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Combined Effects of Soil Applications of Humic Acid and Foliar Spray of Amino Acids on Yield and Fruit Quality of 'Florida Prince' Peach Trees under Calcareous Soil Conditions

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Under calcareous soil conditions, 'Florida Prince' peach trees were treated with foliar spray of amino acids (in the form of Pepton as a commercial product) and soil application of humic acid (in the form of Hammer as a commercial product). The treatments were arranged as follows: (1) control (spraying water only) (2) Foliar spray of amino acids at 0.25% (3) Soil application of humic acid at 0.25% (4) Foliar spray at 0.50 % (5) Soil application of humic acid at 0.50 % (6) Foliar spray of amino acid at 0.25% + soil application of humic acid at 0.25% (T2+T3) (7) Foliar spray of amino acid at 0.50% + soil application of humic acid at 0.50% (T4+T5). All Treatments were applied after fruit set and repeated four times at 15 days intervals. Results show that, spraying amino acids or soil application of humic acid individually or in combination at low (0.25%) or high concentration (0.50%) had a positive effect on productivity and fruit quality, leaf mineral content and chlorophyll contents. Application of amino acids as foliar spray combined with soil application of humic acid at high concentration for both (0.50% + 0.50 %) is the promising treatment (T7) for improving growth, fruit characteristics and maximized the yield of 'Florida Prince' peach trees.

Keywords: Peach - Amino acids - Yield – Fruit Quality – Foliar & soil Applications – Calcareous Soil

INTRODUCTION

Botanically, the fruit of the peach (*Prunuspersica* (L.) Batsch) is a drupe. It develops entirely from a superior ovary, and consists of the outer portion, or skin (exocarp), the middle portion (mesocarp) of the ovary wall, which becomes fleshy, and the inner portion (endocarp), which becomes hard and forms the stone (Teskey and Shoemaker, 1978). Peach (*Prunuspersica* (L.) Batsch) is originated in China and belongs to the family "Rosaceae". It considered one of the most important fruits in the worldwide and ranks second to apple among temperate zone deciduous fruit trees from the standpoint of production and values (Childers, 1978, Farag et al., 2007).

In Egypt, peach is one of the most favorite deciduous fruit trees and the fruit may be consumed fresh or processed into many products such as juice, jam, jelly, canned peach, dried peach and skin care & makeup. The total planted area of peach increased rapidly during the last three decades due to introduced several cultivars of low and moderate chilling requirements by the Agricultural Development System Project (ADS) which is a joint project of the Egyptian Ministry of Agriculture & Food Security and the University of California, Davis sponsored by USAID (Blond, 1983). Where, low-chill peach cultivars are those that require fewer chill units (100–250 chill units / or less than 300 cu) than those cultivars that

originate from temperate climates. Moderate chill cultivars require higher numbers of chill units (300–525 cu). Chill Unit is equal chill-hour as 1 h at or below 7.2°C (45°F) (Olmstead et al., 2016, Williamson et al., 2005).

Recently, the peach's planting spreads in many areas in Egypt especially in the newly reclaimed lands which include many types of soil and reached about 20574 ha and produced 266628 Tons (FAO, 2016). The cultivation of peach nowadays is extended due to its highly economic value, exporting potential and introducing new low chilling cultivar 'Florida Prince' which is an early ripening variety and is exhibited a high adaptation with the local environmental conditions (Shaltout, 1987) Furthermore, 'Florida Prince' peach appears in the Egyptian markets before the other fruits due to its low chilling and temperature requirements that achieve early flowering and fruit maturation. Therefore, 'Florida Prince' peach is a promising cultivar in Egypt (Shaltout, 1987)

Horticulturally, 'Florida Prince' is a delicious and juicy early-season peach was released in 1982 by University of Florida. It has taken 45 years of research and specifically created to produce fruit in the warmer climates since it needs only 150 chill hours (150 hours of at or below 45°F/7.2°C). Its Fruit Development Period (FDP) is 78 days (the period from fruit set to maturity) and it's a standard for lowest chill and early ripening ability which are an important trait. 'Florida Prince' is a very heat resistant variety produces beautiful aromatic fruit, the skin has 80% red blush with faint dark red stripes that covers most of the skin with a background splash of yellow/orange, the flesh is uniformly firm yellow with semi-clingstone pits and the fruit is a bit smaller than your typical peach (Olmstead et al., 2016).

Generally, peach trees need to special practices under calcareous soil conditions for improving their yield and fruit quality, since calcareous soil has a free calcium carbonate ($CaCO_3$) in its profile more than 8 % which characterizes relatively high solubility, reactivity and alkaline character that buffer the pH of most calcareous soils within the range of 7.5 to 8.5. Therefore, the fruit trees in calcareous soils require to practices differ than those in non-calcareous soils due to the impact of soil pH on soil nutrient availability and chemical reactions that affect the loss or fixation of almost all nutrients (Brady and Weil, 1999).

