ORGANİKSA

STRAWBERRY

Test Field Experiment about Humic Acid Effects on Nutrient Uptake and Physiological Characterictics of Fragaria ananassa var: Camarosa

腐植酸對草莓養分吸收和生理特徵的影響

ABSTRACT

The investigation was carried out for evaluation effects of humic acid fertilizer on nutrient uptake (N, P, and K) and physiological characteristics of *Fragaria ananassa* var: Camarosa. Experiment treatments included different concentration of humic acid (0, 10, 20, 30 and 40 ppm) with two methods of application (fertigation and spray). Result of experiment showed that there is highest amount of N in fertigation in concentration of 20 ppm and there are highest of Phosphorus, potassium and amount of assimilation in concentration of 10 ppm. In spray method there are highest amount of N and chlorophyll in concentrations of 10 and 20 ppm and there is potassium in concentration of 10 ppm.

本試驗建議可澆灌使用低濃度的腐植酸作為活化植物葉片營養吸收及生長的肥料。
本試驗測試腐植酸肥料對草莓養分吸收（N，P，K）和生理特性的影響。 實驗處理包括不同濃度的腐植酸（0,10,20,30和40ppm）和兩種施用方法（澆灌和葉面噴霧）。 試驗結果顯示，以20ppm澆灌處理組對N吸收最高，10ppm澆灌處理對磷，鉀的同化量最高。 而在葉面噴霧組，使用10ppm及20ppm葉面噴霧的植株N和葉綠素含量最高，以10 ppm葉面噴霧時鉀含量最高。

www.organiksa.com.tr

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

- **Antalya Gazi Paşa Region (2010) (Strawberry) field test about the Effect of Humic Acid on Nutrient Uptake and Physiological Characteristic of Fragaria ananassa var: Camarosa**

INTRODUCTION

The **garden strawberry** (or simply **strawberry**; ***Fragaria* × *ananassa***) is a widely grown hybrid species of the genus Fragaria (collectively known as the strawberries). It is cultivated worldwide for its fruit. The fruit (which is not a botanical berry, but an aggregate accessory fruit) is widely appreciated for its characteristic aroma, bright red color, juicy texture, and sweetness. It is consumed in large quantities, either fresh or in such prepared foods as preserves, fruit juice, pies, ice creams, milkshakes, and chocolates. Artificial strawberry flavorings and aromas are also widely used in many products like lip gloss, candy, hand sanitizers, perfume, and many others.In terms of exports turkey becomes in third place after USA and Mexica. In past ten years turkey increased its productivity from 1590 Kg/Decar to 2802 Kg/Decar in this progress Humic Acid applications and benefits has been appriciated by our customers.The aim of this study was, therefore, to determine the effect humic acid fertilizer on nutrient uptake (N, P, and K) and physiological characteristic of *Fragaria ananassa*.

MATERIALS AND METHODS

The investigation was conducted in 6 Oct. 2010 to 13 Jan. 2010 at the experimental greenhouse of Antalya Gazi Paşa region.The experiment was arranged in factorial experiment based on randomized complete design with three replications. The treatments of experiment included concentrations of humic acid (0, 10, 20, 30, 40 ppm) with two application methods of spray and fertigation. Daily temperature was 22℃ and nightly temperature was 17℃. Fertigation was begun two week after the planting and repeated each 14 day interval. In Foliar application, the first spray started at the beginning of flowering and later at 14 days interval. No other fertilizer was used during plant growth. Total nitrogen of the sample was determined by Kjeldahl method (Kacar 1972). For determination of P and K contents of leaf, plant samples were air-dried and were then ground. K was determined after dry digestion of dry and sub-samples in a HCL preparation, P was measured spectrophotometrically by reaction with ascorbic acid. Potassium was determined by flame photometry. Also chlorophyll, assimilation, evapotranspiration and gas exchanges were measured. Leaf chlorophyll content was measured by a portable chlorophyll meter, SPAD-502 (Minolta Corporation, Ramsey, NJ). Assimilation, evapotranspiration and gas exchanges were measured by LCi portable photosynthesis meter. Data were analyzed using SAS 9 and means were compared by LSD test at 5% level of confidence.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

FIELD AREA:

The field area selected for the experiment is The above mentioned doses were applied at situated in Antalya Gazipaşa region .

CLIMATE OF ANTALYA:

The area is shielded from the northerly winds by the Taurus Mountains. Antalya has a hot-summer Mediterranean climate (Köppen: Csa) with hot and dry summers and mild and rainy winters. Around 300 days of the year are sunny, with nearly 3,000 hours of sunlight per year. The mean sea temperature ranges between 16 °C (61 °F) in winter and 27 °C (81 °F) in summer.[21] The highest record air temperature reached 45 °C (113 °F) in July which normally averages as high as 34.4 °C (93.9 °F) and the lowest record dropped to −4 °C (25 °F) in February, when the low average is as low as 6.1 °C (43 °F).

RESULTS AND DISCUSSIONS

Analysis of variance showed type of fertilization was effective on all of traits except chlorophyll. (Table 1). Humic acid fertigation application was effective on assimilation, leaf uptake of N and P. foliar application of humic acid was effective on evapotranspiration, gas exchanges and leaf uptake of K. (Table 2). Used concentrations were significant in all of traits except evapotranspiration. ($P< 0.01$) (Table 1). Application humic acid was no effective in assimilation, evapotranspiration, gas exchanges. 20 ppm humic acid had the highest of chlorophyll content. The highest of leaf uptake of N was observed in 10 and 20 ppm and the lowest of leaf uptake of N was in 40 ppm. There are this probably which high concentration is inhibiter agent in leaf uptake of N. the highest of leaf uptake of P and K were related to 10 ppm. (Table 3). Interaction of type of humic acid application and their concentration were effective in all of traits except chlorophyll and gas exchanges. ($P< 0.01$). (Table 4). The highest of assimilation and leaf uptake of P were related to fertigation of humic acid in concentration 10 ppm. There are the highest of percentage N in 20 ppm of fertigation and 10 ppm of foliar application. The highest of percentage of K in leaf was observed in 10 ppm of foliar application. Studies were carried out about effect of humic acid on strawberry characteristics which offered using of low concentration of humic acid. (Pilanal and Kaplan 2003) It has been demonstrated that plant growth can be stimulated by very low concentrations of humic substances (Cacco and Dell'Agnolla 1984).which is in agreement with this investigation, so that in this investigation high concentration was negative effect on traits under study. Fagbenro and Agboola (1993) reported: with addition humic acid to soil, nutrient uptake including N, P, K, Mg ,Ca, Zn, Fe and Cu increased which is in agreement with results of this experiment and low concentration had high leaf uptake. Humic substances (HS) have positive effects on plant physiology (Turkmen *et al*., 2004) so that concentration of 20 ppm acid humic was effective on increasing of chlorophyll content. There are two major peaks in June-bearing strawberries which these are in fall and spring. After the beginning of

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

fruit maturation in late spring, nitrogen moves directly from leaves to fruit and its soil uptake was limited. (Neri *et al*., 2002). In during flowering and fruiting which soil uptake is low, importance foliar application is clear. In this experiment leaf uptake of K in foliar application was higher than fertigation but leaf uptake of N and P were lower than spray which it related to time of measurement which was carried out in postharvest of fruits. In conclusion was better measurement was done in during different periods and also for using humic acid in strawberry should use from low concentration.

