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A PILOT STUDY EXPLORING THE EFFECTS OF BEE HONEY AS A BIO-FERTILIZER ON THE MORPHOLOGICAL FEATURES AND CHEMICAL CONSTITUENTS OF *Syngonium podophyllum* PLANTS

Safia H. El-Hanafy
Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Egypt.

ABSTRACT

Foliage ornamental plants are part and parcel of interiorscaping. Adequate fertilization is essential for their growth, and preservation of viability. Syngonium is a foliage perennial climbing indoor plant characterized by its variably-looking leaves according to its stage of development. Honey is a very complex bee product rich in essential, as well as trace elements, some of which is a component of plant sap, being sucked as nectar by the forager bee. The aim of this study is to explore the effect of spraying dilute preparations of bee honey, as a bio-fertilizer, on growth and chemical constituents of Syngonium podophyllum plants.

Terminal cuttings of Syngonium plant were planted in pots. The plants were divided into 8 groups. Two control groups of plants were used; the first received only water, while the second received Kristalon fertilizer at the rate of 1g /plant every two weeks. The first three treatment groups were drenched with Kristalon fertilizer and sprayed with a diluted solution of honey at the concentrations of 1, 1.5 and 2% for T1, T2 and T3 respectively. The other three treatment groups were only sprayed with a diluted solution of honey at the same concentrations

The plants were left to grow under the condition of glass house for one month before starting treatment. The procedure of spraying and drenching was repeated for different groups every two weeks for a total of 7 months.

At the end of the experiment for every season, the following morphological data were recorded for all groups of plants: plant height, number of leaves per plant, leaf area for the 5th leaf counted from below, fresh and dry weights of leaves per plant, stem diameter, fresh and dry weights of stems, root length, fresh and dry weights of roots.

The chemical analysis included the pigment content of chlorophyll a, chlorophyll b and carotenoids in fresh leaves, and nitrogen, phosphorus, potassium and total carbohydrate percentages in dry leaves, the collected data were statistically analyzed.

The overall analyzed results indicate that, regular spraying of diluted honey for Syngonium podophyllum plants with, or even without Kristalon was associated with adequate growth of the above ground plant parts, with *fluctuation of superiority between the use of honey alone or its use combined with the chemical fertilizer, Kristalon. Being a source of many essential plant nutrients and trace elements, honey can thus represent a highly nutritious fortifying bio-fertilizer that may be used alone or in conjunction with another fertilizer, with almost the same or slightly different results. However, the amount of available information is in need of further studies on different plants, using honey with /or alternative to different fertilizers to portrait a more clear picture of this bio-fertilizer in plant life.*

Key words: Syngonium, honey, morphological features, chemical constituents

INTRODUCTION

Indoor foliage ornamental plants are widely used for interiorscaping. They are now taking an essential role as a component of interior design of public, as well as, private establishments. Consequently, these plants may represent an economic value for different countries. Adequate fertilization is essential for growth, and preservation of viability, with improvement of leaf features which represent the main element of decoration offered by these plants. *Syngonium* is a foliage perennial climbing indoor plant characterized by its variably-looking leaves according to its stage of development. Most of the known chemical fertilizers in use contain N., P., K. and trace elements which are essential nutrients for plant growth and development, and are commonly lacking in soil.

Honey is one of the secretory products of the pollinating, plant-sucking insect *Apis mellifera* (forager bee). During the formation of honey, bees depend on nectar which is secreted by glandular tissue of flowers. Thus, an important component of honey is a plant product. In addition, plant sap that is taken up by bees, and that exceeds their capacity, is secreted in small droplets to fall on the surface of leaves and solidify quickly forming honey dew, before being taken up again by bees. Some of the enzymes used in hives for ripening of honey are also of plant origin (Maurizio, 1975).

Honey is an aqueous dispersion of material covering a wide range of particle size including inorganic ions, monosaccharide's (mainly fructose and glucose), disaccharides (sucrose and other rare sugars as maltose and isomaltose), and polysaccharides (melezitose, raffinose, dextrin and others) (Shin and Ustunol, 2005). Proteins including albumins, globulins, peptones, nucleoproteins, amides, as well as amino acids are also present in honey (White, 1975). The main amino acids found in 31 Spanish honeys of five different single botanical origins, were proline, phenylalanine, tyrosine and lysine, followed by arginine, glutamic acid, histidine and valine (Hermosin *et al*, 2003).

However, its composition depends upon the components of nectar, and external factors as weather and bee keeper practices in extracting honey, as well as the period and condition of storage (Ouchemoukh *et al*, 2007).

