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# Integrated Effect of Mineral, Organic and Bio Fertilization on the Productivity of Plastic House Tomato –A Transition Step towards Organic Farming

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**ABSTRACT:**

A field experiment was carried out in plastic house situated at the College of Agriculture - University of Baghdad in 2009-2010 season in a Silt Clay Loam to study the effect of mineral, organic and bio-fertilizers on the yield and fruit quality (total acidity, vitamin C and total soluble solids)of tomato plants. Treatments included four levels 0%, 25%, 50% and 100% from the recommended mineral fertilizer (600 kg N $ha^{-1}$ and 250 kg P $ha^{-1}$) , two levels of organic fertilizer (0, 10 $Mg.ha^{-1}$ of Organic fertilizer ) and two levels of bio fertilizer( 0, 950 kg ha $^{-1}$) added as side dressed before planting . Results of tomato fruit total yield indicated that, treatment of 50% mineral fertilizers + organic fertilizers + bio fertilizer gave the best values in yield of tomato and quality characteristics with no significant differences than 100% mineral fertilizers + organic fertilizers + bio fertilizer. Application of bio+organic alone can give similar yield to that of 100% NP alone. The treatment of 50% mineral fertilizers + organic fertilizers + bio fertilizer gave the best values in yield of tomato and quality characteristics with no significant differences than 100% mineral fertilizers + organic fertilizers + bio fertilizer. This confirms the importance of organic and bio-fertilizer to compensate for half of the mineral fertilizers requirements and certainly with positive consequences on economical and environmental aspects.

**Key Words: Integrated management, Al-mufer -Bio *(Azotobacter spp + Bacillus polymyxa)*, Organofert, and tomato fruit nitrate concentration.**

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## INTRODUCTION:

The challenge facing the specialists in agricultures and farmers is the proper identification of all yield limiting factors and use the best management practices to increase the crop productivity. To increase crop productivity fertilizers in different forms should be applied especially for high producing crop varieties. However, unwise mineral fertilizer applications can lead to adverse effect on environment, and this lead to the necessity to reduce this application through balanced nutrient application and adaptation of bio and organic fertilizers applications for higher yield and safe environment. So, Fertilizer application, crop productivity and environmental concern can be considered as one of the issues challenging farmers and crop producers nowadays. Using the proper management practices which can be called "4 R's": right time, right rate, right source, right placement—to maximize the economic benefits of fertilizer while minimizing the environmental impacts can be the solution as Scharf,(2015) indicated . As the right source , the integrated of mineral-organic –bio fertilization can be consider as a management practice for balanced and sustainable nutrient supplying power and higher sustainable crop productivity as mentioned by Chen,( 2006), and was the goal behind this work for high tomato fruit yield with good quality and as a transition step for organic farming .

**Materials & Methods:**

A field experiment was carried out in plastic house at the College of Agriculture- University of Baghdad in 2009-2010 season in a Silt Clay Loam soil (pH 7.42, ECe 3.30, Carbonate minerals 238.31 g $kg^{-1}$ soil, SOM 30.43 g $kg^{-1}$ soil), to study the effect of mineral, organic and bio- fertilizers on the yield and quality of tomato (*Lycopersicon esculentum* Mill) plants. The experiment was a factorial experiment in a randomized complete block design (RCBD) with three replications. Treatments included four levels of the recommended mineral fertilizer ((0%, 25%, 50% and 100%) , with100% level as 600 kg N $ha^{-1}$ and 250 kg P $ha^{-1}$ applied in the form of DAP(18-46-0) added at six split application)), two levels of organic fertilizer (0, 10 $Mg.ha^{-1}$ of organic fertilizer named "Organofert" which have OM 60%,Total N 2.5%,Total P 0.3%,Total K 0.13% & C/N 15:1) and two levels of bio fertilizer (0, 950 kg ha $^{-1}$ of bio-fertilizer called "Al-mufer –Bio" ( *Azotobacter spp* + *Bacillus polymyxa* ) added as side dress before planting). Potassium was applied to all treatments at 200 kg K $ha^{-1}$. Nutrient use efficiency (NUE) or recovery efficiency was calculated from the following equation (Ali, 2012):

NUE =increment on Nutrient taken up by plants /amount of nutrient applied.

Agronomic Efficiency (AE) or Fertilizer productivity was calculated as (Ali, 2012):

AE=yield increment due fertilizer application /amount of nutrient fertilizer applied.