TREATMENTS:

Table 1. Analysis of variance of the traits under study.

S.V	DF	M.S						
		Assimilation (μmol/m^2.s)	evapotranspiration (mmol/m^2.s)	gas exchange (mol/m^2.s)	chlorophyll	%N	%P	% K
F	1	5.36**	0.077**	0.0017*	1.24 ns	0.010*	0.0136**	0.57**
C	4	7.20**	0.029 ns	0.0015**	16.87**	0.17**	0.0079**	3.38**
F × C	4	3.64**	0.051**	0.00028 ns	2.24 ns	0.014**	0.0205**	0.129**
Error	20	0.095	0.0027	0.0003	1.026	0.002	0.00066	0.014

NS, *,** Nonsignificant or significant at $P = 0.05$ or 0.01, respectively.
F= Type of fertilization, C= concentration of humic acid, F × C= fertilization × concentration.

Table 2. Effect of type of fertilization on physiological characteristics and leaf nutrient uptake of strawberry cv. Camarosa.

Treatment	Assimilation (μmol/m^2.s)	evapotranspiration (mmol/m^2.s)	gas exchanges (mol/m^2.s)	chlorophyll	%N	%P	% K
Fertigation	2.86 a	0.16 b	0.05 b	44.36 a	0.73 a	0.30 a	2.41 b
Spray	2.02 b	0.26 a	0.06 a	43.96 a	0.69 b	0.26 b	2.69 a

Different letters indicate significant difference between treatments at 5% levels.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Table 3. Effect of concentration of humic acid on physiological characteristics and leaf nutrient uptake of strawberry cv. Camarosa.

Treatment	Assimilation (µmol/m^2.s)	evapotranspiration (mmol/m^2.s)	gas exchange (mol/m^2.s)	chlorophyll	%N	%P	% K
0 ppm Humic acid	4.03 a	0.22 ab	0.06 ab	42.96 c	0.58c	0.27bc	2.18 c
10 ppm Humic acid	2.90 b	0.26 a	0.07 a	44.86 b	0.86a	0.34a	3.85 a
20 ppm Humic acid	2.41 c	0.19 b	0.06 ab	46.26 a	0.88a	0.24 c	2.54 b
30 ppm Humic acid	1.60 d	0.23 ab	0.036 c	44.70 b	0.72b	0.28 b	1.99 d
40 ppm Humic acid	1.27 d	0.17 b	0.04 bc	42.01 c	0.49d	0.29b	2.20 c

Different letters indicate significant difference between treatments at 5% levels.

Table 4. Effect of concentration of humic acid and type fertilization on physiological characteristics and leaf nutrient uptake of strawberry cv. Camarosa.

Treatment						
Fertilization	Concentration Of Humic acid (ppm)	Assimilation (µmol/m^2.s)	evapotranspiration (mmol/m^2.s)	%N	%P	%K
Fertigation	0	4.03 b	0.22 b	0.58 e	0.27 b	2.18 d
	10	4.68 a	0.25 b	0.81 bc	0.46 a	3.51 b
	20	2.82 c	0.12 c	0.90 a	0.21 c	2.5 c
	30	1.58 de	0.12 c	0.77 c	0.28 b	1.74 e
	40	1.22 e	0.11 c	0.57 e	0.29 b	2.14 d
Foliar application	0	4.03 b	0.22 b	0.58 e	0.27 b	2.18 d
	10	1.12 e	0.27 ab	0.91 a	0.22 c	4.18 a
	20	2.01 d	0.26 ab	0.86 ab	0.27 b	2.58 c
	30	1.62 de	0.34 a	0.68 d	0.28 b	2.25 d
	40	1.32 e	0.23 b	0.41 f	0.28 b	2.26 d

Different letters indicate significant difference between treatments at 5% levels.

CONCLUSIONS:

Using of humic acid is proposed as fertilizer of activator nutrition uptake of leaf and growth if was used in low concentration.

本試驗建議可澆灌使用低濃度的腐植酸作為活化植物葉片營養吸收及生長的肥料。

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Tarım Mad. Nak. San. ve Tic. A.Ş.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

ORGANİKSA

APPLE

The Effect of the Foliar Application of Potassium, Calcium, Boron and Humic Acid on Vegetative Growth, Fruit Set, Leaf Mineral, Yield and Fruit Quality of Apple Trees

葉面噴施鉀，鈣，硼，腐植酸對蘋果樹營養生長，果實，葉片礦物質，產量及果實品質的影響

ABSTRACT

This experiment was carried out during 2012 and 2013 seasons on seven years old apple trees. Trees were planted at 5.5 meters on sandy loam soil under drip irrigation system in a private orchard at Isparta, Turkey. The experiment involved ten foliage spraying treatments as follows: control, sprayed with water, K at 2% as potassium sulphate, Ca at 0.2% as calcium chloride, B at 0.2% as boric acid, H.A. at 5% as humic acid, potassium sulphate+ humic acid, calcium chloride+ humic acid, boric acid+ humic acid, potassium sulphate+ calcium chloride+ boric acid and potassium sulphate+ calcium chloride+ boric acid+ humic acid. The obtained results showed that potassium sulphate+ calcium chloride+ boric acid+ humic acid combination was the best treatment. This combination had the highest positive effect to improve the percentages of yield, fruit set, reducing sugar and total soluble solids. Also, it increased Ca, P, K, N, B, Zn, Mn and Fe in the leaves in the two seasons, as compared to the control. Moreover, this combination improved significantly anthocyanin concentration, TSS/acid ratio, shoot diameter, shoot length, leaf area, fruit diameter, fruit length, average fruit weight and fruit firmness. It decreased the percentages of fruit drop and acidity in the two seasons as compared to the control and the other treatments.

本試驗於2012及2013年間進行，試驗農場位在土耳其伊斯帕爾塔，採用滴灌系統，在5.5米的沙壤土上種植蘋果已七年。試驗共分為十種葉面施肥組如下：對照組，噴灑水，2% K（硫酸鉀），0.2% Ca（氯化鈣），0.2% B（硼酸），5% H.A.（腐植酸），硫酸鉀+腐植酸，氯化鈣+腐植酸，硼酸+腐植酸，硫酸鉀+氯化鈣+硼酸以及硫酸鉀+氯化鈣+硼酸+腐植酸5%。試驗結果顯示，硫酸鉀+氯化鈣+硼酸+腐植酸組合處理效果最好。這種組合對提高產量，結果率，還原糖和總可溶性固形物的百分比具有最高的正面效果。與對照相比，兩年的結果季節葉片中的Ca，P，K，N，B，Zn，Mn和Fe也增加。此外，該組合顯著改善了花青素濃度，TSS /酸比例，枝條直徑，枝條長度，葉面積，果實直徑，果實長度，平均果重和果實硬度。與對照和其他處理相比，本組合降低了兩年結果季節的落果率和酸度。

- **Isparta Region (2012-2013) Apple field test about The Effect of the Foliar Application of Potassium, Calcium, Boron and Humic Acid on Vegetative Growth, Fruit Set, Leaf Mineral, Yield and Fruit Quality of Starking Apple Trees**

INTRODUCTION

The **apple tree** (Malus pumila, commonly and erroneously called Malus domestica) is a deciduous tree in the rose family best known for its sweet, pomaceous fruit, the apple. It is cultivated worldwide as a fruit tree, and is the most widely grown species in the genus Malus. Turkey becomes in third place in terms of world wide apple exports after China, USA.Turkey had produced 3.1 million tons of apple in 2013. Most of the apple production in turkey comes from Isparta region (%24 percent of total production). Turkey mostly produces Starking, Golden,Amasya and Grannysmith type of apples. İn this experiment we examined starking type of apple trees.The purpose of this study was investigate the effect of foliar application of either humic acid, potassium, calcium or boron as well as their combinations on vegetative growth, fruit set, leaf mineral, yield and fruit quality of 'Starking' apple trees.