Amino acids are organic nitrogenous compounds and they are play a role in the building blocks in the synthesis of proteins which formed by a process in which ribosome catalyze the polymerization of amino acids (Davies, 1982). In addition, amino acids have a high integrity with the different metabolic pools in plants which were used to promote plant growth (Coruzzi and Last, 2000). Moreover, the foliar spray of amino acids is very necessary for plants because they considered as precursors and constituents of proteins (Rai, 2002) which are important for stimulation of cell growth due to they contain both acid and basic groups and act as buffers, which help to maintain favorable pH value within the plant cell (Davies, 1982). Also, the spraying with amino acids led to increased leaf containing from growth regulators cytokinines (Cks), Gibberellins (GA_3), Auxins, chemical eliminates and reducing Abscisic acid (ABA) (Talaat et al., 2013). Meanwhile, the amino acids can directly or indirectly influence the physiological activities in plant growth and development especially under calcareous soil conditions, since the exogenous spray of amino acids have been used to modulate the growth, yield and fruit quality of 'Perlette', 'Red Globe' and 'Red Roomy' grapevines (Khan el al., 2012, Sabry et al., 2009, Ahmed and Abd El-Hameed, 2003), 'Williams' pear trees (Lihami et al., 1999). They are used also to improve the growth of 'Kronaki' olive seedlings (Yousef et al., 2011) and to produce high yield and fruit quality of 'Manzanillo' olive trees as well as many olive varieties (Haggag, et al., 2015).

Furthermore, the amino acids play an important role in reducing pH of the soil when they were conducted directly as the soil application. Therefore, uses of the amino acids improve nutrient availability especially microelements in calcareous soils as a result to decrease soil pH. However, it is preferred to apply the foliar spray of amino acids to achieve the two purposes together: 1) Stimulation of cell growth (Davies, 1982, Talaat et al., 2013). 2) Reducing soil pH, where the spray solution falls on the soil and decrease soil pH.

On the other side, humic acid is one of bio-stimulants are known as the organic substances which promote plant growth and help the trees to withstand harsh environments when applied in small amounts (Chen et al., 1994). It is highly beneficial also for both the trees and the soil, since it maintains proper plant growth as well as it increases nutrient uptake, tolerance to drought and temperature extremes, activity of beneficial soil microorganisms, and availability of soil nutrients particularly in alkaline soils and low

organic matter such as calcareous soil conditions without excessive use of agricultural chemicals which are considered a menace to the environment (Russo and Berlyn, 1990, Eissa et al., 2007 and Ismail et al., 2007). Uses of humic acid as a soil application improve nutrient availability especially microelements in calcareous soils because it promotes nutrient uptake in the form of chelating agent. Moreover, humic substances may increase root growth in a similar manner to auxins (O'Donnell, 1973, Tatini et al., 1991 and Khattab et al., 2012). In addition, the humic acid has many effects due to it raises of cation exchange capacity which affects the retention and availability of nutrients, as well as due to a hormonal effect, or a combination of both (Chunhua et al., 1998) as a result it can use to solve many problems in calcareous soil such soil nutrient availability and chemical reactions that affect the loss or fixation of almost all nutrients. Generally, there is growing interest of the use of humic acid and K-humate as a substitute to chemical fertilizers which have potential polluting effects in the environment (Senn and Kingman, 2000).

The 'Florida Prince' peach trees have a rapid growth cycle which is starting in the beginning of winter and the early fruit set is developing to mature fruit before the beginning of spring. Under the winter conditions, the low heat temperature of the soil reduces the activation degree of nutrients absorption by the roots. In this respect, humic acid plays an important role in raising the cation exchange capacity which increases the water and mineral absorption and they reflect on tree productivity. Furthermore, during this speed growth cycle, the foliar application of amino acids has a positive effect in improving both the yield and fruit quality under calcareous soil conditions. Therefore, the aim of this work is to study the combined effects of the soil application for humic acid and the foliar spray of amino acids on the yield and fruit quality of 'Florida Prince' peach trees under calcareous soil conditions. However, little studies are known until present.

MATERIALS AND METHODS

Plant materials and treatments:

The present study was conducted during two successive seasons at Al-Nubaria district near Alexandria, Egypt on ten years old Florida Prince peach trees (*Prunus persica*) budded on Nemaguard rootstock and grown in calcareous soil under drip irrigation system. The soil physical and chemical properties are showing in Table (1). The trees were planted at 4 ×5 m spacing, pruned on November and the selected trees were chosen in similar figure. In October before pruning, the trees were fertilized with organic manure (0.2 % N) and elemental sulfur (90 % S) at a rate of 10 and 1.5 kg per tree, respectively. Also, 1kg Ammonium nitrate (33% N) and 1.5 kg potassium sulphate (48% K_2O) per tree were mixed with the organic matter then the mixture was added to the soil in two holes for each tree which were dug on both sides of the tree and those located beside the shadow of the tree (at depth of 50 cm) then the holes were covered with sand and irrigated to provide adequate moisture for the degradation of organic fertilizers. In the first week of December for both seasons, the trees were sprayed with potassium nitrate 7% of the compound fertilizer (6-6-42 NPK) plus 0.5% mineral oil to break the bud dormancy. After fruit set when the fruits reached pea size, fruitlets were thinned (15 cm apart on the same branch to leave 300 fruitlets per tree). All trees of this experiment were received the same recommended fertilization through the drip irrigation and also received the regular fungi, pest and weed control treatments. Trees were arranged in randomized complete block design (RCBD) and the following treatments were done with three replicates for each treatment (1 replicate = 3 trees). The treatments were arranged as follows:

