توصي الدراسة بأنه تحت ظروف الاجهاد الحراري والمائي الشديدة مع عدم وجود مشكلة زيادة تركيز عنصر الحديد سواء في التربة أو مياه الري فإن برنامج التسميد الأمثل تحت هذه الظروف هو التكامل بين التسميد الأرضي بالـ{ EM بوكاشي+ السماد العضوي (بنسبة 1:1) + EM سيراميك بمعدل (ا كجم/ م3) }والتسميد الورقي بالصيغة الجديدة ($EM_{5-legume\ plus}$) مرتين عند 45 و 60 يوم بعد تاريخ الزراعة ، في حين كان البرنامج الأمثل للتسميد تحت ظروف زيادة تركيز الحديد في مياه الري أو التربة كما هو الحال في بعض واحات مصر هو التكامل بين التسميد الأرضي بالـ{ EM بوكاشي + السماد العضوي (بنسبة 1:1) + EM سيراميك بمعدل (ا كجم/ م3)}و التسميد الورقي بالصيغة الجديدة ($EM_{5-legume}$) مرتين عند 45 و 60 يوم بعد تاريخ الزراعة.