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ENHANCEMENT OF VEGETATIVE GROWTH, FLOWERING, YIELD AND FRUIT QUALITY OF 'HOLLYWOOD' PLUM BY USING BIOSTIMULANTS AND FOLIAR FERTILIZERS

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ABSTRACT

The response of 'Hollywood' plum (*Prunus domestica* L.) to treatment with five locally available commercial biostimulants and foliar fertilizers was studied in a private farm in Menofia Governorate, Egypt during the 2005 and 2006 seasons. A randomized complete block design was used. Data were recorded on soil microbial count (viz., bacteria, actinomycetes, and fungi), soil and leaf NPK analysis, foliage characters (viz., number of leaves, leaf area, and leaf chlorophyll content), flowering, fruit set percentage, yield/tree, and fruit quality attributes (viz., fruit weight, size, polar and equatorial diameters, firmness, flesh thickness, total soluble solids and titratable acidity). Biostimulants applied were Wesko plus K, which contains 56 % K-humate, micronutrients, polymers and 3 % amino acids; Atonic, which contains 0.6 % aromatic nitrocompounds; Setter-2, which is rich in ascorbic and citric acids, N, Ca, Cu, Mn and B; Faster, which is also rich in ascorbic and citric acids in addition to P and K and contain several organic compounds, including free proteins and peptides; and Calcuzn, which is rich in N, Ca, Mg and all micronutrients. Most of these biostimulants induced significant positive effects on all measured characters relative to control. The Wesko Plus K treatment ranked first, followed by the Calcuzn treatment; but in several instances, it was not significantly different from the Wesko Plus K treatment. Atonic, Setter-2, and Faster were mostly intermediate in their effects, but one or more of them were, in some of measured characters, not significantly different from the control treatment. It was recommended to use either of the Wesko Plus K or the Calcuzn treatment for improving growth, yield, and fruit quality of 'Hollywood' plums grown under loamy clay soil condition.

INTRODUCTION

One of the major goals of horticulturists is to improve crop yield and fruit quality without adversely affecting the environment. This goal could be achieved by increasing dependence on biostimulants (BSs) in crop production. BSs were defined by Russo and Berlyn (1990) as being "non-fertilizers which benefit plant growth". However, many of the commercial BSs are enriched with some macro and/or micronutrients, and the majority comprise mixtures of a number of components, including humic acids (HAs); organic acids, nucleic acids and vitamins; proteins, polypeptides, and free amino acids (AAs); and natural plant extracts with or without supplementary macro and/or micronutrients.

HAs or humates, such as K-humate (K-H), applied as various commercial products, have been found to improve growth and/or yield of various *Citrus* species (Webb and Biggs, 1988, Swietlik, 1991 and Alva and Obreza, 1998). Liquid fertilizer containing HA increased 'Starkrimson' apple fruit yield and improved fruit quality (Li *et al*., 1999).

Extracts of marine algae such as *Ascophyllum nodosum* are considered BSs. They contain numerous nutrients and organic compounds

and have been shown to increase growth, yield and quality of different fruit trees, including orange (Fornes *et al*., 1995) and several deciduous fruit (Kloareg *et al*., 1996 and Bertschinger *et al*., 1997).

Ascorbic acid treatment improved fruit quality in apple (Johnson *et al*., 1999) and pear (Voltman *et al*., 1999) fruits and improved germination of apricot seeds (Ercisli *et al*., 1999). Also, spraying of SA-100/GA3 or Siapton, preparations containing amino acids and peptides, enhanced fruit set in 5 cultivars of apple, pears, and plums (Filiti *et al*., 1986).

Several BSs, each comprising a mixture of several components, have been tried, either alone or in combination with some other chemicals, on some deciduous fruit trees.

Spraying 'Desert Red' peach trees with GA_3 combined with either Super Tron (contains organic N, K and Ca, chelated organic Zn, HA, several enzymes and AAs), K-H, or ascorbic acid significantly increased yield, fruit quality and growers income. Also, foliar plus soil applications of Super Tron alone to 'Anna' apple trees gave similar improvement in yield and fruit quality (Fathi *et al*., 2002).

