MINERALIZING ORGANIC ADDITIVES COMBINATION AS A MODERN TECHNIQUE FOR MAXIMIZING CROP PRODUCTIVITY IN ORGANIC FARMING SYSTEMS

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ABSTRACT

Recently ecological intensification is introduced as a modern approach for enhancing the productivity of organic farming systems to maximize their economic returns. For this purpose, a pot experiment was conducted during the autumn season of 2018 at the Experimental and Agricultural Research Center, Mansoura University in order to evaluate the efficiency and applicability potential of engineered organic blocks derived from mineral and organic additive combination for improving cucumber productivity under sandy soil conditions. In a split-split plot design with three replicates, 36 treatments were arranged to represent three combinations of compost application (i.e. 100% compost, 75% compost + 25% rice straw and 50% compost + 50% rice straw), organic additives (control, seaweed (SW), chicken manure (CM), and seaweed + chicken manure combination) and three mineral additives (control, natural mineral ores (rock phosphate and feldspar) and a partial dose of NPK fertilizers). The obtained results cleared that 100% compost, (SW) + (CM) combination and the partial mineral NPK application were the superior treatments for increasing marketable yield productivity (Mg Fed’), quality of fruits shape (weight, length and diameter) as well as nitrogen (N), phosphorus (P) and potassium (K) concentrations in fruits. The mutual interaction among mineral and organic constitutions of the engineered blocks introduced mineral ores application as an efficient treatment with a high capability to improve the uptake of plant nutrients (N and P in particular). It is recommended, therefore, using the combination of organic additives (e.g. CM, SW) as well as mineral additives (e.g. rock phosphate, feldspar or partial dose of NPK) to achieve the ecological intensification in organic farming systems.

INTRODUCTION

Egypt is facing a turbulent increase in its growth population, as it has become nearly 100 million habitats or more. This imbalance between fast growth population and limited agricultural resources has resulted in a shortage in food, feed and fiber supplies. Consequently, it is necessarily to expand in the projects of sandy soils reclamation to fill the gap of food supplies to achieve the food security for new generations.

There is a debate between researchers regarding the most efficient approach for managing the low nutrient supply potentials of sandy soils. A group of scientists favor the absolute organic farming system (AOFs) as traditional technique for improving the fertility and water holding capacity of sandy soils. On contrary, others scientists favor the conventional farming system CFS (chemical fertilization) as the most efficient approach for sandy soil reclamation given the low productivity of organic farming. Thus, there is a critical need to capitalize modern approaches for modern soil reclamation to maximize the economic returns in an ecological manner. This modern approach should combine both properties of AOFs sustainability and the high productivity of CFS.

According to Selim and Mosa, (2012), the traditional method of organic fertilizers applications depends on incorporating organic fertilizers (e.g. compost) into the plow layer of soil. However, this traditional technique needs huge amounts of compost to achieve a pronounced influences; this is beside the high cost of labor.

Cucumber (Cucumis sativus L.) is an ancient vegetable and belongs to the Cucurbitaceae family (Eifeyidi and Remison, 2010). Cucumber fruits are rich source of both vitamins and minerals. It is ranked as the third economic vegetable crop in Egypt after tomato and cabbage; however, it ranks the second in Europe after tomato (El-Sayed et al., 2014). However, cucumber production requires moderate to high nutrient rates to achieve high cumulative yields (Eifeyidi and Remison, 2010). There is an urgent need, therefore, to apply the sufficient nutrients requirements necessarily to sustain its growth and yield.

Compost is one of the most common sources of manures application. The addition of compost has a positive influences on all soil properties such as soil structure, water holding capacity, porosity, compaction strength, availability of elements in soil, O.M. content of the soil, hence enhances plant growth parameters, yield and crop quality (Fahmy, 2012). Additionally, chicken manure is rather an important source in organic farming systems. According to Mohammed et al., (2010), chicken manure is a useful organic fertilizer as it contains about 3.5% N, 1.5-3.5% P, 1.5-3.0% k and many microelements. On the other hand, seaweeds (marine algae) not only contain N, P and K but also contain substantial molecules with ability to improve soil aggregation and phytohormones with various metabolic activities like organic and amino acids (Ahmed and Shalaby, 2012).