(1) Control (spraying water only).
(2) Foliar spray of amino acids at 0.25% (Pepton 85/16®).
(3) Soil application of humic acid at 0.25% (Hammer®).
(4) Foliar spray of amino acids at 0.50 %.
(5) Soil application of humic acid at 0.50 %.
(6) Foliar spray of amino acid at 0.25% + soil application of humic acid at 0.25% (T2+T3).
(7) Foliar spray of amino acid at 0.50% + soil application of humic acid at 0.50% (T4+T5).

All Treatments were applied after fruit set and repeated four times at 15 days intervals. Where, Hammer is a commercial product contains 86% potassium humate + 6% potassium oxide. Hammer (Humic acid) presented with 5 liters/tree as soil application. In addition, Pepton 85/16 is a commercial product of mixture of 18 amino acids. The total percent of amino acids in the product is 85% (16% as free amino acids in L-α type) + 12% organic nitrogen + 3% potassium oxide. Tween-20

(0.1%) as surfactant was added to the foliar solution then the foliar application was applied directly to trees with a handheld sprayer until runoff in the early morning.

Yield:

In both seasons, the yield of fruits from each tree was harvested at maturity stage on April and all the harvested fruits were weighed and the yield was recorded as kg/tree.

Fruit characteristics at harvest:

Physical characteristics:

At harvest, a sample of 10 fruits for each replicate was randomly collected to use for determining the following physical characteristics: fruit weight (g), fruit length (cm), fruit width (cm), fruit volume (cm^3), flesh firmness ($lb/inch^2$) using fruit pressure tester.

Chemical characteristics:

Another sample of 10 fruits for each replicate was randomly chosen in both seasons to determine the following chemical characteristics: total soluble solids % (T.S.S) using a hand refractometer, fruit acidity % (TA) as malic acid was determined by titration using 0.1 N of Na OH according to A.O.A.C. (1990). In addition, maturity index (MI) defined as the TSS/acid ratio was estimated. Total anthocyanins content was determined according to Abd El-Razek (2008) where, four fruits from each sample were weighed, homogenized in a solution of Me OH:formic acid (95:5) under cooling, put in ultrasonic bath at 4 °C for 30 min., centrifuged at 5000 rotation mint $^{-1}$ for 10 min. at 4 °C, filtered through a folded filter paper 595½ (Whatman®, Germany), then refilled to 25 ml., shaked well, absorbance at 520 nm by Spectrophotometer and the obtained data were compared with the standard curve of cyanidin and expressed as mg cyanidin/100 g fresh weight.

Leaf content of Macro-nutrients:

Macro-nutrients were determined in dry leaf samples which collected at the second week of July of each season and were taken from the sixth node from the base of shoots. Nitrogen % was measured by Micro-Kjeldahl according to Pregel (1945). Also, phosphorus % was determined as described by Champman and Parker (1961), while potassium % was measured according to Brown and Lilleland (1945).

Leaf content of chlorophylls:

Forty leaves were collected on 1st May for each season, then chlorophylls (a) & (b) and (a+b) were determined spectrophotometrically at 660, 640 mm wavelength for chlorophyll (a) and (b), respectively, against the blank methanol using the method described by Beckett et al., (2005).

Statistical analysis:

The data were statistically analyzed by analysis of variance (ANOVA), and means were compared using Duncan's test at $p < 0.05$ to determine the significance of differences between the conducted treatments (Duncan, 1955).

RESULTS

Results in Table 2 showed that foliar spray of amino acids or humic acid soil application individually or in combination at the low and the high concentration significantly increased fruit weight (gm) of 'Florida prince' peach in both seasons of study than the control. In this respect, spraying amino acid at the low concentration (0.25%) or at the high concentration (050%) gave more or less similar fruit weight values and no significant values were detected. The fruit weight values were 63.9, 63.7 gm and 66.1, 66.2 gm in the first and second season, respectively. Similarly, result cleared that soil application of humic acid at the low concentration (0.25%) or at the high concentration (50%) resulted in fruit weight values similar from the statically stand point, where the values recorded 62.6, 64.6 gm and 65.1, 67.2 gm in the first and second season, respectively. As for the effect of foliar application of amino acids + soil application of humic acid at the low concentration (0.25 + 0.25) or at the high concentration (0.50 + 0.50) on fruit weight (gm), results showed that amino acids foliar spray+ humic acid soil application at the high concentration (T4 + T5) tended to slightly and insignificantly increased fruit weight (gm) than amino acids foliar spray + humic acid soil application at low concentration (T2 + T3) in both seasons of this study except, fruit firmness ($lb./inch^2$), acidity % and leaf mineral content of K% were effected significantly due to increasing amino acids + humic acid application to high concentration (T4+T5) that significantly increased acidity % (Table 4), leaf mineral content of K% (Table 5) and decreased fruit firmness (Table 3) than application of amino acids + humic acid at the low concentration (T2+T3).

