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RESPONSE OF STRAWBERRY CV. FESTIVAL TO FOLIAR APPLICATIONS OF SOME ANTIOXIDANTS

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ABSTRACT

During 2009/ 2010 and 2010/ 2011 seasons strawberry cv. Festival plants received three sprays at 30, 45 and 60 days after planting with seven antioxidants namely citric acid at 500 ppm, vitamins B complex, K, E, D, A each at 50 ppm and ascorbic acid at 500 ppm either singly or in combinations. The study focused on the effect of these antioxidants on growth, yield as well as physical and chemical characteristics of the fruits.

Results revealed that single or combined application of the seven antioxidants (citric and ascorbic acids, vitamins namely B, K, E, D and A) was very effective in improving plant height, number of leaves per plant, diameter and weight of fruit, early and total yields, total soluble solids %, total sugars %, total anthocyanins and reducing total acidity % comparing with the control treatment. The promotion was associated with using citric acid at 500 ppm, ascorbic acid at 500 ppm, K + E + D + A vitamins each at 50 ppm, in ascending order. Combined application of these antioxidants was preferable than using each antioxidant alone.

According to the obtained results, application of mixture of all antioxidants (citric acid and ascorbic acids each at 500 ppm, B + K + E + D + A vitamins each at 50 ppm) was suggested to be beneficial for promoting yield quantitively and qualitatively of strawberry cv. Festival.

INTRODUCTION

Strawberry is considered as one of the most important vegetable crops grown in Egypt for fresh local consumption and export. It has higher nutritional value and used for curing from different human diseases.

Recently, it was suggested that all vitamins participate in plant growth and fruiting through enhancing IAA, GA_3 and cytokinins. Various physiological processes such as nutrient uptake, respiration, photosynthesis and building of plant pigments and most organic foods depend more or less on the availability of vitamins. Vitamins with their antioxidant properties play an important role in plant defense against oxidative stress induced by selected pesticidees (Oretili, 1987 and Samiullah *et al.*, 1988).

Antioxidants such as citric acid have been used instead of auxins and other chemicals for controlling plant diseases, protecting the cells from senescence as well as enhancing the biosynthesis of carbohydrates, proteins plant pigments and cell division (Prusky, 1988; Elade, 1992 and Galal *et al.*, 1999). Previous studies showed that using antioxidants was beneficial in improving yield and quality of horticultural plants (Vianello and Macri, 1991; Sharma and Davis, 199٧; Sies, 1997; Sandermann *et al.*, 1998; Galal *et al.*, 1999; Nicholas and Wheeler, 2000; Bandypadhyay *et al.*, 2000; Rao *et al.*, 2000; Blokhina *et al.*, 200١; Darwish, 2004; Senaratna *et al.*, 2004; Shehata *et al.*, 2011 and Hamed- Mona, 2012).

The main target of this study was elucidating the various benefits of using some antioxidants on strawberry cv. Festival.

MATERIALS AND METHODS

This study was performance during winter seasons of 2009/ 2010 and 2010/ 2011 on strawberry cv. Festival in a private farm located at talkha, Mansoura City, Dakhalia Governorate. The texture of soil is clay soil. Planting dates were on the last week of October on both seasons. The obtained data of the soil analysis (Wilde *et al.*, 1985) are shown in Table 1.

Table 1: Analysis of the tested soil:

Constituents	Values
Sand %	12.0
Silt %	18.0
Clay %	70.0
Texture	Clay
pH (1:2.5 extract)	7.91
$CaCO_3$ %	1.19
E.C (1: 2.5 extract)	0.75
O. M. %	1.8
Total N %	0.09
Available P (ppm)	2.25
Available K (ppm)	410

This experimental included the following nine treatments from single and combined application of seven antioxidants-

1-Control (plants treated with water).
2-Spraying plants with citric acid at 500 ppm (0.5 g/ L).
3-Spraying plants with ascorbic acid at 500 ppm (0.5 g/ L).
4-Spraying plants with K + E + D + A vitamins (soluble in Ethyl alcohol) at 50 ppm per each.
5-Spraying plants with vitamin B complex (250 ppm B_1 + 15 ppm B_2 + 200 ppm B_6 + 250 ppm B_{12}).
6-Spraying plants with citric acid + ascorbic acid each at 500 ppm.
7-Spraying plants with citric acid at 500 ppm + K + E + D + A vitamins each at 50 ppm.
8-Spraying plants with citric acid at 500 ppm + vitamin B complex as previously mentioned.
9-Spraying plants with mixture of all antioxidants.

Each treatment was applied four times. Each plot consisted 3 ridges, 5 m. long and 0.7 m. apart occurring an area of 10.5 m^2. The distance between plants was 25 cm. The studied antioxidants sprayed three times on 30, 45 and 60 days after planting. Triton B as a wetting agent was added at 0.05 % to all antioxidant solutions before carrying out spraying. Sprays were performed till runoff. The selected plants received all common horticultural practices that were applied in the form except those concerning of the application of any antioxidants. Complete randomized block design was followed.