Feldspar is a three dimensional mineral structure with a network of SiO2 tetrahedral in the two groups. Potassium occurs as a major component within the feldspars and felspathoid mineral groups, thereby it is considered as an important source of potassium fertilization (Manning, 2010). Also, rock phosphate is one of the most important sources of phosphorus. Through composting technology, the unavailable P is expected to convert into available forms for plants due to the acidic environment prevailing during composting technology, thereby enhanced the nutrient content of compost (Meena and Biswas, 2015).

The main aim of this study, therefore, is to explore the applicability of organic and mineral additives incorporation alongside with compost in order to maximize the crop productivity of cucumber grown under sandy soil conditions.

MATERIALS AND METHODS

Design of the experiment, and its layout.

A pot experiment was carried out during the autumn season of 2018 at Experimental and Agricultural Research Center, Mansoura University, Dakahlia Governorate, Egypt aiming to evaluate the applicability of engineered organic blocks as a substitution of the ordinary compost in organic farming systems. Cucumber (Cucumis
satìvs, L. cv. 196) was selected to serve as a tested plant based on its economic revenue. In a split-split plot design with three replicates, treatments were arranged to represent three compost combinations, organic additives and mineral additives. Main plots were assigned to the compost combination (i.e. 100% compost, 75% compost + 25% rice straw (RS) and 50% compost + 50% rice straw). In subplots, each combination was involved (control, seaweed, chicken manure and seaweed, chicken manure combination). In sub-subplots, mineral additives were involved (control, natural mineral ores and partial dose of NPK fertilizers). Table (1) clarified layout of the experiment.

Table 1. Experimental Layout for Treatments.

<table>
<thead>
<tr>
<th>Compost combination</th>
<th>Organic additives</th>
<th>Mineral additives</th>
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</thead>
<tbody>
<tr>
<td>100% compost</td>
<td>control</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>CM</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>SW+CM</td>
<td>RP+FS</td>
</tr>
<tr>
<td>75% compost + 25% RS</td>
<td>control</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>CM</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>SW+CM</td>
<td>RP+FS</td>
</tr>
<tr>
<td>50% compost + 50% RS</td>
<td>control</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>CM</td>
<td>RP+FS</td>
</tr>
<tr>
<td></td>
<td>SW+CM</td>
<td>RP+FS</td>
</tr>
</tbody>
</table>

(RS) rice straw. (RP) rock phosphate. (FS) Feldspar

Materials

Mature compost (50% rice straw, 25% farmyard manure and 25% musty compost) was purchased from a private company (El-Wedian) located at Giza Governorate. Rice straw obtained from Mansoura District, Dakahlia Governorate, was cut into small pieces (0.5-2.5 cm length), air dried, and preserved for the experiment. Seaweed (SW) as organic additives was a kindly endowed from National Institute of Oceanography and Fisheries in Hurghada (NIOF), Egypt (Table 2). Chicken manure (CM) was obtained from Experimental and Agricultural Research Center, Mansoura University, Dakahlia Governorate, Egypt.

The mineral NPK fertilizers were urea (46% N), mono-oxide phosphorus (21.8% P) and potassium sulfate (41.5% K). In addition, rock phosphate was purchased from the Fertilizers and Chemical Company at Abu-Zaabal District, Qalubia Governorate to serve as a source of phosphorus. Feldspar was obtained from Sinai Manganese Company to represent the potassium source. In order to improve the efficiency and applicability of mineral additives incorporated with organic additives, nitrogen fixing as well as potassium and phosphorus dissolving bacteria were inoculated for nitrogen fixation and accelerate the dissolution phosphorus and potassium from phosphate rock and feldspar. These bacterial inoculations have complemented kindly from the Department of Soil, Water and Environmental Research Institute, Giza.

The chemical composition of the used organic additives and the natural mineral ores additives is illustrated in Table 2.

Table 2. Chemical composition of the organic additives and natural mineral ore additives.

