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*Full Length Research Paper*

# Influence of compost, amino and humic acids on the growth, yield and chemical parameters of strawberries

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**There is increasing concern about human health and environmental contamination risks associated with the extensive use of mineral fertilizer in vegetables production. Compost and growth stimulate agents could be a suitable alternative to mineral fertilizer. The effect of soil addition of compost and foliar fertilizers with humic and/or amino acids on growth and yield of strawberry (*Fragaria* x *ananassa*) cv. festival plants was investigated. Compost fertilization of soil at a rate of 8 ton/fed, foliar application of humic acid at a rate of 1 g $l^{-1}$, foliar fertilization of amino acids at a rate of 2 ml $l^{-1}$ and their combinations were used. The results from this study showed that plants of strawberries grown from compost fertilized plots exhibited generally higher plant length and fruit weight. Total yield was significantly increased by all treatments compared to mineral fertilizer. Moreover, the compost fertilizer also produced fruits with higher level of total soluble solid and anthocyanin content. Limited effects on growth were observed by foliar fertilizer with either humic acid or amino acids.**

**Key words:** Strawberry, organic fertilizer, chemical parameters, quality.

## INTRODUCTION

Strawberries are considered as one of the most important crops grown in Egypt for fresh local consumption and export especially during the period from December to April. The production of strawberry in Egypt was 200254 MT during the winter season of 2008/2009 (FAOSTAT).

Fertilizer management is a vital demand for high quality yield of organically grown strawberry. Humate is an organic substance having bio-regulatory effects. It was found that under certain conditions humic acid applied to the root zone had beneficial effects on plant development. Several studies have been reported that humic acid improved not only vegetative growth but also yield and it quality. El-Ghozoli (2003) and L-Ghanam and El-Ghozoli (2003) indicated that the application of humic acid significantly increased the dry matter production of faba bean plants. El-Desuki (2004) reported that growth (number and fresh weight of leaves) and yield of onion were gradually and significantly increased with increasing the level of humic acid application from 0 to 6 l/fed. Also, Habashy and Laila (2005) concluded that plant growth and yield of wheat crop were increased by fertilization with humic acid at a rate of 100 ppm. In addition, Salman et al. (2005) indicated that the application of humic acid up to 6 l/fed linearly increased total yield of watermelon crop.

Zaky et al. (2006) found that the number of shoots/plant, average leaf area, total yield, average pod fresh weight and P content were increased by application of humic acid as a foliar fertilizer at a rate of 1 g/L. Manure and compost are organic sources of nutrients that have been also shown to increase soil organic matter and improve soil quality (Wright et al., 1998). Previous works have shown the importance of adding compost to increase soil fertility and crops yield. In this regard, Arancon et al. (2004a, b) studied the effect of fertilizer with recycled paper waste at the rates of 5 t $ha^{-1}$ or 10 t $ha^{-1}$ on the growth and yield of strawberry plants. They found that leaf areas, numbers of flowers, shoot weights, and total marketable strawberry yields were significantly increased in plots treated with compost compared to those that received inorganic fertilizers only. Neeraja et al. (2005) found that amino acids application increased

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the number of flowers, fruit setting and fruit yield of tomatoes. However, foliar and root application of commercial amino acids product from animal origin led to a severe plant growth depression. On the contrary, shoot and root fresh weights were not affected by addition of plant origin amino acids product (Cerdán et al., 2006).
The aim of this study was to compare the effect of compost, humic acid and amino acids (AA) on the growth, yield and chemical parameters of strawberry under greenhouse condition.

## MATERIALS AND METHODS

### Experimental design

This investigation was conducted at experiment station of the Faculty of Agriculture, Cairo University during winter seasons of 2008/2009 and 2009/2010 to study the effect of plant compost (CO) (N: 1.49; P: 0.73; K: 1.44; Organic carbon: 12.56; Organic matter: 21.66; Iron: 0.189; Manganese: 0.046 and Zinc: 0.0121%), Humic acid (HA) (Hammar, Arabian Group of Agricultural Service (AGAS), Egypt, potassium humate 86% and potassium oxide 6%) and amino acids (AA) (Amino power, AGAS comp., Egypt, free amino acid, citric acid 3%, potassium oxide 3.5% and L-amino acid) on growth and yield of strawberry cv. Festival.