Likewise, foliar application of Super Tron and K-H, either alone or in combination to 'Canino' apricot significantly enhanced shoot length, leaf area, leaf chlorophyll content, fruit yield and fruit size, while foliar treatment with ascorbic acid significantly increased fruit firmness and TSS content (Eissa *et al*., 2003).

Soil applied Retender, (a biostimulant containing 24 % HA in addition to NPK and all micronutrients) and foliar applied Vegimx (a biostimulant containing 17 AAs, 7 vitamins and all nutrients) significantly improved soil microbial count, soil and leaf NPK analysis, vegetative growth, yield parameters, and fruit quality attributes of 'Kelsey' plum relative to the control (Eissa, 2003a).

Soil application of K-H significantly increased rhizosphere count of various groups of microorganisms, including total bacteria (TB), total actinomycetes (TA), and total fungi (TF), and improved various foliage characteristics, fruit yield and fruit quality attributes of 'Canino' apricot relative to the control treatment; but had no significant effect on leaf chlorophyll content (Eissa, 2003b).

Foliar application of various macro and micronutrients often led to growth and yield increases. Pear yield and fruit quality were improved by spraying plants with a complete fertilizer containing macro and micronutrients (Kabeel *et al*., 1998). Also, prebloom foliar B, Zn and urea application enhanced fruit yield of some 'Empire' and 'McIntosh' apple orchards (Stover *et al*., 1999). Likewise, vegetative growth, fruit retention, yield and fruit quality of 'Montakhab El-Kanater' guava were significantly improved by foliar application of either potassium sulphate or zinc sulphate (El-Sherif *et al*., 2000). Also, B and Zn foliar sprays significantly increased retention of 'Zard' olives (Talaie and Taheri, 2001). Additionally, foliar application of boron to 'Conference' pear trees before full bloom increased fruit set and fruit yield, but had no effect on leaf NPK content (Wojcik and Wojcik, 2003).

On light of these beneficial effects of biostimulants and foliar fertilizers' use in crop production, this study was conducted to assess

whether some of the locally commercially available products may enhance growth, yield and fruit quality of 'Hollywood' plum (*Prunus domestica* L.)

MATERIALS AND METHODS

This study was conducted in a private farm in Menofia Governorate during the 2005 and 2006 seasons on 19-year-old trees of 'Hollywood' plum grown in a loamy clay soil. Trees, budded on Marianna rootstock and planted 4 x 5 m apart, were surface-irrigated and received similar agricultural practices. Trees used in the experiment were selected to be healthy and as uniform as possible.

Biostimulants used in this study were Wesko Plus K (Technogreen, Egypt), Atonic (Asahi Chemical Manufacturing Company, Japan), and Setter-2, Faster, and Calcuzn (Union for Agricultural Development, Egypt). They differ in their chemical components as follows:

1. Wesko Plus K is rich in potassium humate (K-humate, 56 %) and contains micronutrients, polymers and 3 % AAs.
2. Atonic contains 0.6 % (w/v) aromatic microcompounds. It is marketed as a natural plant growth stimulator.
3. Setter-2 contains 0.5 % ascorbic acid, 0.5 % citric acid and 5 % N in addition to Cu and Mn and chelated Ca (9 %) and B (1.5 %).
4. Faster contains 5 % ascorbic acid, 2 % citric acid, 7 % P_2O_5, 38 % K_2O in addition to methionine, thiamine, niacin, allicin, propyl sulfide, free proteins and peptides.
5. Calcuzn is rich in B, Cu, Zn and Mo and contains also N (5 %), $MgSO_4$ (2 %) and CaO (8 %).

These products were used according to label recommendations (Table 1). Control plants were not treated.

Table (1). Rates used and developmental stages at which various biostimulants were applied.