Table (1): Physical and chemical properties of the experimental soil.

Particle size distribution (%)			Texture	Ca CO_3 (%)	EC (1:1) dSm^{-1}	pH	Available nutrients							
							Cations (meq/L)				Anions (meq/L)			
Sand	Silt	Clay					K^+	Na^+	Mg^{++}	Ca^{++}	SO_4^{--}	Cl^-	HCO_3^-	CO^{--}
72.12	17.46	9.42	Sandy loam	16%	1.98	7.82	0.84	5.0	9.5	12	18.62	2.1	2.8	0

Table (2): Effect of foliar spray of amino acids and soil applications of humic acid on fruit weight and yield of 'Florida Prince' peach trees during the two seasons.

Treatments	Fruit weight (g)		Yield (kg\tree)	
	First season	Second season	First season	Second Season
T1= Control	51.2 d	53.2 d	43.3 d	44.0 d
T2= 0.25 % A	63.9 c	66.1 c	54.1 c	55.3 c
T3= 0.25 % H	62.6 c	65.1 c	53.2 c	56.7 c
T4= 0.50 % A	63.7 c	66.2 c	54.2 c	58.2 c
T5= 0.50 % H	64.6 bc	67.2 bc	56.5 bc	60.4 bc
T6=T2+T3	72.1 ab	75.0 ab	60.7 ab	63.9 ab
T7=T4+T5	73.5 a	78.4 a	62.0 a	65.3 a

Means within a column followed by different letter (s) are statistically different at 5 % level.

Table (3):Effect of foliar spray of amino acids and soil applications of humic acid on fruit length, width, volume and firmness of 'Florida Prince' peach trees during the two seasons.

Treatments	Fruit length (cm)		Fruit width (cm)		Fruit volume (cm^3)		Fruit firmness ($lb/inch^2$)	
	First season	Second season	First Season	Second Season	First season	Second season	First Season	Second Season
T1= Control	4.26 c	4.32 b	4.19 c	4.25 b	45.2 d	45.0 d	7.05 a	7.16 a
T2= 0.25 % A	4.95 b	4.98 a	4.96 b	5.12 a	58.0 c	59.3 c	4.92 b	5.03 b
T3= 0.25 % H	5.10 ab	5.18 a	5.04 ab	5.23 a	61.8 bc	63.2 c	3.94 c	4.12 c
T4= 0.50 % A	5.05 ab	5.00 a	5.00 ab	5.15 a	60.0 c	63.5 c	4.37 bc	4.26 c
T5= 0.50 % H	5.07 ab	5.02 a	5.04 ab	5.25 a	63.2 bc	69.6 ab	3.95 c	4.12 c
T6=T2+T3	5.11 ab	5.04 a	5.17 a	5.28 a	65.7 ab	63.5 bc	3.90 c	4.04 c
T7=T4+T5	5.20 a	5.05 a	5.15 a	5.20 a	69.5 a	71.3 a	3.00 d	3.15 d

Means within a column followed by different letter (s) are statistically different at 5 % level.

Concerning the yield (kg/tree), the data in Table (1) proved that foliar spray of amino acid or soil application of humic acid alone at the low or high concentration (T2, T4 and T3, T5) increased fruit yield (kg/tree) over the control. The values recorded 54.1, 54.2, kg/tree and 53.2, 56.5 kg/tree in the first year and 55.3, 58.2 kg/tree and 58.2, 60.4 kg/tree, sequencelly. Where, the control recorded 43.3 and 44.0 kg/tree in the both seasons, respectively.

As for the effect of increasing amino acid in the spraying solution from 0.25 to 0.50 (T2, T4) no significant differences in the yield (kg/tree) were found. Similarly, soil application of humic acid at rate of 0.50 % (the high rate) which presented in T5 tended to increase yield (kg/tree) than those of the low concentration (T3) but the differences lacked significance in both seasons. However, spraying amino acid combined with soil application of humic acid (T6 and T7) tended to increase the yield (kg/tree) than the spraying amino acids or humic acid soil application individually. Especially, when amino acids spray combined with humic acid soil application at the high concentration (T7) which gave the highest yield (kg/tree) that recorded 62.0 and 65.3 kg/tree in both seasons, respectively compared with the control which gave 43.3 and 44.0 kg/tree in the first and second season, sequentially.