MATERIALS AND METHODS

This experiment was carried out during the two successive seasons, 2012 and 2013 on seven years old "Starking" apple trees, planted at 5x5 meters apart in a clay loam soil under drip irrigation system in a private orchard.Forty uniform trees were selected for this study and all of them were subjected to the same cultural practices in the two seasons. They were sprayed three times, before flowering, 10 days after full bloom and one month later after adding misrol liquid soap (1 ml/l) as a wetting agentin the two seasons with the following treatments:

T1: Control (sprayed with water)
T2: K at (2%) as potassium sulphate
T3: Ca at (0.2%) as calcium chloride
T4: B at (0.2%) as boric acid
T5: H.A.(humic acid 5%) T6: K + H.A
T7: Ca + H.A. T8: B + H.A. T9: K + Ca + B
T10: K + Ca + B + H.A.

The trees were treated with Black Diamond 10-10-10 a fertilizer whose NPK ratio is 10-10-10 and humic acid Black Diamond Humic Acid of 12% The previous treatments were applied and arranged in a randomized complete block design. Each treatment included four replicates with one tree for each replicate. The effect of the previous treatments was studied by evaluating their influence on the following parameters.

1.1 Vegetative Parameters

At the end of growing seasons, the selected shoots were measured for the average of shoot length cm, shoot diameter cm and leaf area cm2.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

1.2 Fruit Set and Fruit Drop Percentage

Two main branches from two direction (east and west) of each tree were chosen and tagged in March of the two experimental seasons, the number of flowers was recorded and those set fruits on the selected branches were counted for calculating the percentage of fruit set according to Westwood [12] equation:

Fruit Set% = [(Number of set Fruitlets)/(Numbers of Opened flowers)]x100

Pre-harvest fruit drop was calculated by counting the number of dropping fruit from the 4th week of May till the commercial harvesting time under the experimental conditions (3rd week in June),then expressed as a percent from the whole number of fruits existed on the tree at the 4th week of May.

Fruit Drop% = [(Number dropped Fruitlets)/(Numbers of set Fruitlets)]x100

1.3 Yield per Tree

Yield was pressed in weight kg and number of fruits per tree was recorded at harvest time (3rd week of June).

1.4 Leaf Chemical Composition

Samples of twenty leaves from the middle part of the shoots according to [13] were randomly selected from each replicate (at the 2nd week of June) to determined their content from N%, P %, K %, Ca% and Fe, Zn, Mn and B at ppm.

Leaf samples were washed with tap water, then with distilled water and dried at 70ºC until a constant weight, finally, ground and acid digested using H2SO4 and H2O2 until clear solution was obtained according to Wilde et al.

The digested solution was used for the determination of each of nitrogen (N) using micro Kjeldhal method, phosphorus (P) by vanadomolybdo method and potassium (K) was determined by flame photometer. Zinc, manganese, calcium and iron were determined on atomic absorption spectrophotometer. The B in leaf samples was determined by dry ashing , and subsequent measurement of B was done through colorimetry Azomethine-H.

1.5 Fruit Quality

Twenty fruits were randomly taken at harvest time from each replicate for the determination of both physical and chemical characteristics.

1.6 Fruit Physical Characteristics

Fruit weight (g), fruit length (cm), fruit diameter (cm) and L/D ratio, fruit firmness (Ib/ inch2) using a Magness and Taylor pressure tester with 7/18 inch plunger.

1.7 Fruit Chemical Characteristics

Total soluble solids were determined using a hand refractometer, percentage of titra table acidity in fruit juice was determined according to [18], total soluble solid / total acidity ratio were calculated.Total sugars, reducing and non-reducing sugars were estimated According to [19]. Anthocyanin was determined at the stage of coloration (mg/100 g fresh weight peel) according to Rabino et al.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

1.8 Statistical Analysis

The obtained data were subjected to the proper analysis of variance (ANOVA) [21]. Least significant difference (LSD) at 0.05% level of significance was used to compare the treatment means.

FIELD AREA:

The field area selected for the experiment is The above mentioned doses were applied at situated in Isparta.

CLIMATE OF ISPARTA:

Isparta has a climate type between Mediterranean (Köppen climate classification: Csa) and Central Anatolia's typical climate type (Köppen climate classification: Dsa). Winters are cool and rainy, summers are hot and dry. The lakes around the city have important influence on the climate. Rainfall occurs mostly in January and December in a year. Monthly rainy days reduce until August. Rainy days increase again with September.

RESULTS AND DISCUSSIONS

Data in Table 1, clearly showed that shoot diameter, shoot length and leaf area were increased significantly over the control by the foliar application of potassium sulphate alone or combined with humic acid, humic acid alone, potassium sulphate + calcium chloride + boric acid combination. Moreover, they also improved by usage, potassium sulphate + calcium chloride + boric acid + humic acid, calcium chloride + humic acid and boric acid + humic acid combinations as compared to the control in both study seasons. Boric acid improved significantly leaf area, but it did not have any significant effect on shoot length or shoot diameter. Also, the usage of calcium chloride alone did not have any significant effect on shoot length, shoot diameter or leaf area, in both seasons as compared to the control.

Results in Table 2, showed that the foliar application of potassium sulphate alone and humic acid alone or in combination with each other gave great increases in the yield, fruit set percentages, average fruit weight and decreased the percentages of fruit drop. The similar results were obtained by the usage of boric acid alone or combined with humic acid. Furthermore, calcium chloride + humic acid, potassium sulphate + calcium chloride + boric acid or potassium sulphate + calcium chloride + boric acid + humic acid combinations increased significantly the yield, fruit set percentages, average fruit weight and decreased the fruit drop percentages with comparing to the control. On the opposite side, the combination between potassium sulphate and humic acid gave non- significant increase in average fruit weight as compared to the control. The usage of calcium chloride did not have any remarkable effect on fruit set, yield, average fruit weight or/and fruit drop as compared to the control treatment in the two seasons.