**Results & Discussion:**

Results of tomato fruit total yield (Table 1) indicated that mineral fertilizers applied at 100% gave the best fruit yield with an increment of 36.8% compared to that of control(0 %). Application of bio-fertilizers increased the total fruit yield by 23.6% compared to that of control (without bio-fertilizers). Organic fertilizers application gave an increment of 16.7% compared to that without organic fertilizers. The integration of mineral, organic and bio fertilizer led to a significant increment in most studied parameter. The treatment of 50% mineral fertilizers + organic fertilizers + bio fertilizer gave the best values in yield of tomato and quality characteristics with no significant differences than 100% mineral fertilizers + organic fertilizers + bio fertilizer. This confirms the importance of organic and bio-fertilizer to compensate for half of the mineral fertilizers requirements and certainly with positive consequences on economical and environmental aspects. The recovery efficiency of nitrogen and phosphorus with this treatment were, 72.2%, 35.0% respectively, which signify the importance of adopting best management practice for high recovery. The fertilizer productivity (Agronomic Efficiency) was 74.1 kg fruit per kg mineral fertilizer. This confirms the importance of mineral fertilizers application on crop productivity. The application of the right rate and balanced mineral fertilizer application improved the fertility value of the soil and this was reflected on fruit yield of tomato. Organic fertilizer had its effect through its influence on different soil properties mainly plant nutrients (Sumner, 2000). Bio fertilizer application had its effects through its role as plant growth promoting rhizo-bacteria (PGPR)(El-Zeiny *et al* .,2001 ;Giri *et al* .,2005 and Mathur *et al* .,2010) especially for tomato plants .

**Table 1 Impact of Mineral, Bio, and Organic fertilizers on total yield of tomato fruits (Mg $House^{-1}$)***

| Mineral Fertilizer (M) | Organic Fertilizer (O) | Bio fertilizer (B) | | M×O |
|---|---|---|---|---|
| | | -B | +B | |
| | -O | 2.80 | 3.46 | 3.13 |

| | | | | |
|---|---|---|---|---|
| 0%NP | +O | 3.25 | 4.03 | 3.64 |
| 25%NP | -O | 3.21 | 3.75 | 3.48 |
| | +O | 3.67 | 4.50 | 4.09 |
| 50%NP | -O | 3.71 | 4.27 | 3.99 |
| | +O | 4.10 | 4.80 | 4.45 |
| 100%NP | -O | 3.83 | 4.53 | 4.18 |
| | +O | 4.46 | 4.89 | 4.67 |
| LSD(0.05) | | 0.34 | | 0.23 |
| | | | | M |
| M×B | 0%NP | 3.02 | 3.74 | 3.38 |
| | 25%NP | 3.44 | 4.13 | 3.78 |
| | 50%NP | 3.90 | 4.54 | 4.22 |
| | 100%NP | 4.14 | 4.71 | 4.43 |
| LSD(0.05) | | 0.23 | | 0.16 |
| | | | | O |
| O×B | -O | 3.39 | 4.01 | 3.70 |
| | +O | 3.87 | 4.57 | 4.22 |
| LSD(0.05) | | 0.16 | | 0.11 |
| | | | | |
| B | | 3.63 | 4.29 | - |
| LSD(0.05) | | 0.11 | | |
| *Area of the plastic house =180 $m^2$<br>House Yield ×55.56= Mg $ha^{-1}$ | | | | |

Nitrate concentration in the tomato fruits (Table 2) decreased with organic and bio fertilizer by 38.5% compared to that of mineral fertilizer. The concentration of nitrate still at the safe level so for, but need to be monitored frequently. These results confirmed results of Koznitsov,(2003) who indicated that bio and /or organic fertilization decreased tomato fruit nitrate concentration by 20-40% .

**Table 2 Impact of Mineral, Bio, and Organic fertilizers on nitrate concentration in tomato fruits (mg $g^{-1}$DM)**

| Mineral Fertilizer (M) | Organic Fertilizer (O) | Bio fertilizer (B) | | M×O |
|---|---|---|---|---|
| | | -B | +B | |
| 0%NP | -O | 0.093 | 0.110 | 0.101 |
| | +O | 0.114 | 0.128 | 0.121 |
| 25%NP | -O | 0.178 | 0.152 | 0.165 |

| | | | | |
|---|---|---|---|---|
| | +O | 0.155 | 0.172 | 0.164 |
| 50%NP | -O | 0.196 | 0.161 | 0.178 |
| | +O | 0.171 | 0.194 | 0.176 |
| 100%NP | -O | 0.208 | 0.177 | 0.192 |
| | +O | 0.189 | 0.200 | 0.194 |
| $LSD_{(0.05)}$ | | 0.09 | | 0.06 |
| | | | | M |
| M×B | 0%NP | 0.104 | 0.119 | 0.112 |
| | 25%NP | 0.166 | 0.162 | 0.164 |
| | 50%NP | 0.183 | 0.178 | 0.180 |
| | 100%NP | 0.198 | 0.189 | 0.193 |
| $LSD_{(0.05)}$ | | 0.06 | | 0.04 |
| | | | | O |
| O×B الحيوي | -O | 0.169 | 0.150 | 0.159 |
| | +O | 0.157 | 0.173 | 0.163 |
| $LSD_{(0.05)}$ | | 0.04 | | 0.03 |
| | | | | |
| O | | 0.163 | 0.160 | – |
| $LSD_{(0.05)}$ | | 0.03 | | |