In each season of the study, plant height (cm.) and number of leaves per plant were recorded at 80 days after planting. At harvesting date, early yield (the first three harvest times) and total yields expressed at ton/fed. were measured. Fruit diameter (cm.) and weight (g.), total soluble solids %, total sugars % were determined (AOAC, 1995). Total acidity % was determined by titration against 0.1 N NaOH using phenolphthalein as indicator and expressed as percentage of citric acid (g/ 100 g) (AOAC, 1995). Total anthocyanins (mg/ 100 g FW) was measured by using spectrophotometer (AOAC, 1995).

Statistical analysis was done using new LSD at 5 % for made all comparisons among various treatment means (Mead *et al.*, 1993).

RESULTS AND DISCUSSION

1-Growth characters:

Data in Table 2 show clearly that foliar application of the seven antioxidants in addition to the mixture of antioxidants significantly was accompanied with stimulating plant height and number of leaves per plant comparing with the control treatment. Significant differences on these growth characters were observed among the eight antioxidant treatments. Application of citric acid at 500 ppm, ascorbic acid at 500 ppm, K + E + D + A each at 50 ppm and B vitamins (250 ppm B_1 + 15 ppm B_2 + 200 ppm B_3 + 250 ppm B_{12}), in ascending order was significantly very effective in stimulating the two growth traits. Combined application of these antioxidants was more effective than using each antioxidant alone in this connection. Application of all antioxidants together gave the maximum values. Untreated plants produced the minimum values. Similar results were announced during 2009/ 2010 and 2010/ 2011 seasons.

These results might be attributed to the positive effects of antioxidants on enhancing cell division and the biosynthesis of most organic foods (Raskin, 1992 and Elade, 1992).

These results are in agreement with those obtained by Darwish (2004); Shehata *et al.*, (2011) and Hamed- Mona (2012).

2-Yield:

Data in Tables 2 & 3 obviously reveal that yield (early or total) expressed as ton/ fed. was significantly improved with using these antioxidants either singly or in combination rather than non- application. The yield was significantly maximized with using the mixture of antioxidants followed by citric acid at 500 ppm, ascorbic acid at 500 ppm, K + E + D + A each at 50 ppm and vitamin B complex, in ascending order. Yield was significantly varied among the nine treatments. The maximum total yield (14.7 and 14.52 ton/fed. during both seasons, respectively) were obtained on the plants that received the mix. of antioxidants. Untreated plants produced the minimum values (9.33 and 9.17 ton/fed. during both seasons, respectively). These results were true during both seasons.

The beneficial of antioxidants on promoting the yield was mainly attributed to their positive action on enhancing growth and nutritional status of the plants in favour of producing more fruits (Raskin, 1992 and Elade, 1992).

These results are in agreement with those obtained by Darwish (2004); Shehata *et al.*, (2011) and Hamed- Mona (2012).

3-Physical and chemical characteristics of the fruits:

Fruit quality as shown in Tables 1& 2 was significantly varied according to different antioxidant treatments. Single or combined application of these antioxidants was significantly very essential in promoting both physical and chemical characteristics of the fruits in terms of increasing fruit diameter and weight, total soluble solids %, total sugars % and total anthocyanins and reducing total acidity % in relative to the check treatment.

Table 2: Effect of some antioxidants on plant height, number of leaves per plant, diameter and weight of fruit and early yield of strawberry cv. Festival during 2009/ 2010 and 2010/ 2011 seasons.

Antioxidant treatments	Plant height (cm.)		No. of leaves per plant		Fruit diameter (cm.)		Fruit weight (g.)		Early yield (ton/ fed.)	
	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011
Control	12.0	11.3	6.1	6.0	2.59	2.57	9.3	9.2	1.56	1.62
Citric acid at 500 ppm	12.9	12.4	7.3	7.5	2.65	2.66	9.9	9.8	1.84	1.93
Ascorbic acid at 500 ppm	14.0	13.4	7.4	7.6	2.71	2.72	10.8	10.7	2.27	2.21
K + E + D + A vitamins each at 50 ppm	14.9	14.5	7.4	7.6	2.77	2.80	11.6	11.5	2.61	2.50
B vitamins (B1 + B2 + B6 + B12)	16.0	15.7	7.5	7.6	2.82	2.84	12.7	12.6	2.52	2.70
Citric + Ascorbic	16.8	16.8	7.5	7.6	2.83	2.86	12.9	13.0	2.61	2.73
Citric + K + E + D + A	17.9	17.7	7.5	7.6	2.83	2.86	12.9	13.0	2.70	2.83
Citric + B vitamins	18.9	17.7	7.5	7.6	2.86	2.87	13.0	13.0	2.88	2.93
Mixture of antioxidants (Mix. Of antiox.)	19.8	19.9	7.7	8.0	2.95	2.97	13.4	13.5	2.93	3.27
New LSD at 5 %	0.8	1.0	1.2	1.0	0.05	0.04	0.6	0.6	0.٢٨	0.٢١

Table 3: Effect of some antioxidants on total yield as well as some chemical characteristics of fruit of strawberry cv. Festival during 2009/ 2010 and 2010/ 2011 seasons.