Biostimulant (and its mean of application)	Application s rate	Developmental stage of growth at application	Application date	
			2005	2006
Atonic [z] (foliar)	20 ml/20 l	Before bud swelling At the beginning of flowering Pre-harvest	Feb. 20 March 2 May 15	Feb. 19 March 5 May 16
Setter-2 [z] (foliar)	50 ml/20 l	At the beginning of flowering Pre-petal fall	March 2 March 29	March 5 March 14
Calcuzn [z] (foliar)	30 g/20 l	At bud swelling After fruit set 3 weeks later	Feb. 24 March 29 April 21	Feb. 26 April 4 April 25
Wesko Plus K [y] (soil)	250 g/tree	Before bud swelling	Feb. 20	Feb. 19
Faster [z] (foliar)	50 ml/20 l	After fruit set Prior to fruit maturation	March 29 May 12	April 4 May 9

[z] Every tree received 5 l of spray solution at each application date.

[y] Biostimulant was incorporated into the top 10 cm of soil about 1 m away from tree trunk.

Measurements were recorded for soil microflora and its NPK analysis, vegetative growth characters and analysis, flowering and fruit set, yield and fruit quality attributes.

Soil microflora and NPK analysis:

Soil samples were collected from 3 sites around each tree, to 30 cm depth, using soil augers. Samples were collected in early August at the end of each season. Thoroughly mixed composite samples were made from subsamples collected from soil of each experimental unit. Small portions of these composite samples were used for density estimation of colony forming units (CFU) of total bacteria (TB), total actinomycetes (TA) and total fungi (TF). This part of the study was conducted at the Agricultural Microbiology Department; Soil, Water and Environment Institute, ARC. Media used in culturing the various microorganisms were the soil extract agar medium (Allen, 1953) for TB, rose-bengal streptomycin agar medium (Martin, 1950) for planting TF, and Jensen's medium (Allen, 1953) for counting TA. The total CFU of various groups of microorganisms was determined using 1 ml of a suitable dilution in inoculating each plate. Three plates were poured with selective media and incubated at 28 ^{o}C for 1 week for growing bacteria and 5 days for counting fungi and actinomycetes.

The same composed soil samples were used for NPK analysis by the Kjeldahl digestion method for N as described by Jackson (1973), the ammonium molybdate method for P as described by Troug and Mayer (1949) and the flame photometric analysis for K as described by Chapman and Pratt (1961).

Foliage measurements:

In both seasons, measurements included the number of leaves on a 2-year-old shoot for each experimental unit. Also, leaf area and leaf chlorophyll content were determined in early August as averages of 20 fully-expanded leaves per tree. These leaves were sampled from the middle of 2-year-old shoots. Leaf area was recorded using a CL203 Area Meter (CID, Inc., USA), while a SPAD 502-chlorophyll meter (Minolta Corporation, Ramsey, NJ, USA) was used in recording chlorophyll reading.

Leaf samples were also collected for chemical analysis in early August of both seasons. Each sample consisted of 30 leaves/tree. Leaves were washed several times with tap water, rinsed with distilled water, and then dried at 70 ^{o}C to a constant weight. Dried leaves were ground in a stainless steel rotary knife mill, screened through 20 mesh screen, and 0.5 g dried samples were taken for NPK analysis as described for soil analysis.

Flower count and fruit set:

A two-year-old shoot was selected from each tree and was used for recording data on total number of flowers at full bloom in March and number of set fruits in April. These data were used in calculating the percentage of fruit set.

Fruit quality attributes and yield:

Fruit harvest was made on June 1st and June 4th in the two consecutive seasons, respectively. Samples of 10 randomly picked mature

fruits from each experimental unit were used for measuring various fruit quality attributes. Characters measured were fruit weight, size, polar and equatorial diameters, flesh thickness, firmness using a pressure tester with ¼ inch plunger (Catalytic Generators, Inc., Norfolk, VA, USA), TSS content using a hand refractometer, and titratable acidity as percent malic acid (AOAC, 1975).

Data obtained on fruit number and weight were used in estimating yield per tree.

Experimental design:

The experiments were conducted in a randomized complete block design with 3 replicates. Each experimental unit consisted of one tree. Data obtained were subjected to analysis of variance according to Snedecor and Cochran (1990). Means were compared using the LSD test at the 5 % level of probability.