From the results in Table 3, it can be concluded that potassium sulphate + calcium chloride + boric acid + humic acid combination gave a remarkable increase in the percentages of Ca, P,

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

K and N in the leaves as compared to the control treatment. The usage of potassium sulphate alone or combined with humic acid enhanced significantly the percentages of K and N, but it did not have any significant effect on P and Ca percentages as compared to the control. Potassium sulphate and humic acid combination improved the percentages of P, but it did not have any remarkable effect on the percentages of Ca. The usage of calcium chloride had a positive effect to increase the percentages of calcium, but it did not have any great effect on N, P and K percentages in the leaves. Calcium chloride and humic acid combination improved remarkably N, P and K percentages in the leaves but it did not affect significantly Ca percentages as compared to the control. Boric acid had no significant effect on N, P, K and Ca percentages. The combination between humic and boric acid increased significantly P and Ca percentages, but it had insignificant effect on the percentages of N and K. Humic acid gave a great increase in Ca, K and N percentages over the control. Potassium sulphate + calcium chloride + boric acid combination increased positively N percentage, but it gave non-significant increase in Ca, K and P percentages in the leaves with comparing to the control in both study seasons.

Listed data in Table 4, B, Zn, Mn and Fe content in the leaves was affected positively by the foliar application of humic acid alone, calcium chloride + humic acid, potassium sulphate + calcium chloride + boric acid or potassium sulphate + calcium chloride + boric acid + humic acid combinations as compared to the control in the two seasons. Potassium sulphate increased significantly Zn, Mn and Fe concentrations, but its effect on B content was insignificant as compared to the control in the two seasons. Potassium sulphate + humic acid combination enhanced Zn and B concentration but, it had no significant effect on Fe or Mn concentration in the leaves as compared to the control. Moreover, calcium chloride gave a considerable enhancement in Zn and Mn concentration but it did not have any significant effect on Fe or B content in the leaves in both seasons as compared to the control. Boric acid gave no remarkable increase in Fe, Mn and Zn content in the leaves. On the other side, boric and humic acid combination caused significant increments in Zn, Mn and B concentrations but it gave in significant increase in F concentration in the leaves with comparing to the control treatment in the two seasons.

From the results in Table 5, it can be noticed that potassium sulphate + calcium chloride + boric acid + humic acid combination enhanced remarkably fruit diameter**,** fruit length and fruit firmness in both seasons as compared to the control. Potassium sulphate, boric acid, humic acid, calcium chloride + humic acid combination or potassium sulphate + calcium chloride + boric acid combination increased fruit lengthand fruitdiameter but, they did not give a significant increase in fruit firmnessin the two seasons as compared to the control. Calcium chloride enhanced fruit length and fruit diameter only in the first season and fruit firmness in the second season as compared to the control. Potasium sulphate + humic acid and/or boric acid + humic acidcombination gave a slight increase in fruit length or fruit diameter in the two seasons as compared to the control.

From the results in Table 6, the foliar application of potassium sulphate, humic acid, boric acid or calcium chloride + humic acid combination improved TSS and TSS/ acid ratio and decreased acidity percentage in the fruitsas compared to the control in the two seasons. In

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

addition, the combination of potassium sulphate + calcium chloride + boric acid or potassium sulphate + calcium chloride + boric acid + humic acid had the same effect. Potassium sulphate combined with humic acid increased positively TSS/ acid ratio but it had insignificant effect on TSS or acidity, with comparing to the control. On the opposite side, calcium chloride alone and boric + humic acid combination did not have any remarkable effect on acidity, TSS, TSS/acid ratio in both seasons as compared to the control.

Data in Table 7, showed that the combination of potassium sulphate + calcium chloride + boric acid + humic acid gave a remarkable increases in reducing sugar percentages and anthocyanin in the two seasons as compared to the control.

Potassium sulphate, boric acid and calcium chloride + humic acid combinationincreased significantly anthocyanin concentrationin the fruits. Additionally, Potassium sulphate + humic acid or potassium sulphate + calcium chloride + boric acid combination had the same effect, however all of them gave insignificant increase in reducing sugar and total sugar percentages as compared to the control in the two seasons. Humic acid achieveda great increase in reducing sugar percentage, although it gave insignificant enhancement in the total sugar percentage and anthocyanin with comparing to the control in the two seasons. On the other side, calcium chloride or boric acid + humic acid combination did not have any remarkable effect on anthocyanin concentration, total sugar or reducing sugar percentages as compared to the control in the two seasons. All the treatments did not achieve any significant increases in the total sugar percentages in the fruits in the first season or in non-reducing sugar in both seasons as compared to the control.

According to our results the foliar application of potassium, calcium, boron and humicacid either alone or incombinations improved vegetative growth, fruit set, leaf mineral, yield, chemical and physical fruit characteristics of 'Starking' apple trees.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Table 1. Effect of spraying potassium, calcium, boron and humic acid on some vegetative growth of "Starking" apple trees in 2012 and 2013 seasons

Treatments	Shoot length (cm)		Shoot diameter (cm)		Leaf area (cm^2)	
	2012	2013	2012	2013	2012	2013
T1: Control (sprayed with water)	35.76e	36.47g	0.65g	0.67d	23.36e	24.17d
T2: K at (2%) as potassium sulphate	40.36c	41.65c	0.73de	0.74c	27.18bcd	28.53bc
T3:Ca at (0.2%) as calcium chloride	36.81de	37.27fg	0.67fg	0.69cd	25.37de	26.67c
T4: B at (0.2%) as boric acid	36.92de	37.31fg	0.68efg	0.70cd	26.46d	27.85c
T5:H.A. (humic acid5%)	41.87b	43.52b	0.81bc	0.82b	29.24ab	30.46ab
T6:K + H.A	37.28d	38.52ef	0.72def	0.73cd	26.85cd	27.14c
T7: Ca + H.A.	42.74b	43.83ab	0.77cd	0.82b	28.65abc	30.06ab
T8: B + H.A.	37.65d	39.67de	0.71ef	0.74c	26.12d	27.23c
T9: K + Ca + B	38.14d	40.36cd	0.84b	0.85b	27.25bcd	28.65bc
T10: K + Ca + B + H.A.	44.67a	45.17a	0.91a	0.94a	30.67a	31.42a
$L.S.D._{0.05}$	1.46	1.57	0.05	0.06	2.11	2.17

Means not sharing the same letter(s) within each column, significantly different at 0.05 level of probability

Table 2. Effect of spraying potassium, calcium, boron and humic acid on fruit set, fruit drop, yield and average fruit weight of "Starking" apple trees in 2012 and 2013 seasons

Treatments	Fruit set (%)		Fruit drop (%)		Yield (kg/ tree)		Average fruit weight (g)	
	2012	2013	2012	2013	2012	2013	2012	2013
T1: Control (sprayed with water)	13.64e	12.96g	76.37a	75.85a	36.47f	38.14f	117.38f	120.54g
T2: K at (2%) as potassium sulphate	18.42cd	18.57d	70.25cde	68.46cd	43.52d	45.27d	134.65cd	137.94e
T3:Ca at (0.2%) as calcium chloride	13.87e	13.72g	75.84ab	73.25ab	38.56ef	40.71ef	119.73ef	121.41g
T4: B at (0.2%) as boric acid	19.86bc	19.75cd	70.86cd	69.14c	45.17cd	49.63c	132.38d	135.46e
T5:H.A. (humic acid5%)	20.36b	20.85bc	68.46def	65.36de	52.74b	53.67b	145.20b	152.46b
T6:K + H.A	17.65d	16.36e	71.25cd	68.56cd	39.82e	42.62de	119.65ef	122.46g
T7: Ca + H.A.	20.46b	21.74bc	67.36ef	65.47de	47.85c	49.36c	137.81c	146.54c
T8: B + H.A.	14.67e	15.27ef	72.37bc	70.85bc	40.17e	43.65de	122.45e	128.37f
T9: K + Ca + B	21.37b	22.57b	66.31f	64.73ef	50.76b	51.36bc	137.56c	142.17d
T10: K + Ca + B + H.A.	24.56a	24.87a	60.27g	61.83f	58.47a	60.27a	152.37a	167.24a
$L.S.D._{0.05}$	1.67	2.05	3.48	3.29	2.84	3.04	4.38	4.14