<table>
<thead>
<tr>
<th>Chemical composition</th>
<th>Moisture content (%)</th>
<th>pH (1:10)</th>
<th>EC (1:10) dSm⁻¹</th>
<th>OM (%)</th>
<th>Organic carbon (%)</th>
<th>Total nitrogen (%)</th>
<th>C/N ratio</th>
<th>Total Phosphorus (%)</th>
<th>Total potassium (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic substrates</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Rice straw</td>
<td>8.37</td>
<td>6.38</td>
<td>2.53</td>
<td>82.06</td>
<td>47.60</td>
<td>0.62</td>
<td>76.77</td>
<td>0.28</td>
<td>0.49</td>
</tr>
<tr>
<td>Compost</td>
<td>27.4</td>
<td>7.49</td>
<td>2.37</td>
<td>33.77</td>
<td>19.59</td>
<td>1.51</td>
<td>12.97</td>
<td>0.57</td>
<td>0.71</td>
</tr>
<tr>
<td>Sea weed</td>
<td>9.5</td>
<td>7.63</td>
<td>2.11</td>
<td>57.87</td>
<td>33.57</td>
<td>0.86</td>
<td>39</td>
<td>0.67</td>
<td>3.21</td>
</tr>
<tr>
<td>Chicken manure</td>
<td>23.51</td>
<td>7.59</td>
<td>5.17</td>
<td>40.87</td>
<td>23.71</td>
<td>2.48</td>
<td>9.56</td>
<td>0.61</td>
<td>2.01</td>
</tr>
<tr>
<td>natural mineral ore</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rock phosphate</td>
<td>1.3</td>
<td>8.19</td>
<td>3.41 (1.25)</td>
<td>N.D.</td>
<td>N.D.</td>
<td>0.04</td>
<td>-----</td>
<td>11.36</td>
<td>0.59</td>
</tr>
<tr>
<td>Feldspar</td>
<td>0.87</td>
<td>9.72</td>
<td>7.74 (1.25)</td>
<td>N.D.</td>
<td>N.D.</td>
<td>0.03</td>
<td>-----</td>
<td>0.09</td>
<td>12.01</td>
</tr>
</tbody>
</table>

N.D. means not detected

Chemical analyses of compost combinations, types of organic additives and mineral additives were carried out according to the standard methods: (Richards, 1954), (Richards, 1954), (Walkley and Black, 1954) (Peterburgski, 1968).

Engineered organic blocks.

Prior to block preparation, SW and CM were applied to investigated compost at rates of 2.0, 20.0 g/block, respectively. RP and FS were applied at rates of 16.5 and 17.5 g/block, respectively. Urea, mono-oxide phosphorus and potassium sulfate were applied at 3.19, 2.14 and 5.2 g per block, respectively. All mixtures were compressed to 2.5 bar inch⁻¹ using a mechanical compressor at moisture content of 45% for making compost blocks (Fig. 1). The compressed blocks of compost combination were air-dried until the weight constant (less than 5% difference between successive two weights).

The pot experiment.

Outdoor pot experiment was undertaken at Experimental and Agricultural Research Center, Mansoura University, Dakahlia Governorate, Egypt. Before cucumber seeding, 108 polyethylene pots of 25 cm diameter and 25 cm length were used. Each pot was filled with 15,200 Kg of washed sand. Engineered organic blocks were instilled inside sandy soil in pots. Irrigation was scheduled according to the plant growth stage, and soil moisture content. At harvesting stage (55-60 days from sowing), fruit yield during the harvesting stage was recorded. Besides, fruit quality parameters (fresh weight of one fruit, fruit height and diameter) were also measured. In addition, representative fruit samples were air and oven dried at 70 ±5 °C until weight constant. 0.2 g of subsamples
were acid-digested with a 1:1 mixture of sulfuric (H$_2$SO$_4$) and per-chloric (HClO$_4$) acids according to Peterburgski, (1968) to determine total N, P and K concentrations. Representative compost samples (0.2 g) were collected for carrying out compost analyses at harvesting stage. Subsampling was carried out by hand after quartering homogenous soil sample until obtaining desired amount for analysis (ISO 11464). Blank corrections were performed without the analytic to ensure reliability of data. Besides, calibration curves were performed using stock standards to optimize quality control standards.