RESULTS AND DISCUSSION

Soil microbial and NPK analysis

Soil treatment with Wesko Plus K significantly increased soil TB, TA and TF. Foliar Calcuzn treatment to 'Hollywood' plum trees followed the soil Wesko Plus K treatment in this positive effect, but the 2 treatments were significantly different only on their effect on total bacterial count in 2005. Setter-2 came next in its effect on soil microbial count, but without significant differences from Wesko Plus K and Calcuzn treatments with regard to TF and from Calcuzn treatment with regard to TA. However, foliar treatment with Setter-2 was not significantly different from the control treatment regarding total bacterial count in 2006 and TA in both seasons. Atonic ad Faster foliar treatments were the least regarding effects on soil microbial count. In fact, the treatment with Faster was significantly different from the control treatment only in total bacterial count, while that of Atonic was significantly different from the control treatment only in TB and TF in 2005 (Table 2).

Table (2). Effect of 'Hollywood' plum treatment with some biostimulants on the number of CFU of various groups of rhizosphere microflora (CFU x 10^6 g^{-1} dry

Treatment	Total bacterial count		Total actinomycetes		Total fungi	
	2005	2006	2005	2006	2005	2006
Atonic	18.00	16.67	33.33	34.33	6.56	6.63
Setter-2	16.00	15.00	35.00	35.33	8.16	8.13
Calcuzn	25.00	24.67	43.33	43.33	8.00	7.86
Wesko Plus K	28.67	27.33	51.67	52.33	8.40	8.30
Faster	16.67	22.00	26.67	28.33	5.73	6.03
Control	12.33	13.00	23.33	24.00	5.26	5.50
$LSD_{0.05}$	3.20	4.54	12.17	12.13	0.80	1.26

[Z]CFU: colony forming units, soil samples for microbial count were taken on August 3 and August 2 of the two years of the study, respectively.

Wesko Plus K contains 56 % K-humate, rich in micronutrients, and was used as soil treatment. These factors probably explain its highest significant effect on microbial count. Meanwhile, Calcuzn is rich in N, Ca, Mg, Cu, Zn, B and Mo. Some or all of these elements could have reached the soil directly as drips during foliar treatment; henceforth, positively affecting activity and population of soil microorganisms.

These results are in harmony with those obtained by Eissa (2003a and 2003b) on 'Kelsey' plum and 'Canino' apricot.

All treatments had significant positive effects on soil NPK analysis in both seasons, except that the effects of Atonic, Setter-2, Calcuzn and Faster treatments on P analysis were significant only in 2005. Wesko Plus K induced, once again, the greatest effects, though these effects were not significantly different from all other biostimulants on N in 2005 and on K in 2006 and from Atonic, Setter-2, and Faster treatments on P in 2005 (Table 3). These effects reflect the effective NPK content of the various biostimulants used, especially Wesko Plus K that has high N and K contents and which induced the greatest consistent positive effect on those two elements. Other materials used could have reached the soil directly as drips during foliar treatment. These results confirm those obtained by Eissa (2003a) on 'Kelsey' plum.

Table (3). Effect of 'Hollywood' plum treatment with some biostimulants on soil NPK analysis (%)

Treatment	N		P		K	
	2005	2006	2005	2006	2005	2006
Atonic	0.26	0.25	0.13	0.10	0.34	0.34
Setter-2	0.25	0.27	0.14	0.09	0.33	0.36
Calcuzn	0.27	0.28	0.11	0.12	0.33	0.33
Wesko Plus K	0.28	0.29	0.13	0.14	0.36	0.36
Faster	0.26	0.26	0.12	0.10	0.29	0.30
Control	0.18	0.21	0.10	0.11	0.21	0.25
$LSD_{0.05}$	0.08	0.02	0.02	0.02	0.02	0.06

Foliar measurements

Mostly, the Wesko Plus K treatment induced the highest positive significant effect on leaf NPK analysis, while the control treatment was significantly the least. However, the Atonic treatment induced significantly higher positive effect on leaf N content than the Wesko Plus K treatment in 2005, and the Atonic and Faster treatments were inferior to the control treatment regarding leaf K content in 2005. Similarly, Atonic and Setter-2 treatments were inferior to the control regarding leaf K analysis in 2006. Other treatments were mostly intermediate in their effects, and were sometimes not significantly different from each other, from the Wesko Plus K treatment, or from the control, without any specific trend in NPK analysis or seasons. However, N and K values were generally low, probably due to their late measurement in August.