Fruit length (cm) and fruit width (cm) of 'Florida prince' peach trees during both seasons as shown in Table (3) were increased significantly by spraying amino acids concentrations and / or soil application of humic acid rates at the low and the high levels than the control. Generally, no significant differences were noticed in fruit length and fruit width among amino acid and humic acid treatments. Since, praying amino acids and or soil application of humic acid were gave similar values from the statistical stand point in the two seasons of this study. Fruit volume (cm^3) results in Table (3) indicated that spraying amino acid or humic acid soil application alone or in combination significantly increased fruit volume of 'Florida prince' in both season. Where, the volume of different treatments ranged between 58.0 to 69.5 cm^3 in the first season and ranged between 59.3 to 71.3 cm^3 in the second season compare with the control which recorded 45.2 and 45.0 cm^3 in the first and second seasons, respectively. However, a particular trend was detected due to the effect of the concentration used. In this respect, increasing amino acids in the spray solution from 0.25 to 0.50 % slightly increased fruit volume but the differences were not significant means, while increasing humic acid soil application from 0.25 to 0.50 % significantly increased fruit volume in the second season, where the effect was more pronounced in the second season. Similarly, combine application of the high amino acids and humic acid at the high concentration 0.50% + 0.50% (T7) was more effective on increasing fruit volume of peach than those of the low concentration 0.25 % + 0.25 % (T6).

Fruit firmness (lb./ $inch^2$) was decreased significantly in peach fruit sprayed with amino acid and or soil application of humic acid alone or in both than the control (Table 3). Fruit firmness reduces ranged between 7.05 to 7.16 Ib. /$inch^2$ in untreated trees (T1) to 3.00 to 3.15 Ib. /$inch^2$ in trees sprayed with 0.50 % of amino acids + 0.50 % soil application of humic acid (T7) in the first and second seasons, respectively. This means that spraying amino acid or soil application of humic acid alone or in combination at the high concentration tended to decrease fruit firmness than those of the lower ones.

Table (4) cleared the effect of spraying amino acids or soil application of humic acid individually or in combination on total soluble solids % (T.S.S), acidity %, T.S.S/acid ratio and total

anthocyanin in fresh fruit weight of Florida Prince peach trees.

Table (4): Effect of foliar spray of amino acids and soil applications of humic acid on fruit total soluble solids (T.S.S), acidity, TSS/acid ratio and total anthocyanins in fresh fruit weight of 'Florida Prince' peach trees during the two seasons.

Treatments	T.S.S (%)		Acidity (%)		T.S.S/acid ratio		Total anthocyanins (mg/100 g fresh fruit weight)	
	First season	Second season	First Season	Second Season	First season	Second season	First Season	Second Season
T1= Control	5.6 d	5.7 d	0.53 a	0.54 a	10.6 c	10.6 c	3.06 d	3.13 d
T2= 0.25 % A	7.7 bc	8.0 bc	0.49 b	0.50 b	15.7 b	16.0 b	4.00 bc	4.14 bc
T3= 0.25 % H	8.2 ab	8.5 ab	0.45 c	0.45 c	18.2 b	18.9 b	4.25 ab	4.25 bc
T4= 0.50 % A	7.1 c	7.5 c	0.48 b	0.49 b	14.8 b	15.3 b	3.75 c	4.03 c
T5= 0.50 % H	8.3 ab	8.4 ab	0.49 b	0.48 b	16.9 b	17.5 b	4.40 ab	4.00 c
T6=T2+T3	8.0 ab	8.0 ab	0.31 e	0.33 e	25.8 a	24.2 a	4.63 a	4.56 a
T7=T4+T5	8.8 a	8.9 a	0.39 d	0.40 d	22.6 a	22.3 a	4.70 a	4.65 a

Means within a column followed by different letter (s) are statistically different at 5 % level.

Concerning T.S.S %, all treatments (T2-T7) significantly increased T.S.S in comparison with the control (T1) during the two seasons. The T.S.S. values for treatments ranged from 7.1 to 8.8 % in the first season and from 7.5 to 8.9 % in the second season compare with the control that recorded 5.6 and 5.7% in the both seasons. During the two seasons of study, there was slightly increasing in the value of T.S.S related with the increasing of amino acids in the spray solution and the rate of soil application of humic acid, but this increment was no significant. In this regard, the highest value of T.S.S % was achieved by spraying amino acid in combination with soil application of humic acid at high concentration (T7) which had 8.8 and 8.9 % in the two years. However, T7 was not significant with spraying amino acid in combination with soil application of humic acid at low concentration (T6) as well as soil application of humic acid treatments at low and high concentrations (T3, T5).