Means not sharing the same letter(s) within each column, significantly different at 0.05 level of probability

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Table 3. Effect of spraying potassium, calcium, boron and humic acid on some leaf macro elements content of "Starking" apple trees in 2012 and 2013 seasons

Treatments	N (%)		P (%)		K (%)		Ca (%)	
	2012	2013	2012	2013	2012	2013	2012	2013
T1: Control (sprayed with water)	1.87e	1.90e	0.31de	0.30cd	1.83d	1.87e	1.31cd	1.34cde
T2: K at (2%) as potassium sulphate	1.98bcd	2.02bcd	0.32cde	0.34abc	2.01c	2.04bcd	1.30cd	1.34cde
T3:Ca at (0.2%) as calcium chloride	1.89de	1.91de	0.31de	0.32bcd	1.82d	1.85e	1.44ab	1.48a
T4: B at (0.2%) as boric acid	1.96cde	1.98cde	0.29e	0.28d	1.84d	1.90de	1.28d	1.29de
T5:H.A. (humic acid5%)	2.07b	2.11ab	0.34bcd	0.35abc	2.04bc	2.07bc	1.40b	1.44ab
T6:K + H.A	2.04bc	2.08bc	0.37ab	0.38a	2.01c	2.02cd	1.34c	1.37bc
T7: Ca + H.A.	2.07b	2.10b	0.35abc	0.36ab	2.14ab	2.18ab	1.30cd	1.35cd
T8: B + H.A.	1.91de	1.95de	0.36ab	0.38a	1.87d	1.90de	1.49a	1.50a
T9: K + Ca + B	2.05bc	2.07bc	0.34bcd	0.35abc	1.86d	1.94cde	1.28d	1.27e
T10: K + Ca + B + H.A.	2.20a	2.22a	0.38a	0.37ab	2.20a	2.25a	1.46a	1.48a
L.S.D.$_{0.05}$	0.10	0.11	0.03	0.05	0.12	0.14	0.05	0.07

Means not sharing the same letter(s) within each column, significantly different at 0.05 level of probability

Table 4. Effect of spraying potassium, calcium, boron and humic acid on some leaf microelements content of "Starking" apple trees in2012 and 2013 seasons

Treatments	Fe (ppm)		Zn (ppm)		Mn (ppm)		B (ppm)	
	2012	2013	2012	2013	2012	2013	2012	2013
T1: Control (sprayed with water)	119.00d	118.00de	25.00f	26.00g	45.00e	47.00d	68.00e	70.00e
T2: K at (2%) as potassium sulphate	123.00b	124.00b	30.00de	30.00e	50.00c	52.00b	71.00de	73.00de
T3:Ca at (0.2%) as calcium chloride	119.00d	117.00e	28.00e	29.00ef	49.00cd	49.00bcd	68.00e	71.00e
T4: B at (0.2%) as boric acid	120.00cd	119.00cde	25.00f	27.00fg	46.00de	48.00cd	86.00bc	88.00b
T5:H.A. (humic acid5%)	126.00a	128.00a	32.00cd	34.00c	56.00ab	58.00a	88.00b	89.00b
T6:K + H.A	121.00bcd	120.00cd	31.00d	33.00cd	48.00cde	49.00bcd	75.00d	78.00c
T7: Ca + H.A.	126.00a	130.00a	35.00b	37.00b	55.00b	57.00a	83.00c	89.00b
T8: B + H.A.	120.00cd	119.00cde	30.00de	31.00de	51.00c	50.00bcd	74.00d	76.00cd
T9: K + Ca + B	122.00bc	121.00c	34.00bc	38.00b	49.00cd	51.00bc	88.00b	91.00b
T10: K + Ca + B + H.A.	128.00a	129.00a	41.00a	44.00a	59.00a	60.00a	93.00a	97.00a
L.S.D.$_{0.05}$	2.18	2.36	2.02	2.05	3.46	3.67	4.61	4.67

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Table 5. Effect of spraying potassium, calcium, boron and humic acid on fruit length, diameter, the ratio between them and fruit firmness of "Starking" apple trees in 2012 and 2013 seasons

Treatments	Fruit length (cm)		Fruit diameter (cm)		L/ D (ratio)		Fruit firmness	
	2012	2013	2012	2013	2012	2013	2012	2013
T1: Control (sprayed with water)	5.27g	5.36e	5.21h	5.29f	1.01b	1.01a	12.86b	12.73e
T2: K at (2%) as potassium sulphate	5.47d	5.68c	5.36d	5.58d	1.02ab	1.02a	12.81b	12.57e
T3:Ca at (0.2%) as calcium chloride	5.35ef	5.48e	5.26fg	5.34f	1.02ab	1.03a	13.37b	13.84bc
T4: B at (0.2%) as boric acid	5.45d	5.57d	5.31e	5.42e	1.03a	1.03a	12.83b	12.69e
T5:H.A. (humic acid5%)	5.76b	5.89b	5.63b	5.72b	1.02ab	1.03a	13.04b	13.45cd
T6:K + H.A	5.30fg	5.38e	5.23gh	5.29f	1.01b	1.02a	13.26b	13.51cd
T7: Ca + H.A.	5.62c	5.72c	5.54c	5.65c	1.01b	1.01a	13.08b	13.14cde
T8: B + H.A.	5.37e	5.52de	5.27f	5.47e	1.02ab	1.01a	14.64a	14.37ab
T9: K + Ca + B	5.60c	5.74c	5.54c	5.63cd	1.01b	1.02a	13.00b	12.96de
T10: K + Ca + B + H.A.	5.92a	6.03a	5.84a	5.97a	1.01b	1.01a	14.77a	14.63a
L.S.D.$_{0.05}$	0.05	0.07	0.03	0.05	0.01	0.02	0.64	0.71

Means not sharing the same letter(s) within each column, significantly different at 0.05 level of probability

Table 6. Effect of spraying potassium, calcium, boron and humic acid on total soluble solids, acidity andthe ratio between them of "Starking" apple trees in 2012 and 2013 seasons

Treatments	TSS (%)		Acidity(%)		TSS/Acid Ratio	
	2012	2013	2012	2013	2012	2013
T1: Control (sprayed with water)	12.50b	12.60c	0.48a	0.49ab	26.04d	25.71f
T2: K at (2%) as potassium sulphate	14.70a	14.90a	0.39b	0.43bcde	37.69b	34.65d
T3:Ca at (0.2%) as calcium chloride	12.60b	12.50c	0.49a	0.50a	25.71d	25.00f
T4: B at (0.2%) as boric acid	14.60a	14.80ab	0.40b	0.42cde	36.50b	35.24d
T5:H.A. (humic acid5%)	15.10a	15.40a	0.37b	0.38e	40.81a	40.53ab
T6:K + H.A	13.10b	13.40bc	0.45a	0.46abcd	29.11c	29.13e
T7: Ca + H.A.	15.20a	15.40a	0.37b	0.40de	41.08a	38.50bc
T8: B + H.A.	12.70b	12.90c	0.47a	0.48abc	27.02cd	26.88ef
T9: K + Ca + B	14.80a	14.90a	0.39b	0.41de	37.95b	36.34cd
T10: K + Ca + B + H.A.	15.80a	15.70a	0.37b	0.38e	42.70a	41.32a
L.S.D.$_{0.05}$	1.26	1.48	0.04	0.06	2.18	2.27