These results reflect, to a large extent, the relative content of the different biostimulants used of the various nutrients, especially, N, P and K.

they are also in harmony with those obtained by Eissa (2003a) on 'Kelsey' plum.

Table (4). Effect of 'Hollywood' plum treatment with some biostimulants on leaf NPK analysis (%)

Treatment	N		P		K	
	2005	2006	2005	2006	2005	2006
Atonic	3.35	2.62	0.28	0.28	0.93	0.94
Setter-2	2.63	2.96	0.27	0.24	1.08	0.97
Calcuzn	2.17	3.28	0.46	0.37	1.13	1.13
Wesko Plus K	3.14	3.45	0.56	0.53	1.12	1.15
Faster	2.04	2.91	0.30	0.22	0.98	1.06
Control	2.16	2.63	0.26	0.22	1.02	1.03
$LSD_{0.05}$	0.02	0.41	0.02	0.26	0.02	0.06

The Wesko Plus K treatment also induced the highest positive significant effect on the number of leaves per shoot, leaf area, and leaf chlorophyll content. However, it was not significantly different from Setter-2 regarding the number of leaves per shoot in both seasons and chlorophyll reading in 2006, and from Calcuzn regarding leaf chlorophyll content in both seasons. The control treatment was low in these three characters, but it was not significantly different from each of (a) Atonic, Setter-2 and faster treatments regarding leaf area and chlorophyll content in both seasons; (b) Atonic and faster treatments regarding the number of leaves per shoot in 2005; (c) Calcuzn and faster treatments regarding the number of leaves per shoot in 2006; and (d) Calcuzn treatment regarding leaf chlorophyll content in 2005 (Table 5).

Table (5). Effect of 'Hollywood' plum treatment with some biostimulants on leaf number/shoot, area and chlorophyll content.

Treatment	Number of leaves/shoot		Leaf area (cm^2)		Chlorophyll reading (SPAD)	
	2005	2006	2005	2006	2005	2006
Atonic	86.67	94.32	18.88	18.67	40.63	40.93
Setter-2	120.00	114.30	19.43	18.94	41.02	41.90
Calcuzn	106.70	92.23	31.38	31.69	42.28	44.78
Wesko Plus K	130.00	112.20	38.32	44.26	46.47	46.00
Faster	80.00	86.65	18.25	17.82	41.33	42.75
Control	70.00	78.77	17.11	17.32	40.88	38.85
$LSD_{0.05}$	16.83	15.51	2.94	3.43	4.20	5.05

Consequent to the positive effect of the Wesko Plus K treatment on soil microflora (Table 2) and soil and leaf NPK analysis (Tables 3 and 4), it also induced the highest effects on the various foliar characters measured (Table 5). Treatment with Calcuzn, which is rich in Mg, was also high in leaf chlorophyll content in both seasons. Considering that Calcuzn and Setter-2 are high in N content (5 % in each), they also came next to Wesko Plus K regarding the number of leaves per shoot. Setter-2 with its additional content

of macro and microelements and organic acids, came also next to Wesko Plus K in leaf chlorophyll content.

Fruit set and yield

Fruit set values, as presented in Table 6, were calculated as percentage of fruits that were set of the total number of flowers produced. In both years of the study, the Wesko Plus K treatment was significantly the greatest in fruit set, while the control was significantly the lowest. Nevertheless, Wesko Plus K was not significantly different from Atonic or Calcuzn in 2005 and from Setter-2 or Calcuzn in 2006, while the control treatment was not significantly different from Faster in 2006.