The pH of honey which averages 3.9 (3.2-4.5), is attributed to its acid content which includes organic acids like acetic, butyric, citric, gluconic, lactic, maleic, malic, oxalic, pyroglutamic, succinic and amino acids. Gluconic acid is present in considerable excess over all other acids, and is produced by the action of glucose oxidase in honey upon the dextrose in it. This acid is present in honey in equilibrium with its lactone. Acids corresponding to inorganic ions such as phosphate, chloride and sulphate may also be considered to be honey constituents (White, 1975).

Honey ash includes potassium, sodium, calcium, magnesium, chloride, phosphorus, sulphur and silica (Terrab *et al*, 2004). Honey also contains iron, copper and manganese. Small amounts of other elements have been found in some types of honey of different origins such as aluminum, iodine, boron, titanium, molybdenum, cobalt, zinc, lead, tin, antimony, chromium and nickel (Rashed and Soltan, 2004).

Honey also contains a battery of enzymes including glucose oxidase, catalase, invertase, acid phosphatase and diastase. Glucose oxidase acts on glucose in honey to form gluconic acid and hydrogen peroxide with its known antibacterial activity. Catalase enzyme acts on hydrogen peroxide in honey to release nascent oxygen. Diastase enzyme digests starch in honey (White, 1975).

Vitamin B (thiamine, riboflavin, pyridoxine, niacin and pantothenic acid) and vitamin C (ascorbic acid) represent minor constituents of honey. Other minor constituents include carotenoids, polyphenolic compounds, formaldehyde, acetaldehyde, acetone, isobuteraldehyde, diacetyl-hydroxymethyl-furaldehyde and others (White, 1975).

Sixty six volatile compounds were detected in Spanish citrus honeys (Vazquez *et al*, 2007)

Honey lipids include glycerides, sterols, phospholipids, fatty acids (palmetic, oleic, lauric, myristoleic, stearic and linoleic) and traces of bee wax (White, 1975). Antioxidant and scavengering activities of honey were confirmed by Kucuk *et al* (2007).

Flavonoids are major functional components of many herbal and insect preparations e.g., propolis (bee's glue) and honey, which have been used medically since ancient times. Flavonoids are plant pigments ubiquitous to green plant cells. The flavonoids are used by botanists for taxonomical classification. They regulate plant growth by inhibition of the exocytosis of the auxin indolyl acetic acid, as well as by induction of gene expression (Havsteen, 2002).

The aim of this study is to explore the effect of spraying dilute preparations of bee honey, as a biofertilizer, on growth and chemical constituents of *Syngonium podophyllum* plants.

MATERIALS AND METHODS

This experimental trial was performed throughout two successive seasons (2003/2004 and 2004/2005) at the Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Egypt.

Terminal cuttings of the perennial foliage plant, *Syngonium podophyllum*, taken from mother plants grown in the Nursery (each having 4 leaves, and was 15cm high), were planted on Oct.1st 2003 and 2004 (in the first and second seasons, respectively) in 20 cm diameter plastic pots filled with 1:1(by volume) mixture of fine sand and peat moss at a rate of one plant per pot. Chemical analysis of the growing medium was carried out by Soils and Waters Research Institute, Agriculture Research Center, as shown in Table A.

Table A: Chemical analysis of growing medium according to Soils and Waters Research Institute, Agriculture Research Center, Ministry of Agriculture

Fine sand + peat moss	Anions			Cations (ppm)				pH	EC
	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+		Mmhos /cm
	5.2	6.4	9.5	6	3.4	9.6	2.0	7.2	1.3
	N	P	K	Fe	Zn	Mn			
	52	14.29	60.45	5.86	6.2	14.78			

The plants were divided into 8 groups (shown in Table B), each consisting of 18 plants. Two control groups of plants were used, the first received only water, while the second received Kristalon fertilizer containing N: P: K: Mg (19; 19:19:2), at the rate of 1g/plant every two weeks. The first three treatment groups were drenched with Kristalon fertilizer and sprayed with a diluted solution of honey at the concentrations of 1, 1.5 or 2% for T1, T2 and T3 respectively. The other three treatment groups were only sprayed with a diluted solution of honey at the concentrations of 1, 1.5 or 2% for T4, T5 and T6, respectively.