Antioxidant treatments	Total yield (ton/ fed.)		T.S.S %		Total acidity %		Total sugars %		Anthocyanins (mg/ 100 g FW)	
	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011
Control	9.33	9.17	7.11	7.12	0.75	0.71	4.91	4.81	26.1	25.3
Citric acid at 500 ppm	10.16	10.21	7.47	7.48	0.66	0.63	5.01	4.95	27.0	26.2
Ascorbic acid at 500 ppm	12.20	12.51	7.79	7.82	0.64	0.62	5.15	5.09	27.8	27.0
K + E + D + A vitamins each at 50 ppm	12.56	12.96	7.85	7.89	0.60	0.61	5.25	5.29	28.5	28.0
B vitamins (B1 + B2 + B6 + B12)	13.33	13.52	7.99	8.01	0.59	0.61	5.36	5.41	29.1	28.9
Citric + Ascorbic	13.13	13.22	8.35	8.41	0.56	0.60	5.49	5.55	30.0	30.6
Citric + K + E + D + A	13.46	13.82	8.41	8.51	0.55	0.60	5.62	5.69	31.0	31.5
Citric + B vitamins	13.90	13.82	8.48	8.55	0.55	0.57	5.71	5.81	32.2	32.4
Mixture of antioxidants (Mix. Of antiox.)	14.70	14.52	8.83	8.61	0.52	0.51	5.82	5.91	33.1	33.3
New LSD at 5 %	0.83	0.92	0.32	0.27	0.08	0.07	0.09	0.08	0.7	0.8

The best antioxidant in this connection was B- vitamins (B_1 + B_2 + B_6 + B_{12}) followed by K + E + D + A vitamins. Combined application of all antioxidants gave the best results with regard to fruit quality. The trend was noticed during 2009/ 2010 and 2010/ 2011 seasons.

The beneficial effects of antioxidants on quality of the fruits were mainly attributed to their essential role on enhancing the biosynthesis of carbohydrates and plant pigments (Elade, 1992).

These results are in agreement with those obtained by Darwish (2004); Shehata *et al.* (2011) and Hamed- Mona (2012).

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"إستجابة نباتات الفراولة صنف الفيستيفال للرش الورقي لبعض مضادات الأكسدة"

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خلال موسمي ٢٠٠٩/ ٢٠١٠، ٢٠١٠/ ٢٠١١ تم رش نباتات الفراولة صنف الفيستيفال ثلاثة مرات بعد ٣٠، ٤٥، ٦٠ يوم من الزراعة بسبعة مواد من المواد المضادة للأكسدة هي حامض الستريك بتركيز ٥٠٠ جزء في المليون، فيتامينات ب المركب، فيتامينات ك، هـ، د، أ بتركيز ٥٠ جزء في المليون لكل منهما كذلك حامض الأسكوربيك بتركيز ٥٠٠ جزء في المليون إما بصورة فردية أو بخليطهم ولقد تركزت الدراسة علي التعرف علي تأثير هذه المواد علي النمو وكمية المحصول وكذلك الخصائص الطبيعية والكيميائية للثمار.

أشارت نتائج الدراسة أن الاستخدام الفردي أو خليط من للمواد المضادة للأكسدة السبعة (حامض الستريك والأسكوربيك، فيتامينات ب المركب، ك، هـ، د، أ) كان فعالا جدا في تحسين طول النبات وعدد الأوراق للنبات الواحد وقطر ووزن الثمرة وكمية المحصول المبكر والكلي والنسبة المئوية للمواد الصلبة الذائبة الكلية والسكريات الكلية والأنثوسيانين الكلي وتقليل النسبة المئوية للحموضة وذلك بالمقارنة بمعاملة الكونترول وكان التحسن مرتبطا باستخدام حامض الستريك بتركيز ٥٠٠ جزء في المليون وحامض الاسكوربيك بتركيز ٥٠٠ جزء في المليون وفيتامينات ك، هـ، د، أ بتركيز ٥٠ جزء في المليون ثم فيتامين ب المركب مرتبة ترتيبا تصاعديا وكان الاستخدام المشترك لهذه المواد أفضل من الاستخدام الفردي. طبقا لهذه النتائج فإنه يقترح استخدام مخلوط من جميع هذه المواد (حامض الستريك والاسكوربيك بتركيز ٥٠٠ جزء في المليون لكل منهما، فيتامينات ك، هـ، د، أ + ب المركب وذلك لأجل تحسين كمية المحصول كما ونوعا لنباتات الفراولة صنف الفيستيفال.

قام بتحكيم البحث

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