Table (6). Effect of 'Hollywood' plum treatment with some biostimulants on fruit set and yield.

Treatment	Fruit set (%)		Yield/tree (kg)	
	2005	2006	2005	2006
Atonic	7.78	7.30	125.10	123.90
Setter-2	7.53	7.53	126.30	125.70
Calcuzn	8.10	7.96	128.60	128.30
Wesko Plus K	8.30	8.40	151.00	151.30
Faster	6.00	5.66	121.90	117.20
Control	4.50	4.86	90.61	89.56
$LSD_{0.05}$	0.73	0.85	6.62	4.67

Faster, which does not contain micronutrients, was the least effective in improving fruit set, while products containing micronutrients, i.e. Wesko plus K, Calcuzn, and Setter-2, were more effective. Setter-2 and Calcuzn are rich in B, which probably improves fruit set through its enhancement of pollen grain germination and growth.

Treatments resulted in significant clear-cut differences in yield. All products used induced significant increases in yield/tree relative to the control, with Wesko Plus K being the most effective and Faster the least. However, yield of the Faster treatment was not significantly different from that of Atonic or Setter-2 treatments in 2005 (Table 6).

These results are generally a reflection of the relative positive effects of the various treatments on the different measured characters [i.e. total soil microbial count (Table 2), soil (Table 3) and leaf (Table 4) NPK analysis, foliage characters (Table 5) and fruit set percentage (Table 6)], which are likely to be associated positively with yield.

Fruit quality attributes

Results obtained on fruit weight, size and polar and equatorial dimensions were nearly similar with respect to treatments applied. Wesko Plus K and Calcuzn were the best in increasing these characters in both years and control treatment the least. The faster treatment was not significantly different from the control in four occasions, viz., fruit weight, size and polar diameter in 2005, and fruit equatorial diameter in 2006. The remaining two treatments, viz., Atonic and Setter-2, were mostly intermediate in their effects on the measured characters. They were always significantly

different from the control, while in some instances they were not significantly different from either Wesko Plus K or Calcuzn, and still in some other instances they were not significantly different from the Faster treatment (Table 7).

Table (7). Effect of 'Hollywood' plum treatment with some biostimulants on weight, size, and dimensions of mature fruits.

Treatment	Weight (g)		Size (cm^3)		Polar diam. (cm)		Equatorial diam. (cm)	
	2005	2006	2005	2006	2005	2006	2005	2006
Atonic	51.89	52.34	52.08	51.63	4.66	4.60	4.20	4.36
Setter-2	51.28	54.22	52.08	52.50	4.47	4.60	4.20	4.46
Calcuzn	55.54	58.86	55.83	56.17	4.80	4.73	4.32	4.53
Wesko Plus K	56.58	59.02	57.83	57.82	4.76	4.70	4.40	4.60
Faster	47.79	51.41	47.59	50.80	4.45	4.50	4.13	4.20
Control	46.47	47.07	45.83	48.33	4.38	4.36	3.95	4.20
$LSD_{0.05}$	3.32	2.91	4.34	2.31	0.21	0.12	0.10	0.08

Nearly similar trends were obtained with the other fruit measurements, firmness, flesh thickness and TSS content. Meanwhile, the trend obtained with titratable acidity was different. The Atonic and control treatments were significantly the highest in fruit titratable acidity, while the Wesko Plus K, Calcuzn, Setter-2 and Faster treatments were significantly the least (Table 8).

Table (8). Effect of 'Hollywood' plum treatment with some biostimulants on firmness, flesh thickness, TSS and titratable acidity of mature fruits.