Table B:

Groups	Procedure (every 2 weeks) Drenching	Spraying
C1	Water	Water
C2	Kristalon 1g /plant	Water
T1	Kristalon 1g /plant	Honey 1%
T2	Kristalon 1g /plant	Honey1.5%
T3	Kristalon 1g /plant	Honey 2%
T4	Water	Honey 1%
T5	Water	Honey1.5%
T6	Water	Honey 2%

(C)= Control. (T) = Treatment groups

The honey used in spraying was an Egyptian product, licensed by the Egyptian ministry of health under the number 3682-2005, and attested by the American

Systems Registrar, a provider of ISO 9000, accredited by the ANSI-ASQ National Accreditation Board.

The plants were left to grow under the condition of glass house for one month before starting treatment. The procedure of spraying and drenching was repeated for different groups (shown in Table b) every two weeks till the first of July (a total of 7 months from the beginning of treatment for every season). Regular agricultural practices such as irrigation, weeding …..etc were carried out whenever necessary.

At the end of the experiment for every season, the following morphological data were recorded for all groups of plants: plant height (cm), number of leaves per plant, leaf area (cm2) for the 5^{th} leaf counted from below, fresh and dry weights of leaves per plant (g.), stem diameter (cm), fresh and dry weights of stems (g.), root length (cm), fresh and dry weights of roots (g).

The chemical analysis included the pigment content of chlorophyll a, chlorophyll b and carotenoids (mg/g.) in fresh leaves (a method of estimation according to Saric *et al*, 1976), and nitrogen, phosphorus, potassium and total carbohydrate percentages in dry leaves. Nitrogen percentage was estimated by Nesslar method according to the procedure of A.O.A.C. (1960). Phosphorus percentage was determined according to Troug and Meyer (1939). Potassium percentage was determined by using Flame Photometer 410 (Dewis and Freitas, 1970). Carbohydrate percentage was determined according to Dubois *et al* (1956).

The design for this experiment was Complete Randomized Design (CRD) with three replicates. Data were statistically analyzed with the Analysis of Variance (ANOVA) according to Snedecor and Cochran (1980) using Mstatc program. When significant differences ($P<0.05$) were detected, the least significant difference (LSD) test was used to separate the mean values according to Steel and Torrie (1981).

RESULTS AND DISCUSSION

1. Morphological changes (Table 1&2)

1.1. Plant height (cm)

In comparison to the first control (C1), data in Table 1 show clear increment in plant height with all treatments in both seasons, with the increase being significant in most of the treatments. In comparison to the second control (C2), five of the treatments had significantly higher results in both seasons. In comparing the first triad of treatments (3 treatments consisting of honey at 3 concentrations + Kristalon) with the second triad (the other 3 treatments consisting of honey alone at 3 concentrations), Honey alone gave higher results in both seasons (75.72 versus 70.73 cm and 95.17 versus 79.59 cm for the first and second seasons respectively). Honey alone at 1% (T4) gave the highest results in both seasons (85.22 and 99.11 cm with T4 compared to 63.37 and 75.25 cm with Kristalon alone in C2 in the first and second seasons, respectively).

1.2. Leaf parameter (Table 1)

1.2.1. Number of leaves /plants

In comparison to C1, data show increment in plant height with all treatments in both seasons, with the increase being significant in most of the treatments. In comparison to C2, no significant differences were recorded with any of the treatments in the first season, while three treatments (T1, T5, T6) gave significantly higher results in the second season. On comparing the two triads of treatment (the triad of honey with Kristalon in comparison to the triad of honey alone), the mean value was significantly higher with the first triad in the first season (12.30 versus 11.28 leaves /plant), and with the second triad in the second season (14.90 versus 13.87 leaves /plant). The highest result was recorded with T1 (honey at 1% + Kristalon) in both seasons.

1.2.2. Leaf area (cm^2)

In comparison to C1, data show increment in leaf area with all treatments in both seasons; with the increase being significant in most of the treatments (it was insignificant only with T3 in the second season). In comparison to C2, leaf area was higher with all the honey alone-treatments in both seasons, with the increments being significant in the first season. T1(honey 1% with Kristalon) gave significantly higher results in both seasons compared to C2 (Kristalon alone). On comparing the two triads of treatment, honey alone was associated with higher results in both seasons, with significance in the first (169.31 versus 139.46 cm^2 and 118.74 versus 118.23 cm^2 for the first and second seasons respectively). The best results were recorded with honey 1% in the first season, and honey 1% with Kristalon in the second.

1.2.3. Fresh weight of leaves (g)

In comparison to C1, all treatments in both seasons gave significantly higher results except for only one insignificant increment with T3 in the second season. In comparison to C2, no significant differences were noted with most of the treatments in both seasons. On comparing the two triads of treatment (the triad of honey with Kristalon in comparison to the triad of honey alone), the mean value was significantly higher with the first triad in the first season (36.31 versus 29.88 g), and with the second triad (with insignificance) in the second season. The highest result was recorded with T1 (honey at 1% + Kristalon) in both seasons.