Poultry manure application recorded a stimulating effect to the growth performance and total productivity of the obtained yield. As cleared in Table 3. CM application enhanced the produced yield by about 33.9% compared to the control treatment. This could be attributed to the beneficial effect of poultry manure on soil physical properties (e.g. soil porosity, soil heat and water supply potential of soil (Ojeniyi, 2008). Furthermore, several reports have presented the beneficial effect of CM on increasing soil organic matter content, improving soil microbial populations, control plant pests and nematodes (Malik and Bradford, 2007).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fruit weight (cm)</th>
<th>Fruit length (cm)</th>
<th>Fruit diameter (cm)</th>
<th>Total yield Mg Fed$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>50.113</td>
<td>8.929</td>
<td>2.018</td>
<td>3.299</td>
</tr>
<tr>
<td>SW</td>
<td>52.520</td>
<td>10.377</td>
<td>2.163</td>
<td>3.778</td>
</tr>
<tr>
<td>CM</td>
<td>63.129</td>
<td>11.053</td>
<td>2.259</td>
<td>4.991</td>
</tr>
<tr>
<td>SW+CM</td>
<td>65.154</td>
<td>11.518</td>
<td>2.316</td>
<td>5.478</td>
</tr>
<tr>
<td>Significant</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>0.220</td>
<td>0.047</td>
<td>0.015</td>
<td>0.183</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total yield Mg Fed$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>54.609</td>
</tr>
<tr>
<td>RP+FS</td>
<td>57.085</td>
</tr>
<tr>
<td>NPK min</td>
<td>62.528</td>
</tr>
<tr>
<td>Significant</td>
<td>**</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>0.160</td>
</tr>
</tbody>
</table>

Seaweed incorporation with CM led to enhance the total marketable yield of cucumber fruits compared to the sole application of CM (5.478 and 4.991 Mg Fed$^{-1}$). Seaweed extracts could have several beneficial effects on growth stimulation, seed germination, growth performance, root development as well as yield and quality of most vegetables, (Vasantharaja et al., 2019).

Regarding the effect of mineral additives application, it is clearly noticeable that mineral NPK application recorded the highest application treatment with an increment of about 11.2% comparing with mineral ores application. Given the short-life period of cucumber until completing the harvesting stage (approximately 75 days), the mineral fertilizer dose gave the plant its full requirements necessarily to obtain the high yield. However, not only the quantitative yield parameters but also its qualitative indices are underlying the economic returns of cucumber fruit yield.

In modern agricultural systems, the target is not only to maximize the quantity of the obtained yield, but also to raise its qualitative parameters including its post-harvest shelf life. According to a recent study, the extract of Sargassum swartzi (brown seaweed) (SSE) and Kappaphycus alvarezii (red seaweed) showed a stimulating effect on the shelf life of Vigna unguiculata (Vasantharaja et al., 2019).
et al., 2019). In addition, the fruit's shape (i.e. length and diameter) is an important criterion to justify the quality of fruits. According to the obtained data in Table 3, the quality parameters of cucumber fruits (fruit's weight, length and diameter) followed the same aforementioned trend as the full application of compost, CM + SW and mineral NPK fertilizers were the superior treatment for improving these quality indices.

Regarding the interaction effect between treatments, as shown in Table 4, it is cleared that the combined treatment of mineral NPK application alongside with 100% compost and CM + SW was the superior treatment for obtaining the highest total marketable yield and quality of fruits shape. The mutual interactions among these treatments might improve water and nutrient supply potentials of soil to sustain the plant growth until reaching harvesting stage.

### Table 4. The interaction effect among compost, organic and mineral additives application treatments on cucumber fruit parameters.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fruit weight</th>
<th>Fruit length</th>
<th>Fruit diameter</th>
<th>Total yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>44.600</td>
<td>7.007</td>
<td>1.777</td>
<td>0.800</td>
</tr>
<tr>
<td>control</td>
<td>45.554</td>
<td>8.057</td>
<td>1.907</td>
<td>2.460</td>
</tr>
<tr>
<td>control</td>
<td>50.810</td>
<td>9.947</td>
<td>2.097</td>
<td>3.480</td>
</tr>
<tr>
<td>control</td>
<td>51.300</td>
<td>10.757</td>
<td>2.157</td>
<td>2.600</td>
</tr>
<tr>
<td>control</td>
<td>59.540</td>
<td>9.847</td>
<td>2.067</td>
<td>2.384</td>
</tr>
<tr>
<td>control</td>
<td>62.420</td>
<td>10.897</td>
<td>2.177</td>
<td>3.416</td>
</tr>
<tr>
<td>control</td>
<td>63.500</td>
<td>11.107</td>
<td>2.207</td>
<td>3.800</td>
</tr>
<tr>
<td>control</td>
<td>61.700</td>
<td>10.547</td>
<td>2.127</td>
<td>2.840</td>
</tr>
<tr>
<td>control</td>
<td>64.100</td>
<td>11.317</td>
<td>2.207</td>
<td>3.920</td>
</tr>
<tr>
<td>control</td>
<td>65.780</td>
<td>11.527</td>
<td>2.237</td>
<td>4.520</td>
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</table>