Treatment	Firmness ($lb/inch^2$)		Flesh thickness (cm)		TSS (%)		Titratable acidity (%)	
	2005	2006	2005	2006	2005	2006	2005	2006
Atonic	5.23	5.82	1.54	1.72	12.00	12.17	0.55	0.50
Setter-2	5.36	6.11	1.57	1.80	11.50	11.50	0.33	0.30
Calcuzn	5.65	6.11	1.61	1.81	13.50	13.50	0.33	0.32
Wesko Plus K	5.25	4.73	1.75	1.84	13.50	13.50	0.36	0.36
Faster	4.84	5.61	1.45	1.72	11.27	11.33	0.36	0.35
Control	5.95	6.37	1.47	1.63	11.00	10.50	0.60	0.58
$LSD_{0.05}$	0.53	1.20	0.06	0.06	0.38	0.81	0.08	0.09

These results are in accordance with the relative effects obtained for the various treatments on the different measurements made in this study. Apparently, the presence of organic acids, vitamins, natural organic compounds, free amino acids, in addition to nutrients P and K only, as present in Faster, was not sufficient for improving the various fruit quality criteria. Concerning treatments' effects on fruit titratable acidity, it seemed logical that the control treatment, which did not enhance any of the fruit measurements, was the highest in titratable acidity, which is indicative of delayed maturity. However, Atonic, which is marketed as a natural plants

growth stimulator, was not significantly different from the control treatment, a result not explainable on light of Atonic's effect on other fruit quality measurements.

General discussion

Wesko Plus K, a commercial product rich in K-humate (56%) and several nutrients in addition to amino acids (3 %) ranked first in its positive effects on all soil and plant measurements recorded, though, in some characters, it was not significantly different in its effects from Calcuzn, a commercial product rich in all micronutrients, in addition to N, Ca, Mg (Tables 2-8).

Though it is not fully clear how HA and humates, such as K-H induce their effects, some studies had suggested that these compounds can mimic plant hormones (Senn and Kingman, 1975; Tattini *et al*., 1991; Chunhual *et al*., 1998). O'Donnel (1973) had found that HA promoted root tip elongation in peas, which was similar to the effects of auxin compounds. HA had been also shown to induce bioassay effects similar to those of cytokinin and gibberellin (Hoany and Tichy, 1976). Other benefits ascribed to the use of HA and humates include increased nutrient uptake, tolerance to drought, and temperature extremes, activity of beneficial soil microorganisms, and availability of soil nutrients (Senn and Kingman, 1975 and Russo and Berlyn, 1990).

According to Chen *et al*. (2002), two soil biostimulants, vastly different in their content of the various macro and microelements, stimulated both the breakdown and mineralization of soil organic materials, perhaps by selectively inhibiting or stimulating particular components of the microbial community, leading to lasting increases in soil nitrogen.

In the present study, two commercial products, viz., Setter-2 and Calcuzn, were particularly rich in B, which contributes to seed set, fruit set and consequently, to fruit size and weight. In a previous study, fall foliar sprays of B to lowbush blue berry plants (*Vaccinium angustifolium* Ait.) increased the number of seeds per berry (Chen *et al*., 1998). Also, foliar applied B to almond trees [*Prunus dulcis* (Mill.) D.A. Webb] enhanced *in vivo* pollen germination and tube growth (Nyomora *et al*., 1999).

Most character measurements in the present study (Tables 2-8) were highly associated with each other. In former studies, positive significant correlations were found between olive leaf K concentration and each of fruit set (Talaie and Taheri, 2001), size and weight (Taheri and Talaie, 2001).

These results are in harmony with positive results previously reported for the application of various biostimulants and micronutrients on vegetative growth, flowering, fruit set, fruit yield and/or fruit quality in each of *Citrus* spp (Webb and Biggs, 1988; Swietlik, 1991; Alva and Obreza, 1998) using HA and/or K-H; apples (Li *et al*., 1999) using liquid fertilizers containing HA; apple (Johnson *et al*., 1999) and pears (Voltman *et al*., 1999) using ascorbic acid; apples, pears and plums (Filiti *et al*., 1986) using preparations containing AAs and peptides; peach and apples (Fathi *et al*., 2002) using biostimulants Super Tron, K-H or ascorbic acid; apricots (Eissa *et al*., 2003 and Eissa 2003b) using commercial biostimulants Super Tron or K-H, and plums (Eissa 2003a) using biostimulants Retender or Vegimax. Though not considered as

biostimulants, nutrient elements, which are commonly used as enrichments to commercial biostimulants including some of those used in the present study have often given similar positive results when used as foliar sprays. These responses are evident from the studies of Kabeel *et al*. (1998) and Wojcik and Wojcik (2003) on pears and those of Stover *et al*. (1999) on apples.