Concerning the fruit acidity %, the treatments (T2-T7) effected significantly on decreasing the acidity % (ranged from 0.31 to 0.49 % in 1st season and from 0.33 to 0.50 % in 2nd season) than the control (T1) which achieved the highest acidity % (0.53 and 0.54 %) during the two seasons. In addition, the treatments varied significantly in decreasing the acidity%. The combination between spraying amino acid and soil application of humic acid at low or high concentration had a positive effect on decreasing acidity % in both seasons. In this respect, spraying amino acids with soil application of humic acid at low rate (T6) followed by the high rate (T7) had the lowest acidity % (0.31 and 0.39 % in 1st season and 0.33 to .040 % in 2nd season, respectively) between other treatments which came in the third and fourth orders. Furthermore, there was significant difference in decreasing acidity % when raised the rate of soil application of humic acid from low (T3) to high (T5) concentration, since T3 recorded 0.45 % in both seasons, while T5 recorded 0.49 and 0.48 % in the two studied years. In opposite, this trend was not found when increasing amino acids in spray solution from 0.25 to 0.50 % in both seasons.

As for TSS/acid ratio which considered as maturity index, all treatments impacted significantly on T.S.S/acid ratio (ranged from 14.8 and 25.8 in 1st season and from 15.3 to 24.2 % in 2nd season) in comparison with the control (10.6 in both years). In this trend, the combination between spraying amino acids with soil application of soil acid at low and high levels (T6 and T7) had the greatest T.S.S/acid ratio which was 25.8 and 22.6 in 1st year and 24.2 and 22.3 in 2nd year, respectively) followed by the other treatments which came in the second order. This means the combined application at low or high rates for both amino acids and humic acid accelerated the maturity compare with the individual application.

Regarding to the total anthocyanins in fresh fruit weight, it was increased significantly by treatments T2-T7 (ranged from 3.75 to 4.70 mg/100 gm fresh weight in 1st year and from 4.00 to 4.65 mg/100 gm fresh weight in 2nd year) compared with the control (T1) which had 3.06 and 3.13 mg/100 gm fresh weight in both seasons, sequentially. The same trend was found, since the combination between spraying amino acids with soil application of soil acid at low and high rates (T6 and T7) gave the highest content of total anthocyanin which was 4.63 and 4.70 mg/100 gm fresh weight in 1st season and 4.56 and 4.65 in 2nd season, respectively). In contrast,

the increasing rate of amino acids in spray solution or humic acid soil application had the same significant effect of low doses in both seasons.

Table (5) presented the effect of spraying amino acids and soil application of humic acid at low or high concentrations alone or in combination on leaf mineral content of 'Florida prince' peach trees during two seasons. The treatments influenced significantly on NPK leaf content than the control in both seasons. Regarding to leaf N content, the results showed that the treatments (T2-T7) gave higher content (ranged from 2.40 to 2.78 % in 1st year and from 2.43 to 2.85 % in 2nd year) than T1 (the control) which had the lowest N content and recorded 1.80 and 1.85 % in both seasons. Meanwhile, there were significant differences among the treatments (T2-T7). In this respect, T7 had the highest content of N (2.78 and 2.85 %) during the two studied seasons. However, there were no significant differences among T7 and T3, T4, T6 which recorded 2.53, 2.51 and 2.65 % in 1st season and 2.60, 2.55 and 2.80% in 2nd season, respectively. While, T2 and T5 came in the second order and recorded 2.42 and 2.40 % in 1st year as well as 2.47 and 2.43 % in 2nd year, respectively. Generally, spraying amino acids combined with soil application of humic acid at high concentration (T7) was outstanding treatment that maximized N content.

Concerning leaf P content (%), the treatments (T2-T7) recorded higher leaf P content than the control (T1) which recorded the lowest value (0.23 and 0.25 % in both years). T7 achieved the highest content of P (0.46 and 0.45 %) followed by T6 (0.42 and 0.44%) during the two seasons. However, there was no significant deference between T6 and T7 in the second season. Other treatments (T2 –T5) occupied the third order which had 0.34, 0.36, 0.35 and 0.36 % in 1st year and 0.35, 0.38, 0.37 and 0.38 % in 2nd year, respectively. Therefore, the combination effect of both amino acids as foliar application and soil addition of humic acid at low and high concentration (T6, T7) was the best treatment gave a high content of P, specially T7 which is prefer to use because its constant effect during the two studied seasons.

Regarding leaf K content, it was increased by all treatments (T2-T7) than the control (T1) which was the lowest content (1.13 and 1.18 %) during the two seasons of this study. The combination effect of spraying amino acid and soil application of humic acid at high concentration (T7) had the highest content of K and recorded 1.57 and 1.62 % in both seasons. Followed by T5 and T6 which recorded 1.44 and 1.48 in 1st season and 1.50 and 1.52 % in 2nd season. While, T3 and T4 came in the third order in the K content (1.33, 1.37 and 1.44 % in 1st year and 1.35, 1.40, 1.50 % in 2nd year, respectively. Then came T2 in the fourth order and recorded 1.25 and 1.31 % in the both years. In general, the combined effect of high doses of amino acid and humic acid application (T7) had a positive influence on improving NPK content among all treatments.

Data in Table (6) explained the effect of spraying amino acids and soil application of humic acid at low or high concentration alone or in combination on leaf content of chlorophyll (a) & (b) & (a+b) of Florida Prince peach trees during the two seasons. All treatments (T2-T7) improved chlorophyll (a) & (b) & (a+b) compared with the control (T1) which recorded the lowest content (41.2 and 43.4 mg/100 g FW) of chlorophyll (a+b) in the two years. In this respect, there was a clear variation among treatments with the same trend for improving the chlorophyll (a) & (b) & (a+b).