The soil of the experimental area was loamy clay in texture with 7.89, EC 1.65 (mmohs/cm) and contained 42 and 35 ppm N, 22 and 20 ppm P, 187 and 180 ppm K. The planting dates were on 15$^{th}$ October, 2007 and 2008. A complete randomize block design (CRBD) was adopted. Each experimental plot was 4.5 m$^2$. The distance between strawberry transplants was 25 cm and between rows was 0.7 cm. This experiment included 10 treatments which were compared: mineral fertilizer (MF) (control) at rate of 60 kg N, 45 kg $P_2O_5$ and 50 kg $K_2O$/fed; CO at 8 ton/fed; CO (8 ton/fed) plus HA foliar application at 1 g l$^{-1}$; CO (8 ton/fed) plus AA foliar application at 2 ml l$^{-1}$; CO (8 ton/fed) plus HA plus AA; CO (4 ton/fed) plus HA foliar application at 1 g l$^{-1}$; CO (4 ton/fed) plus AA foliar application at 2 ml l$^{-1}$; CO (4 ton/fed) plus HA plus AA; half MF plus CO (4 ton/fed) and half MF plus CO (4 ton/fed) plus HA plus AA.

Application of CO was done once before planting; MF application was done in three equal parts before planting, 30 and 45 days after planting. HA and AA application were done in three times 30, 45 and 60 days after planting.

### Measurement of vegetative growth parameters

In each year of the study, plant length and number of leaves per plant were recorded at 60 days after planting. Fruit diameter, length, weight and Total suspended solids (TSS) (by hand rafractometer) were recorded as quality parameters. Early yield (the first three harvest times) and total yield were measured.

### Determination of chemical parameters

#### Titratable acidity (TA*)*

TA was determined by using 10 g aliquots of strawberry fruits poured in 50 ml of distilled water and titrated with 0.1N NaOH to an end-point of pH 8.1. TA was expressed as percentage of citric acid and was calculated using the method reported by Han et al. (2004).

#### Total anthocyanins

Total anthocyanins were extracted by adding a solvent containing ethanolic HCl {95% ethanol, 1.5N HCl (85:15)}. The solvent was added at level (2:1) solvent to sample then the mixture was stored overnight at 4ºC, then filtered on filter paper Whatman no.1 and centrifuged at 1000 rpm for 15 min (Ranganna, 1979). The supernatant intensity was measured by spectrophotometer (model Spectro UV-Vis 0216 USA).

### Statistical analysis

Data were treated by analysis of variance with using SPSS 11.0 for windows software and using L.S.D. test between treatments means determined at the 5% level.

## RESULTS AND DISCUSSION

### Vegetative growth

The effect of soil fertilizer with compost and foliar fertilizers with humic or amino acid on plant length and number of leaves is presented in (Table 1). Plant length in plots treated with MF (control) was significantly higher than those in plots receiving organic fertilizers in 2008 season ($F = 9.88$; $P<0.05$). Plant length was significantly increased by full CO dosage compared to half CO dosage. This trend was observed in both seasons. In the 2009 season, CO+HA+AA treatment had the highest plant length ($F = 4.43$; $P < 0.05$). No significant difference was obtained between the two seasons in plant length parameter. There was no significant difference among all treatments on number of leaves either in 2008 or 2009 season. Our result was supported by Arancon et al. (2004 c) who found that plant height of strawberries was increased considerably with humic acids fertilizer. The increase in growth could be due to increase in microbial biomass in soils receiving compost or due to production of plant growth regulators by microorganisms (Atiyeh et al., 2002) or due to the effects of humates (Canellas et al., 2000).

### Fruit parameters

Fruit diameters in CO treatments were consistently greater, but not statistically different from those in MF treatment (Table 2). Fruit diameter was significantly greater in treatments that received full CO dosage or MF than those that received half CO dosage. The same trend was observed in both seasons. The highest value of fruit weight was obtained by ½ MF+½ CO treatment in first season ($F = 10.29$; $P<0.05$) and by CO treatment in second season ($F = 3.86$; $P<0.05$). There was no significant difference between the two seasons in fruit weight parameter. Foliar fertilizer with HA or AA did not had any effect on fruit diameter or weight in both seasons.

**Table 1.** Effect of compost, humic acid and amino acids on plant length and number of leaves of strawberry in 2008 and 2009 seasons.

| Treatments | 2008 season | | 2009 season | |
|---|---|---|---|---|
| | Plant length (cm) | No. of leaves | Plant length (cm) | No. of leaves |
| Control (MF) | 15.76 | 6.53 | 11.33 | 5.43 |
| CO | 13.83 | 5.83 | 11.40 | 6.43 |
| CO+HA | 12.53 | 6.53 | 12.40 | 6.83 |
| CO+AA | 12.86 | 6.40 | 12.00 | 5.73 |
| CO+HA+AA | 13.53 | 6.83 | 12.76 | 6.63 |
| ½ CO+HA | 11.63 | 5.70 | 10.30 | 5.86 |
| ½ CO+AA | 11.53 | 5.96 | 10.53 | 6.03 |
| ½ CO+HA+AA | 11.86 | 6.30 | 11.06 | 5.53 |
| ½ MF+½ CO | 13.30 | 6.83 | 12.10 | 6.20 |
| ½ MF+½ CO+HA+AA | 12.40 | 6.63 | 12.53 | 6.43 |
| L.S.D. at 5% | 0.76 | ns | 0.71 | ns |