Data presented in Table 5. illustrated that full application of compost (100%) exhibited the highest N content with increments of about 7.43 and 17.39% higher than those obtained by 75%C + 25% RS and 50%C + 50RS, respectively. Unlike most feedstock materials (e.g. wheat straw), rice straw is rapidly decomposed with a noticeable reduction in C/N ratio given the fast increase of composting temperature during the initial phases (Wang et al., 2016). It is worthy noting that the yield reduction of 75%C +25% RS could be considered as a cost-effective treatment for recycling/disposing the huge amounts of rice straw as fresh rice straw could reach its maturity stage during the initial phases of mixing with compost. This finding is matched with those obtained by (El-Ghamry, 2016).

Regarding the effect of organic additives, it is cleared that the supplemental application of seaweed enhanced performance of CM compared to the sole application of CM. Additionally, N concentration in this superior treatment was about twofold higher than the control (without organic additives). Although N concentration in seaweed was significantly lower than that in CM (0.84% vs. %3.5), the motivating effect of seaweed on nitrogen uptake comes from its enhancement effect to the plant tolerance against biotic and abiotic stresses as well as improving plant growth architecture, thereby improving the plant capacity toward nitrogen uptake (Zhang and Schmidt, 2000).

Other reports suggested that this beneficial effect is mainly revealed to the presence of plant nutrients (micro-nutrients in particular), readily available amino acids, vitamins, pigments, and complex polysaccharides that contribute to improve the growth of plant (Calvo et al., 2014).

### Table 5. Effect of compost, organic and mineral additives application treatments on N, P and K concentrations in fruits.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>% N</th>
<th>% P</th>
<th>% K</th>
</tr>
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<tbody>
<tr>
<td>control</td>
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<td>control</td>
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</tbody>
</table>

On the other hand, nitrogen concentration in cucumber fruits was comparable between plants amended with either natural mineral ores of NPK fertilizers (1.756 vs. 1.872, respectively). This concentration, however, was significantly lower in the un-amended treatment (1.372%). Rock phosphate and feldspar provides a slow released supply for P and K requirements until reaching the flowering stage of cucumber as compared with the fast released supply of mineral NPK. Accordingly, their application into organic fertilizers might enhance plant growth and root development/architecture toward the uptake of N.
Regarding the effect of organic amendments application on phosphorus concentration in fruits, it is cleared that 100% compost application ranked as the first treatment with an increment of about 10.17% higher than 75% compost + 25% RS. The higher phosphorus content in compost (0.57 vs 0.28) Table 2. And its higher readiness for plant uptake compared to raw rice straw might encourage phosphorus absorption and translocation into fruits. The beneficial effect of seaweeds application on phosphorus uptake by plants was recently studied (El-Alsawy et al., 2018). According to this study, seaweed extract is able to increase the electronegativity of soil surfaces, thereby reducing its binding capacity by soil particles. Additionally, soil application of seaweed not only increased phosphate mobility but also enhanced its release into soil solution, thereby its uptake by plant roots.

These results suggest that SW extracts applications increased the net negative surface charge also reduces the soil phosphate adsorption capacity. Data of this study showed that seaweed not only decreased phosphate retention by the soil but also increased phosphate release into the soil solution. The same trend of mineral additive application was the same with phosphorus concentration in fruits as the mineral phosphate application enhanced phosphorus uptake by plants given the higher solubility of its phosphorus content compared to rock phosphate.