Means not sharing the same letter(s) within each column, significantly different at 0.05 level of probability

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Table 7. Effect of spraying potassium, calcium, boron and humic acid on some chemical fruit characteristics of "Starking" apple trees in 2012 and 2013 season

Treatments	Total Sugar (%)		Reducing Sugar (%)		Non-reducing Sugar (%)		Anthocyanin (mg/100g)	
	2012	2013	2012	2013	2012	2013	2012	2013
T1: Control (sprayed with water)	7.82a	7.92b	4.67c	4.73cd	3.15a	3.19a	21.37c	22.87d
T2: K at (2%) as potassium sulphate	8.14a	8.21ab	4.89bc	4.92bcd	3.25a	3.29a	27.84ab	28.17ab
T3:Ca at (0.2%) as calcium chloride	7.81a	7.90b	4.66c	4.71d	3.15a	3.19a	21.40c	22.72d
T4: B at (0.2%) as boric acid	8.05a	8.12ab	4.86bc	4.90bcd	3.19a	3.22a	26.35b	26.57bc
T5:H.A. (humic acid 5%)	8.46a	8.57ab	5.12ab	5.17ab	3.34a	3.40a	22.76c	24.36cd
T6:K + H.A	7.92a	7.96b	4.72bc	4.82bcd	3.20a	3.14a	29.47a	28.95ab
T7: Ca + H.A.	8.24a	8.37ab	5.02abc	5.11abc	3.22a	3.26a	28.37ab	29.34a
T8: B + H.A.	7.92a	7.97b	4.70bc	4.78cd	3.22a	3.19a	22.35c	23.47d
T9: K + Ca + B	8.21a	8.35ab	4.97abc	5.01bcd	3.24a	3.34a	27.25ab	28.17ab
T10: K + Ca + B + H.A.	8.45a	8.72a	5.36a	5.42a	3.09a	3.30a	29.46a	30.18a
L.S.D.$_{0.05}$	0.67a	0.74	0.42	0.38	0.27	0.28	2.52	2.74

Means not sharing the same letter(s) within each column, significantly different at 0.05 level of probability

CONCLUSION

The foliar application of potassium sulphate, boric acid and humic acid, singly or in combination, had a positive effect to improve the vegetative growth, fruit set, leaf mineral content, yield and fruit quality of 'Anna' apple trees. Calcium chloride alone had a positive effect to increase calcium content in the leaves. Potassium sulphate + calcium chloride + boric acid+ humic acid combination was the best treatment. This combination had the highest positive effect to improve the percentages of yield, fruit set, reducing sugar and TSS. Also, it increased Ca, P, K, N, B, Zn, Mn and Fe content in the leaves in the two seasons, as compared to the control treatment. Moreover, it improved significantly anthocyanin concentration, TSS/acid ratio, shoot diameter, shoot length, leaf area, fruit diameter, fruit length, average fruit weight and fruit firmness. It decreased the percentages of fruit drop and acidity in the two seasons as compared to the control and the other treatments.

單獨或聯合施用硫酸鉀，硼酸和腐植酸對改善蘋果樹的營養生長，著果率，葉片礦物質含量，產量和果實品質有正面作用。 單獨使用氯化鈣對增加葉片中的鈣含量具有正面作用。硫酸鉀+氯化鈣+硼酸+腐植酸聯合使用的效果最好，這種組合對於提高產量，著果率，還原糖和TSS的百分比具有最佳的正面效益。 與對照相比，兩年結果季節葉片中的Ca，P，K，N，B，Zn，Mn和Fe含量增加。 此外，它顯著提高了花青素含量，TSS /酸比率，枝條直徑，枝條長度，葉面積，果實直徑，果實長度，平均果重和果實硬度。 與對照和其他處理相比，本組合降低了兩年結果季節中的落果和酸度的百分比。

Tarım Mad. Nak. San. ve Tic. A.Ş.

www.organiksa.com.tr

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Tarım Mad. Nak. San. ve Tic. A.Ş.

www.organiksa.com.tr

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

ORGANİKSA

TOMATO

Test Field Experiment about Black Diamond Humic Acid Effects of humic acid application upon the phosphorus uptake of the tomato plant (*Lycopersicum esculentum L.*)
腐植酸對幫助番茄吸收磷之影響

ABSTRACT

Humic acid can transform mineral nutrients into available forms for the plants. High lime content, low organic matter content, high pH, low moisture content and insufficient profile characteristics all higher plant phosphorus uptakes and consequently regress plant growth and development. The present research was conducted to investigate the effects of humic acid treatments (H.A.) (0, 60, 120 mg/kg) on phosphorus use efficiency (PUE) (0, 50, 100 mg/kg P) of grape and pole tomato (*Lycopersicum esculentum L.*) varieties. Pot experiments were carried out in a glasshouse in randomized block design with three replications. As basic fertilization, 250 mg/kg N and 200 mg/kg K was applied to the pots. Plants were harvested when they had their 5th raceme. Dry matter yields, N, P and K contents were analyzed. Dry matter yields increased with humic acid and phosphorus treatments. Phosphorus contents also increased with increasing phosphorus doses. While humic acid and phosphorus treatments affected the potassium contents, Ca contents increased through only the humic acid application.

腐植酸可以將礦物營養素轉化為植物可利用的形式。土壤在高石灰含量，低有機質含量，高pH值，低含水量等狀況下都會導致植物對磷的吸收不足，而導致植物生長和發育退化。本研究旨在探討經腐殖酸處理（HA）（0,60,120 mg / kg）對兩種番茄的磷利用效率（PUE）（0,50,100 mg / kg P）。試驗番茄盆栽採隨機分組，每處理組重複3次。使用250mg / kg N和200mg / kg K作為基肥施用於盆栽。當植株出現第五個總狀花序時收割植株。分析乾物質產量，N，P和K含量。結果顯示，腐殖酸和磷肥使用將使植株乾物質產量增加。磷含量也隨著磷肥使用劑量的增加而增加。使用腐殖酸和磷會增加鉀含量，但僅有腐植酸會增加鈣含量。

- **Antalya/Kumluca Region Tomato Greenhouse Field Test with Black Diamond Humic Acid. Black Diamond Humic Acid Effects on phosphorus uptake of Tomato**

INTRODUCTION

The **tomato** (see pronunciation) is the edible fruit of *Solanum lycopersicum*,[2] commonly known as a **tomato plant**, which belongs to the nightshade family, *Solanaceae*. The species originated in Central and South America. The Nahuatl (Aztec language) word *tomatl* gave rise to the Spanish word "tomate", from which the English word tomato originates. Numerous varieties of tomato are widely grown in temperate climates across the world, with greenhouses allowing its production throughout the year and in cooler areas. The plants typically grow to 1–3 meters (3–10 ft) in height and have a weak stem that often sprawls over the ground and vines over other plants. It is a perennial in its native habitat, and grown as an annual in temperate climates. An average common tomato weighs approximately 100 grams. Turkey becomes in third place in worldwide exports after China and USA.