Each value is presented as mean of triplet treatments, LSD: Least significant difference at P ≤ 0.05 according to Duncan's multiple range test. MF: Mineral fertilizer; CO: compost; HA: Humic acid; AA: Amino acids.

**Table 2.** Effect of compost, humic acid and amino acids on fruit diameter and weight of strawberry in 2008 and 2009 seasons.

| | 2008 season | | 2009 season | |
|---|---|---|---|---|
| Treatments | Fruit diameter (cm) | Fruit weight (g) | Fruit diameter (cm) | Fruit weight (g) |
| Control (MF) | 2.66 | 10.15 | 2.73 | 12.20 |
| CO | 2.83 | 10.26 | 2.93 | 12.65 |
| CO+HA | 2.76 | 11.36 | 3.03 | 11.30 |
| CO+AA | 2.66 | 10.94 | 2.73 | 12.10 |
| CO+HA+AA | 2.86 | 10.13 | 2.83 | 11.56 |
| ½ CO+HA | 2.36 | 9.46 | 2.46 | 8.76 |
| ½ CO+AA | 2.70 | 9.60 | 2.70 | 9.13 |
| ½ CO+HA+AA | 2.50 | 9.50 | 2.63 | 9.19 |
| ½ MF+½ CO | 2.73 | 11.98 | 2.73 | 10.56 |
| ½ MF+½ CO+HA+AA | 2.75 | 10.35 | 2.80 | 10.93 |
| L.S.D. at 5% | ns | 0.65 | ns | 1.13 |

Each value is presented as mean of triplet treatments, LSD: Least significant difference at P ≤ 0.05 according to Duncan's multiple range test. MF: Mineral fertilizer; CO: compost; HA: Humic acid; AA: Amino acids.

The effect of compost on strawberry fruit could be attributed to presence of plant growth regulators and humic acid in compost, which are produced by increased activity of microbes such as fungi, bacteria, yeasts, actinomycetes and algae (Arancon et al., 2004 b).

## Early and total yield

Early yield (the first three harvests) was not affected by CO, HA or AA in both seasons (Table 3). Total yield was increased by all organic fertilizer compared with MF. The treatments of ½ MF plus ½ CO in the first season ($F = 4.79$; $P<0.05$) and CO plus HA plus AA in the second season ($F = 2.89$; $P<0.05$) had the highest total yield. The treatments which received full CO dosage were higher than those received half CO dosage in both seasons.

There was no significant difference between the two seasons in total yield parameter. The increase in yield of strawberry plants in our experiment could be explained by increase the microbial populations resulting from adding compost in soils. These microorganisms can produce materials that may affect plant growth such as substances acting as plant hormone analogues or growth regulators (Brown, 1995).

## Chemical compositions

The effects of fertilizing with CO, HA and AA on chemical

**Table 3.** Effect of compost, humic acid and amino acids on early and total yield of strawberry in 2008 and 2009 seasons.

| Treatments | 2008 season | | 2009 season | |
|---|---|---|---|---|
| | Early yield (kg/m$^2$) | Total yield (kg/m$^2$) | Early yield (kg/m$^2$) | Total yield (kg/m$^2$) |
| Control (MF) | 1.15 | 5.20 | 0.88 | 5.05 |
| CO | 0.90 | 5.22 | 0.84 | 5.75 |
| CO+HA | 0.95 | 5.55 | 0.92 | 5.42 |
| CO+AA | 0.99 | 5.26 | 0.87 | 4.51 |
| CO+HA+AA | 0.97 | 5.53 | 0.90 | 5.86 |
| ½ CO+HA | 0.90 | 3.96 | 0.90 | 4.36 |
| ½ CO+AA | 0.95 | 3.94 | 0.84 | 3.69 |
| ½ CO+HA+AA | 0.88 | 3.88 | 0.82 | 3.49 |
| ½ MF+½ CO | 0.88 | 5.74 | 0.87 | 4.94 |
| ½ MF+½ CO+HA+AA | 0.94 | 5.31 | 0.90 | 4.59 |
| L.S.D. at 5% | ns | 0.55 | ns | 0.72 |

Each value is presented as mean of triplet treatments, LSD: Least significant difference at $P \leq 0.05$ according to Duncan's multiple range test. MF: Mineral fertilizer; CO: compost; HA: Humic acid; AA: Amino acids.