The compost application treatment (100%) gave the highest K concentration in fruits compared to other treatments. Potassium concentration in compost was by far greater than that in raw rice straw. It is well known that potassium is not existed organically in plant tissues (Marschner, 2011). Therefore, it is readily available for plant uptake following soil compost application. Seaweed supplementation into organic additions raised K concentration in fruits as compared to the sole CM application (2.274 vs. 2.140%). Presumably, due to the motivation of the plant physiological, mechanism responsible for potassium uptake by plants. Potassium uptake from soil into plant cells is mediated by low and high affinity transport systems taking advantage of the electrical gradient and/or the proton motive force established by H+ ATPases (Dreyer and Uozumi, 2011). The stimulating effect of SW to hormone signalling in plant responses may be the main reason for increasing plant capacity toward K uptake.

Potassium concentration in cucumber fruits amended with either mineral NPK or natural ores was comparable with as slight increase with those amended with mineral NPK (1.887 and 1.820%, respectively). In Egypt, there are numerous reports suggest the high efficacy of feldspar application as a natural ore application (Manning, 2010). The slow-release of potassium from feldspar might introduce a rich source of potassium with a long-term release during the plant physiological life.

The interaction effect between treatments is presented in Table 6. Surprisingly, it could be noted that mineral ores supplementation alongside with 100% compost and CM + SW recorded the highest concentrations of N and P. Accordingly; it is strongly recommended to incorporate natural ores supplementation in organic additives to achieve the ecological intensification in organic farming systems. The synergistic effect of the chemical constitutions of the combined organic form might lead to improve the mutual uptake of N and P. For example, N-fixing bacteria, which is the main sources for nitrogen supplementation might cause an acidifying effect in the root zone, thereby improved phosphorus uptake conditions

Table 6. The interaction effect among compost, organic and mineral additives application treatments on N, P and K concentrations in fruits.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>% N (%)</th>
<th>% P (%)</th>
<th>% K (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>0.787</td>
<td>0.053</td>
<td>0.703</td>
</tr>
<tr>
<td>NPK min</td>
<td>1.074</td>
<td>0.077</td>
<td>0.987</td>
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<tr>
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<td>0.103</td>
<td>1.003</td>
</tr>
<tr>
<td>SW</td>
<td>1.197</td>
<td>0.120</td>
<td>1.210</td>
</tr>
<tr>
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<td>1.274</td>
<td>0.127</td>
<td>1.287</td>
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<tr>
<td>control</td>
<td>1.596</td>
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<td>1.627</td>
</tr>
<tr>
<td>CM</td>
<td>2.002</td>
<td>0.191</td>
<td>2.027</td>
</tr>
<tr>
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<td>0.197</td>
<td>2.123</td>
</tr>
<tr>
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<td>1.656</td>
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<td>1.693</td>
</tr>
<tr>
<td>SW+CM</td>
<td>2.143</td>
<td>0.202</td>
<td>2.200</td>
</tr>
<tr>
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<td>2.206</td>
<td>0.209</td>
<td>2.267</td>
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<tr>
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<td>0.908</td>
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<tr>
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<td>1.183</td>
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<td>1.117</td>
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<tr>
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<td>0.110</td>
<td>1.177</td>
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<tr>
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<tr>
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<td>1.333</td>
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<td>1.417</td>
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<td>1.763</td>
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<tr>
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<tr>
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<tr>
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<tr>
<td>SW</td>
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<td>1.500</td>
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<tr>
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<tr>
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<tr>
<td>SW+CM</td>
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<td>0.256</td>
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<tr>
<td>NPK min</td>
<td>2.769</td>
<td>0.251</td>
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</table>

**Significant LSD 5% ** 0.004 0.052 0.154

Meanwhile, the mineral NPK application treatment alongside with 100% compost and CM + SW gave the highest potassium concentration in fruits. This could be attributed to the luxury consumption of potassium from several mineral and organic forms.

CONCLUSION

Based on the obtained results of this experiment, it could be concluded that incorporating some organic and mineral additives to alongside with compost application can maximize crop productivity in newly reclaimed sandy soils. This research indicated the urgent need to incorporate additional organo-mineral supplementation alongside with RS to achieve the ecological intensification in organic farming systems.

REFERENCES

El-Sayed, Kh. El- M et al.