Table (5): Effect of foliar spray of amino acids and soil applications of humic acid on leaf mineral content 'NPK' of 'Florida Prince' peach trees during the two seasons.

Treatments	N (%)		P (%)		K (%)	
	First season	Second season	First Season	Second Season	First season	Second season
T1= Control	1.80 c	1.85 c	0.23 d	0.25 c	1.13 e	1.18 e
T2= 0.25 % A	2.42 b	2.47 b	0.34 c	0.35 b	1.25 d	1.31 d
T3= 0.25 % H	2.53 ab	2.60 ab	0.36 c	0.38 b	1.33 c	1.35 cd
T4= 0.50 % A	2.51 ab	2.55 ab	0.35 c	0.37 b	1.37 c	1.40 c
T5= 0.50 % H	2.40 b	2.43 b	0.36 c	0.38 b	1.44 b	1.50 b
T6=T2+T3	2.65 ab	2.80 a	0.42 b	0.44 a	1.48 b	1.52 b
T7=T4+T5	2.78 a	2.85 a	0.46 a	0.45 a	1.57 a	1.62 a

Means within a column followed by different letter (s) are statistically different at 5 % level.

Table (6): Effect of foliar spray of amino acids and soil applications of humic acid on leaf content of chlorophyll (a) & (b) & (a+b) of 'Florida Prince' peach trees during the two seasons.

Treatments	Chlorophyll (a) (mg/100 g FW)		Chlorophyll (b) (mg/100 g FW)		Chlorophyll (a+b) (mg/100 g FW)	
	First season	Second season	First Season	Second Season	First season	Second season
T1= Control	22.7 d	25.0 c	18.5 d	18.4 d	41.2 c	43.4 c
T2= 0.25 % A	29.9 c	32.2 b	25.7 c	25.5 c	55.6 b	57.7 b
T3= 0.25 % H	31.3 b	33.5 ab	27.1 c	27.0 c	58.4 b	60.5 b
T4= 0.50 % A	31.8 b	33.0 ab	26.3 c	26.2 c	58.1 b	59.2 b
T5= 0.50 % H	31.8 b	32.6 b	28.0 c	28.1 c	59.8 b	60.7 b
T6=T2+T3	33.9 a	35.5 a	31.7 b	31.8 b	65.6 a	67.3 a
T7=T4+T5	34.8 a	36.0 a	34.4 a	34.5 a	69.2 a	70.5 a

Means within a column followed by different letter (s) are statistically different at 5 % level

In this regard, T7 achieved the highest leaf content of chlorophyll (a) & (b) & (a+b) which was 69.2 and 70.5 mg/100 g FW for the chlorophyll (a+b) in the two seasons of this study, however, T6 gave similar results except its effect on chlorophyll (b) which was less than T7 and recorded 65.6 and 67.3 mg/100 g FW for the chlorophyll (a+b) in both seasons. The results of the two years pointed out that the other treatments (T2-T5) came in the third arrangement for its impact on improving chlorophyll (a) & (b) & (a+b) which ranged from 55.6 to 59.8 mg/100 g FW for the chlorophyll (a+b) in 1st season and ranged from 57.7 to 60.7 mg/100 g FW for the chlorophyll (a+b) in 2nd season. This means that there was a clear effect for T7 on improving the leaf mineral content of NPK and chlorophyll (a+b).

DISCUSSION

The obtained results cleared the beneficial effect of spraying amino acids and humic acid soil application alone or in combination at low or high concentration on increasing the uptake of different nutrients and availability of soil nutrients particularly in calcareous soil, especially when applied amino acids spray and humic acid soil application at high rate 0.50 + 0.50% (T7). This explains the improving nutrient status (NPK mineral content) and growth (chlorophyll a+b) of 'Florida prince' peach trees that reflected on increasing the yield (Kg/tree) and improving fruit quality (fruit physical and chemical properties).

These explanations are confirmed by many researchers (Russo and Berlyn, 1990, Fayed, 2005, Ismail et al., 2007, Stino et al., 2010, Brackmann et al., 2010, Thomas et al., 2010, Abd El-Razek and Saleh, 2012, Abd El-Razek et al., 2012, Haggag et.al., 2015). The Using of amino acids foliar spray alone or combined with other stimulation's compounds enhanced the leaf macro elements content (NPK) than the untreated ones and it was observed on 'Florida prince' and 'Desert Red' peaches (Fayed, 2005, El-Sheikh et al., 2007), on 'Canino' apricot trees (Eissa et al., 2003, Shaddad et al., 2005, Fathy et al., 2010), and on 'Flame seedless' grapes (Kassem and Marzouk, 2002). In addition, the results are in parallel with those found when N fertilizer was replacement by using humic acid and algae biofertilizer on 'Florida Prince' peach (El-Khawaga, 2011).