**Table 4.** Effect of compost, humic acid and amino acids on TSS and TA of strawberry in 2008 and 2009 seasons.

| Treatments | 2008 season | | 2009 season | |
|---|---|---|---|---|
| | TSS (%) | TA (%) | TSS (%) | TA (%) |
| Control (MF) | 7.17 | 0.70 | 7.16 | 0.72 |
| CO | 8.33 | 0.72 | 8.33 | 0.68 |
| CO+HA | 8.16 | 0.66 | 8.50 | 0.70 |
| CO+AA | 7.83 | 0.66 | 8.33 | 0.74 |
| CO+HA+AA | 8.00 | 0.72 | 8.66 | 0.63 |
| ½ CO+HA | 7.83 | 0.65 | 7.50 | 0.70 |
| ½ CO+AA | 7.16 | 0.70 | 7.33 | 0.68 |
| ½ CO+HA+AA | 7.33 | 0.67 | 7.83 | 0.64 |
| ½ MF+½ CO | 8.16 | 0.69 | 7.16 | 0.71 |
| ½ MF+½ CO+HA+AA | 8.00 | 0.69 | 7.00 | 0.73 |
| L.S.D. at 5% | 0.32 | ns | 0.54 | ns |

Each value is presented as mean of triplet treatments, LSD: Least different significantly at $P \leq 0.05$ according to Duncan's multiple range test. MF: Mineral fertilizer; CO: compost; HA: Humic acid; AA: Amino acids.

compounds of strawberry fruits are presented in (Tables 4 and 5). Mineral fertilizer treatment had significant lowest TSS% than those treatments received CO, HA and AA in both seasons (Table 4). CO and CO plus HA plus AA had the highest TSS value in 2008 ($F = 4.73$; $P<0.05$) and 2009 ($F = 3.56$; $P<0.05$) seasons, respectively. No significant difference between the two seasons in TSS parameter. TA and pH (Table 5) were not affected by adding CO application. Soil CO fertilizer alone or combined with HA and/or AA significantly increased anthocyanin content of fruit in 2008 ($F= 5.30$;

## Conclusion

to MF treatment. Full CO dosage increased anthocyanin

$P<0.05$) and 2009 ($F= 3.68$; $P<0.05$) seasons compared content compared to half CO dosage. There was no significant difference between the two seasons in anthocyanin parameter. Azarmi et al. (2009) observed that fruits harvested from plants that received vermicompost had significantly greater total soluble solid (TSS) than those harvested from the mineral fertilizer plot. The improvement of fruit quality may be attributed to better growth of plant at different rate of compost, which might have favored the production of better quality fruit (Rajbir et al., 2008).

This study indicated that soil fertilizer of compost alone or plus HA and AA is more effective than chemical fertilizers in strawberry plants. Strawberry produced from organic fertilizer had significantly higher yield and fruit quality.

**Table 5.** Effect of compost, humic acid and amino acids on pH and anthocyanin content of strawberry in 2008 and 2009 seasons.

| Treatments | 2008 season | | 2009 season | |
|---|---|---|---|---|
| | pH | Anthocyanin (mg/100g fw) | pH | Anthocyanin (mg/100g fw) |
| Control (MF) | 5.52 | 27.23 | 5.63 | 30.26 |
| CO | 5.57 | 33.55 | 5.66 | 34.52 |
| CO+HA | 5.59 | 32.53 | 5.71 | 33.99 |
| CO+AA | 5.67 | 32.26 | 5.56 | 33.78 |
| CO+HA+AA | 5.55 | 33.43 | 5.54 | 33.39 |
| ½ CO+HA | 5.53 | 31.01 | 5.73 | 32.25 |
| ½ CO+AA | 5.55 | 31.51 | 5.27 | 31.08 |
| ½ CO+HA+AA | 5.46 | 31.33 | 5.52 | 31.78 |
| ½ MF+½ CO | 5.53 | 30.00 | 5.49 | 33.75 |
| ½ MF+½ CO+HA+AA | 5.61 | 30.16 | 5.57 | 33.14 |
| L.S.D. at 5% | ns | 1.33 | ns | 1.19 |

Each value is presented as mean of triplet treatments, LSD: Least different significantly at $P \leq 0.05$ according to Duncan's multiple range test. MF: Mineral fertilizer; CO: compost; HA: Humic acid; AA: Amino acids.

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