The present study was conducted to investigate the effects of humic acid applications upon phosphorus uptake of tomato plant in soils with high lime content. Phosphorus is a macro-element that plays an important role upon the development of higher plants. Phosphorus has several functions in plants. It is a component of key molecules such as nucleic acids, phospholipids and ATP, and, consequently, plants cannot grow without a reliable supply of this nutrient (Daniel et al., 1998). P is also involved in controlling key enzyme reactions and in regulation of metabolic pathways (Theodorou and Plaxton, 1993). Significant yield losses are also experienced in plants which are not nourished with sufficient phosphorus, and the quality of crop is affected negatively, as well. Efficiency and beneficialness of phosphorus fertilizers can increase the solubility of phosphorus in soil solution.

Cation exchange capacity and soil productivity are increased through administering humic acid into soils and having positive impacts on mineral matter uptake of plant (Stevenson, 1994). Humic acid serves as a buffer at a broad pH interval and several micro-elements can be taken by the plants since the soil is neutralized (Yılmaz, 2007). The studies carried out on humic acids have revealed the necessity of using these substances in vegetative production. Commercial humic-fulvic acid treatments improve the phosphorus fertilizer use efficiencies (Delgado et al., 2002). Besides increasing the plant growth of squash, humic acid application also increased fruit yield and quality (Hafez, 2004). Together with increased root dry matter yields and plant heights, humic acid also increased the N. P, K, Ca, Cu, Mn, Zn and Fe uptake of maize plants (Eyheraguibel et al., 2008).

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

MATERIALS AND METHODS

This study was carried out in a greenhouse over experimental fields in the year 2011. A pot experiment was conducted in completely randomized block design with three replications. Pots were filled with four kg of calcareous soil.Bandita and Bestona tomato varieties (*Lycopersicum esculentum L.*) were grown in pots. Each pot had a single plant.Commercial liquid humic substance (Black Diamond Humic Acid; total organic matter 5%, total humic and fulvic acid 12%) was administered at 0.60, 120 mg/kg doses as the humic substance of the experiments. Phosphorus fertilizer was administered at 0, 50, 100 and 150 mg/kg P doses as phosphoric acid (H3PO4). As basic fertilization, 250 mg/kg N as ammonium nitrate and 200 mg/kg K as potassium nitrate were administered to the pots. For plant development, other nutrients were administered to each pot equally as they needed. When the leaves of the plants reached up to 5th raceme, they were harvested, dried to a constant weight at 68°C and their dry weights were determined. The leaves of plant were combusted according to dry combustion method (Kacar and Inal, 2008). Plant N content was analyzed according to distillation method (Bremner, 1965) and P, K, Ca, Mg, and S contents were analyzed using ICP-AES (Perkinelmer 2100DV). In the experimental soil, texture (Gee and Bouder, 1986), soil CaCO3 (Chapman and Pratt, 1961), soil pH (McLean, 1986), exchangeable potassium (Richards, 1954) and available P (Olsen et al., 1954), organic matter (Jackson, 1956) and available Fe, Zn, Cu and Mn contents in DTPA were determined (Lindsay and Norwell, 1978). Experimental soil has a clay-loam texture and has clay, silt and sand contents respectively of 31%, 33% and 36%. Lime content was 18.90%, pH (soil:H2O = 1:2.5) was 8.15, organic matter content was 1.20%, available P content was 1.45 kg/da, CEC = 36.90 me/100 g and exchangeable K content was 200 mg/kg. DTPA soluble Fe, Cu, Zn, and Mn contents were 2.05, 1.02,0.11 and 3.65 µg/g, respectively.Variance analysis of the obtained data was performed using the MSTAT-C statistical software and the differences between the means were determined by Duncan's multiple range test (Düzgüne et al., 1978).

RESULTS AND DISCUSSIONS

Dry matter yields and P contents

The effects of different doses of humic acid and phosphorus treatments on dry matter yields of Bandita and Bestona tomato species and variance analysis results are presented in Tables 1 and 2. Humic acid treatments had significant impacts *($p<0.05$)* on dry matter yields of Bandita and Bestona tomato species. Through the humic substance treatments, dry matter yield of Bandita tomato species increased from 25.8 g/pot to 34.3 g /pot Compared to control treatment, humic substance treatments also significantly increased the dry matter yields of Bestona tomato species (from 18.3 to 26.3 g/pot). Phosphorus treatments also resulted in significant increases in dry matter yields of tomato species ($p<0.01$). The highest dry matter yield of Bandita and Bestona tomato species in 150 ppm P application was respectively observed as 49.5 g/pot and 43.6 g/pot. The effects of humic substance x phosphorus interaction on dry matter yields of tomato species were also found to be significant ($p < 0.01$).

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

The effects of humic acid treatments on phosphorus contents of tomato species were not found to be significant (Tables 1 and 2). In both tomato species, foliar P contents did not significantly change with humic acid treatments. However, phosphorus doses had significant (p<0.01) impacts on P contents of the leaves (Tables 1 and 2) and increasing P contents were observed with increasing phosphorus doses. The highest P content in Bandita tomato species was 1.69% in 100 mg/kg P and 120 mg/kg H.A treatment and the highest P content in Bestona tomato species was 1.65% in 150 ppm P and 60 mg/kg H.A treatment. Exploited phosphorus amounts showed parallelism with phosphorus contents of the plant for both tomato species (Tables 1 and 2).

Table 1. The effects of humic acid and phosphorus treatments on dry matter yield and macro nutrient contents of Bandita tomato species.

H.A ppm	Bandita phosphorus treatment (mg/kg)					Average
	0	14.3	29.4	23.3	31.1	25.8
Dry matter yield (gr/pot)	60	19.4	28.1	38.2	49.5	36.1
	120	28.3	35.8	43.2	44.1	34.3
	0	0.36	0.85	1.09	1.21	0.87
P (%)	60	0.48	1.10	1.26	1.23	1.01
	120	0.39	1.25	1.69	1.47	1.20
	0	51.4	250.1	254.1	375.1	232.3
Total P, mg/pot	60	93.1	306.3	475.1	607.6	370.1
	120	110.3	457.6	733.9	648.2	487.1
	0	3.00	2.91	3.19	2.83	2.98
N (%)	60	3.17	3.20	3.16	2.87	3.07
	120	2.75	3.33	3.26	3.06	3.10
	0	2.60	3.60	3.72	3.28	3.30
K (%)	60	3.66	4.32	4.36	3.54	3.97
	120	3.46	3.91	4.20	3.99	3.89
	0	1.72	1.51	1.42	1.85	1.62
Ca (%)	60	1.96	2.30	2.24	2.14	2.16
	120	2.48	2.06	2.43	2.12	2.27
	0	0.20	0.13	0.14	0.13	0.15
S (%)	60	0.12	0.21	0.13	0.21	0.17
	120	0.21	0.20	0.24	0.17	0.20
	0	0.90	0.80	0.61	0.85	0.79
Mg (%)	60	0.79	0.95	0.80	0.86	0.85
	120	0.92	0.87	0.91	0.83	0.88