Furthermore, the increment in chlorophyll contents might be due to availability of high levels of amino acids to the treated trees. Similar results were observed when some foliar treatments of bio-stimulants were applied and resulted in increase of the chlorophyll contents in ‘Fuji’ apple leaves with a consequent increase in the photosynthesis and respiration rates (Spinelli et al., 2009)

As for fruit parameters, amino acids spray or humic acid soil application increased studied parameters over the control. However, increasing amino acids in the spraying solution or humic acid soil application didn't show significant differences in all. Generally, result showed that a slight and not significant trend was detected in studied parameters due to increasing amino acids spray or humic acid soil application on 'Florida prince' peach trees, except their effect on fruit chemical properties (T.S.S. and acidity). Since, amino acids spray at high concentration (0.50%) or

humic acid soil application at high rate (0.50%) increased T.S.S. and decreased acidity. In addition, spraying amino acids + humic acid soil application at low or high rate (T6 and T7) had a synergistic positive effect on all studied parameters comparing with application of amino acids or humic acid only, except their impact on fruit firmness which tended to decrease significantly due to apply the high concentration (spray mino acids 0.50% + soil application of humic acid 0.50% which presented in T7).

Regarding the yield, the increment in the yield could be attributed to increase the fruit weight which was higher by the treatments (T2-T7) than the control (T1) during the two seasons of this study. Where, increase physical fruit properties (fruit length, width and volume) explain the increment in the fruit weight that was reflected on increasing the yield (kg/tree) and improving the fruit quality.

In this respect, many researches confirmed the same trend of the results when applied foliar spray of amino acid or soil application of humic acid individually. Since, each treatment alone enhanced the yield and fruit quality of 'Florida prince' peach trees and achieved heavier fruit weight and higher yield than the control (Stino et al., 2010, El- Khawaga, 2011, Abd El-Razek and Saleh 2012, Abd El-Razek et al., 2012). Also, they were conducted individually or in combination on the other fruit trees and had a positive effect on improving the productivity and fruit attributes of 'Red Roomy', 'Red Globe' and 'Perlette', grapes (Ahmed et al., 2003, Sabry et al., 2009, Khan et al., 2012), Williams pears (Lihami et al., 1999), Kensington Pride mango trees (Aman and Zora, 2006), 'Desert Red' peach and 'Anna' apple trees (Fathi et al., 2002), 'Manfalouty' pomegranate trees (Khattab et al., 2012), 'Canino' apricot trees (Eissa et al. 2003, Shaddad et al., 2005, Fathy et al., 2010), 'Superior seedless' and 'Roomy Ahmar' grapevines (Omar and Abdelall, 2005, Abbas et al., 2006), 'Le Conte' pear trees (Ismail et al., 2007, Kabeel et al., 2008), and 'Grandnain' banana plants (El-Shenawi et al., 2008), since they confirmed that increasing amino acids spray concentration or humic acid does markedly increased the yield and fruit quality especially when they applied together.

Meanwhile, fruit firmness is considered a good guide for fruit maturity. In this respect, the acceleration of fruit maturation is marketing's benefit for early cultivars such as 'Florida prince' peach. Therefore, the use of spraying amino acids + soil application of humic acid at high rate (T7) is consider a good practice for early marketing of 'Florida prince' peach due to their acceleration of fruit maturity that provide the markets with the fruits earlier than the untreated one. Therefore, T7 produced early fruits with high yield among all treatments (T2-T6).This result in agreement with those of Ola (2001) when estimated the maturity and beginning of ripping and extending shipment time of peach cultivars as well as Shaltout (1987) when described the 'Florida prince' peach as a promising cultivar and expected its very early appearance in the Egyptian markets when use special treatments that accelerate fruit maturity. In addition, the increase in T.S.S and T.S.S. / acid ratio and the decreased in acidity by treatments (T2-T7) may be related with enzymes which are presented when the amino acids and the active uptake of minerals by humic acid enhanced the synthesis of different proteins and sugars (Davies, 1982).

CONCLUSION

Spraying amino acids or soil application of humic acid individually or in combination at low (0.25%) or high concentration (0.50%) had a positive effect on productivity and fruit quality, leaf mineral content and chlorophyll contents when applied after fruit set and repeated four times at 15 days intervals. The application of amino acids as foliar spray combined with soil application of humic acid at high concentration for both (0.50% + 0.50 %) is the promising treatment for improving growth, fruit characteristics and maximized the yield of 'Florida Prince' peach.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

This work was carried out in collaboration between all authors. Author EA designed the study, managed the literature searches, applied the field works, collected samples and measured its physical measurements, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author LFH

consulted the study design, statistical analysis, literature searches, protocol, treatments and analyses of this study. Author MMMA consulted the study design, treatments, and participated in writing the first draft. Author ESE conducted the field works in the experimental design, collected the field samples, prepared the samples for analysis and managed the analyses of the study. All authors read and approved the final version.

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