Results of soluble solids TSS% in tomato fruits indicated that mineral fertilization significantly increased TSS% with an increment of 24.5% at 100% mineral alone compared to that of non-fertilized, although the differences between levels were not significant (Table 3). Adding organic and bio-fertilizer increased total solids by 7.1% and 8.0%, respectively compared to control treatment. These results at the same direction to the results of Abde- Maugoued *et al*., (2007) Mathur *et al*., (2010) and Al-Lammy, (2015) which indicated the increase of soluble solids TSS in response to organic fertilizer application and Al-Klef (2009) to bio-fertilization. Total soluble solids is one of the parameters that reflect fruits nutritional value and shelve life of fruits (Al-Sahaf, 1989, Al-Khafaji, 2010, Al-Lammy, 2015 ). The optimum and balanced fertilization can produce high fruit yield with good quality (Mengel and Kirkby, 1982)

Results of total acidity of fruits% (Table 3) indicated that, the effect of adding mineral fertilization (as main effect) at 100% level led to increased acidity ratio by 36.8% as compared to the non-fertilized treatment (0%). Organic fertilizer application had an increment of 11.4% compared to that of without organic fertilizer. The same trend and response occurred with bio-fertilizer application. Bio fertilizer increased fruit acidity by 16.3% compared to without bio-fertilization. These results can be attributed to the optimum and balanced nutrient availability and better enzymes activity, which was reflected on this parameter (Al-Sammari, and Rahi, 2006 and Mathur *et al*., 2010).

The fruit content of vitamin C (Table 3) was significantly affected by fertilization treatments. The increment due to mineral fertilizer application at 100% was 14.7% compared to that of 0%, although there were no significant differences between the level of 100% and 50% of the mineral fertilizer . Bio-

fertilizer and organic fertilizer application had similar trend. The improvement in vitamin C content can be attributed to the improvement of soil nutrient availability and the improvement in shoot growth and photosynthesis rate and then fruit content of vitamin C. Results of mineral fertilization are consistent with the results of Varis and George (1985) and AL-Batawi (2007), and Al-Lammy,(2015) who indicated an increment on vitamin C with mineral fertilization .

**Table 3 Impact of Mineral, Bio, and Organic fertilizers on fruit quality (total acidity, vitamin C and total soluble solids).tomato fruits**

| TRETMENT | TSS (%) | Vitamin C (mg $ml^{-1}$juice) | total acidity(%) |
|---|---|---|---|
| 0%min + 0% org +0%bio | 3.54 | 12.54 | 0.34 |
| 0%min + 100% org +0%bio | 4.03 | 12.91 | 0.40 |
| 0%min + 0% org +100%bio | 3.75 | 13.24 | 0.39 |
| 0%min + 100% org +100%bio | 4.53 | 13.48 | 0.41 |
| 25%min +0% org +0%bio | 4.31 | 13.33 | 0.38 |
| 25%min + 100% org +0%bio | 4.53 | 13.20 | 0.45 |
| 25%min + 0% org +100%bio | 4.66 | 13.53 | 0.47 |
| 25%min + 100% org +100%bio | 4.74 | 13.85 | 0.52 |
| 50%min + 0% org +0%bio | 4.34 | 13.43 | 0.42 |
| 50%min + 100% org +0%bio | 4.69 | 13.94 | 0.50 |
| 50%min + 0% org +100%bio | 4.83 | 14.87 | 0.53 |
| 50%min + 100% org +100%bio | 5.03 | 14.95 | 0.57 |
| 100%min + 0% org +0%bio | 4.56 | 14.29 | 0.44 |
| 100%min + 100% org +0%bio | 4.94 | 14.87 | 0.53 |
| 100%min + 0% org +100%bio | 5.11 | 15.45 | 0.54 |
| 100%min + 100% org +100%bio | 5.13 | 15.23 | 0.59 |
| $LSD_{(0.05)}$ | | | |
| M | 0.37 | 0.91 | 0.05 |
| O | 0.26 | N.S | 0.03 |
| B | 0.26 | 0.65 | 0.03 |
| M+O | N.S | N.S | N.S |
| M+B | N.S | N.S | N.S |
| O+B | N.S | N.S | N.S |
| M+O+B | N.S | N.S | N.S |

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