Dry matter yield: H.A.:*, P.A.:**, HA x PA:*; P content: H.A.: N.I.,P.A.:**, HA x P.A:N.I.; Total P: H.A.:*, P.A.:**, HA x PA:*; K content: H.A.:**, P.A.:**, H.A x P.A.: ** Ca content: H.A.:**, P.A.:N.I, HA x P.A.:N.I.; NI: Not Important; * P<0,05 and **P<0,01,P<0,001 possibility are important.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

N, K, Ca, S, and Mg contents of tomato plants

Humic substance and phosphorus treatments did not have significant effects on nitrogen contents of tomato species (Tables 1 and 2). On the other hand, H.A. and treatments had significant impacts on K contents of tomato plants at 1% level (Tables 1 and 2). Considering the averages, potassium content of Bendita tomato species increased from 3.30% to 3.97% through the humic acid treatments. In Bestona species, potassium content increased from 3.59 to 3.98% with the humic acid treatments. Similarly, it was also noticed that K contents of both species increased with phosphorus applications. According to research results, it was seen that as a result of the increase at vegetative development the plant produced at low phosphorus, the plant benefited more from the administered potassium.

While the humic acid treatments had significant ($p<0.01$) effects on calcium contents of the plants, phosphorus treatments did not result in any significant impacts on calcium contents. Ca content of Bandita tomato species was observed as 1.62% in H 0 mg/kg treatment, 2.16% in H 60 mg/kg and 2.27% in H 120 mg/kg treatment. Ca contents of Bestona tomato species were, respectively observed as 2.08, 2.31, and 2.11%. Finally, humic acid and phosphorus treatments did not have any significant effects on sulfur and magnesium contents of tomato plants.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Table 2. The effects of humic acid and phosphorus treatments on dry matter yield and macro nutrient contents of Bestona tomato species.

HA ppm	**Bestona phosphorus treatments(mg/Kg)**					**Average**
		0	50	100	150	
	0	11.8	16.3	20.1	24.9	18.3
Dry matter yield (gr/pot)	60	13.2	19.2	19.4	33.0	21.2
	120	16.6	17.9	27.0	43.6	26.3
	0	0.36	1.22	1.23	1.64	1,11
P (%)	60	0.32	1.30	1.65	1.51	1,19
	120	0.36	1.13	1.41	1.30	1,05
	0	42.8	198.2	333.2	408.3	245,8
Total P (mg/pot)	60	42.8	253.6	327.2	500.5	281,1
	120	59.7	202.2	283.4	566.8	227,2
	0	3.11	2.88	2.98	3.25	3,05
N (%)	60	2.94	2.87	3.10	3.28	3,05
	120	3.02	3.52	3.27	3.12	3,23
	0	3.33	4.02	3.54	3.49	3,59
K (%)	60	3.67	3.92	3.98	3.42	3,75
	120	3.86	4.08	4.14	3.86	3,98
	0	2.23	2.39	1.81	1.90	2,08
Ca (%)	60	2.97	2.10	2.16	2.01	2,31
	120	2.25	1.92	2.09	2.18	2,11
	0	0.22	0.19	0.23	0.16	0,20
S (%)	60	0.23	0.23	0.24	0.27	0,24
	120	0.26	0.21	0.21	0.23	0,23
	0	0.76	0.78	0.81	0.84	0,79
Mg (%)	60	0.76	0.88	0.90	0.89	0,86
	120	0.88	0.88	0.87	0.91	0,88

Dry matter yield: H.A.:*, P.A.:**, HA x PA:*; P content: H.A.: N.I.,P.A.:**, HA x P.A:N.I.; Total P: H.A.:*, P.A.:**, HA x PA:*; K content: H.A.:**, P.A.:**, H.A x P.A.: ** Ca content: H.A.:**, P.A.:N.I, HA x P.A. :N.I.; NI: Not Important; * P<0,05 and **P<0,01, P<0,001 possibility are important.

Compared to the control treatment, humic acid treatments resulted in significant increases in dry matter yields of tomato plants. Previous studies also reported significant positive impacts of humic substance treatments on dry matter yields of different plants (Hafez, 2004; Salman et al., 2005; Eyheraguibel et al., 2008). Functional groups of humic molecules form complexes with metals through various means (Livens, 1991). These functional groups

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

provide percolation of cations in soils and serve as natural chelate in soils. Stable complexes of humic substances with metal ions are related to these functional groups. Humic substances have high cation exchange capacity, thus metals in soils can form chelates with humic acids. Humic substances may hold the existing and externally applied soil minerals and consequently enrich plant growth and development. The increases in dry matter yields of the present study may also be related to these functions of humic substances. Increasing foliar phosphorus concentrations were observed in this study with increasing phosphorus doses. Plant phosphorus uptake from the soil is directly related to dry matter yields of the plants. Exploited amount of phosphorus was higher in Bestona than Bandita tomato species. Effects of humic acid were more distinctive in this case.

CONCLUSION:

The present results revealed that tomato dry matter yields significantly increased with humic substance treatments and such results comply with the findings of the previous studies (Hafez, 2004; Türkmen et al., 2004; Akõncõ, 2011). P treatments also significantly increased P contents of the leaves and dry matter yields of the plants at 1% level. High pH, high lime and low organic matter content of experimental soil might have restricted the phosphorus uptake and the effects of these characteristics could clearly be inferred from the results of the study.

K and Ca contents of the plants also increased through the humic acid treatments, but significant effects were not observed on other minerals. These findings comply with the results of previous studies (Eyheraguibel et al., 2008; Mohamed, 2012). It was concluded in this study that the organic sedimentary compounds such as humic acids administered to the rhizosphere part of the plant roots after plantation increased the nutrient uptakes of the plants. Moreover, phosphorus treatments also enriched root development and growth.

目前的結果表明，腐殖質處理番茄乾物質產量顯著增加，這些結果符合先前研究的結果（Hafez，2004;Türkmen等，2004;Akõncõ，2011）。 磷處理也顯著增加葉片的磷含量和植物的乾物質產量約1%。試驗土壤的高pH，高石灰和低有機質含量可能限制了磷的吸收，而由研究結果可以清楚地推斷出這些特徵的影響。

通過腐植酸處理，植物的K和Ca含量也增加，但對其他礦物沒有觀察到顯著的效果。這些發現符合先前研究的結果（Eyheraguibel等，2008; Mohamed，2012）。本研究結論顯示，有機沉積物如施用於植物根部時，這些腐殖酸增加了植物的養分吸收。此外，施以磷肥也豐富了根系的發育和生長。

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Tarım Mad. Nak. San. ve Tic. A.Ş.

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434

Tarım Mad. Nak. San. ve Tic. A.Ş.

www.organiksa.com.tr

Merkez: İstanbul Dünya Ticaret Merkezi
A1-Blok No:272 Kat:7 Yeşilköy
Bakırköy-İstanbul
Tel: +90 (212) 465 65 05
Fax: +90 (212) 465 65 06
BAKIRKÖY V.D. 645 034 2434