Conclusion

Based on the results obtained, it is concluded that the Wesko Plus K treatment (at the rate of 250 g/tree incorporated into the soil before bud swelling was the best among treatments applied in improving growth, yield, and fruit quality characteristics of 'Hollywood' plums. The Calcuzn treatment (applied foliarly at the rate of 30 g/20 l (5 l of spray solution/tree) at bud swelling, after fruit set and 3 weeks later) followed closely the Wesko Plus K treatment in its positive effects. These two treatments is recommended for the improvement of growth, yield, and fruit quality of 'Hollywood' plum under loamy clay soil condition.

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تحسين النمو الخضرى، والإزهار، والمحصول، وجودة ثمار البرقوق هوليوود باستعمال بعض المنشطات الحيوية والأسمدة الورقية

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درست استجابة صنف البرقوق هوليوود للمعاملة بخمسة منشطات نمو وأسمدة ورقية تجارية متاحة محلياً فى مزرعة خاصة بمحافظة المنوفية خلال موسمى ٢٠٠٥، ٢٠٠٦. استعمل تصميم القطاعات الكاملة العشوائية. سجلت النتائج على كل من أعداد الكائنات الدقيقة من البكتيريا والاكتينوميسينات والفطريات بالتربة، وتحليل النيتروجين والفوسفور والبوتاسيوم فى كل من التربة والأوراق، وصفات النمو الخضرى من حيث عدد الأوراق ومساحة الورقة ومحتواها من الكلوروفيل، والإزهار، ونسبة عقد الثمار، ومحصول الشجرة، وصفات جودة الثمار من حيث الوزن والحجم والقطرين القطبى والاستوائي والصلابة وسمك اللحم ومحتوى المواد الصلبة الذائبة الكلية والحموضة المعايرة. وكانت المنتجات المستخدمة هى: فسكو بلص الذى يحتوى على ٥٦ % هيومات بوتاسيوم بالإضافة الى عناصر دقيقة وبوليمرات و ٣ % أحماض أمينية، واتونك الذى يحتوى على ٠,٦ % مركبات نيتروجينية عطرية ، و ستر ٢ الغنى فى محتواه من كل من حامض الأسكوربيك وحامض الستريك والنيتروجين والكالسيوم والنحاس والمنجنيز والبورون، وفاستر الغنى أيضا فى حامضى الأسكوربيك والستريك بالإضافة الى الفوسفور والبوتاسيوم والذى يحتوى –كذلك- على عديد من المركبات العضوية التى تتضمن بروتينات حرة وببتيدات، وكالكوزن الغنى فى كل من النيتروجين والكالسيوم والماغنسيوم وجميع العناصر الدقيقة. وقد كان للمعاملة بمعظم هذه المنتجات تأثيرات إيجابية معنوية على جميع الصفات المقيسة مقارنة بمعاملة الكنترول. كانت المعاملة بالفسكو بلص الأولى فى التأثير الإيجابي، وتلتها المعاملة بالكالكوزن، ولكن تأثيراتهما لم تختلف جوهرياً عن بعضهما البعض فى عديد من الصفات المقيسة وغالباً كانت تأثيرات معاملات الأتونك، و ستر-٢، وفاستر وسطاً بين معاملتى الفسكو بلص والكالكوزن من جهة والكنترول من جهة أخرى، إلا أن واحداً أو اكثر من تلك المنشطات لم تختلف جوهرياً عن الكنترول فى بعض الصفات المدروسة. ولقد أوصت الدراسة بالمعاملة إما بالفسكو بلص واما بالكالكوزن لأجل تحسين النمو والمحصول وجودة ثمار صنف البرقوق هوليوود المزروع فى الأراضي الطميية الطينية.