1.2.4. Dry weight of leaves (g)

In comparison to C1, all treatments in both seasons gave higher results. In comparison to C2, irregular results were recorded with no clear trend in either season.

On comparing the two triads of treatment (the triad of honey with Kristalon in comparison to the triad of honey alone), the mean value was significantly higher with the first triad in the first season (8.80 versus 6.95 g), and with the second triad (with insignificance) in the second season. The highest result was recorded with T1 (honey at 1% + Kristalon) in the first season, and with T5 (honey alone at 1.5%) in the second.

Table 1: Morphological changes of Syngonium plants including plant height, number of leaves/plant, leaf area and fresh and dry weights of leaves per plant in the first and second seasons (2003/2004 and 2004 /

Treatment	Plant height (cm)		Number of leaves /plant		Fifth leaf area (cm^2)		Fresh Wt. of leaves (g)		Dry Wt. of leaves (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
C1(water)	51.19 f	68.47 e	9.86 e	10.71 d	102.98	92.8	23.69	18.20	5.66 d	4.03
C2 (Kristalon)	63.37 e	75.25 d	11.78	13.30	142.45	114.	33.09	26.42	8.32 b	6.32
T1 (K+H 1%)	81.21 b	85.25 c	12.49 a	15.60 a	155.38	135.	44.58	37.45	11.15	7.96
T2 (K+H 1.5%)	64.55	84.85 c	12.06 abc	13.88	137.97	123.	33.93	25.68	7.89	6.12
T3 (K+H 2%)	66.43 d	68.67 e	12.36 ab	12.12	125.02	96.0	30.43	20.64	7.37	5.07
T4 (H 1%)	85.22 a	99.11 a	11.49 bcd	14.31	173.50	122.	30.75	32.11	7.20	7.03
T5 (H 1.5%)	70.37 c	93.18 b	11.01 d	15.15 a	166.53	118.	29.26	31.92	6.76	10.0
T6 (H 2%)	71.57 c	93.23 b	11.35 cd	15.23 a	167.90	115.	29.63	28.11	6.89 c	6.50
LSD at 0.05	2.64	2.67	0.898	1.78	9.88	8.65	4.72	4.37	1.14	1.53
First triad (T1–T3)	70.73	79.59 b	12.303 a	13.87	139.46	118.	36.31	27.92	8.80 a	6.38
Second triad (T4–	75.72	95.173 a	11.283 b	14.90	169.31	118.	29.88	30.71	6.95 b	7.85
1st triad V. 2nd	N.S.	S.	S.	N.S.	S.	N.S.	S.	N.S.	S.	N.S.

Means with different letters within each column are significant at 0.05 level and means without letters are not significant. C = control T = treatment K = Kristalon fertilizer 1g/plant H = honey Wt = weight V. = versus

Table 2: Morphological changes in singonium plant including stem diameter,stem fresh and dry

Treatment	Stem diameter		Stem F.W. (g)		Stem D.W. (g)		Root length (cm)		Root F.W. (g)		Root D.W. (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
C1(water)	0.62 c	0.74 d	10.02 d	16.00 c	1.74 d	2.55e	47.55 e	46.58 abc	9.00 b	19.76 c	2.70 bc	5.91 de
C2 (Kristalon)	0.71 ab	0.85 bc	15.34 ab	19.69 bc	2.26 cd	2.78 de	69.00 b	44.37 bcd	9.80 b	21.58 bc	2.75 bc	6.00 de
T1 (K+H 1%)	0.75 a	0.90 ab	17.15 a	22.30 ab	3.01 abc	3.54 cd	65.11 bc	47.32 abc	11.13 ab	24.00 b	2.90 bc	6.78 bcd
T2(K+H 1.5%)	0.71 ab	0.91 a	16.76 a	18.33 bc	3.07 ab	3.50 cd	60.95 c	42.53 cd	10.78 b	19.38 c	3.85 a	5.41 e
T3(K+H 2%)	0.72 ab	0.91 a	13.01 bc	15.97 c	3.25 a	3.54 cd	68.03 b	39.86 d	9.40 b	20.49 bc	2.92 bc	6.57 cde
T4 (H 1%)	0.69 b	0.83c	13.04 bc	25.40 a	2.42 bcd	5.43 a	56.55 d	44.71 bcd	11.57 ab	25. 61 b	3.59 ab	7.89 b
T5 (H 1.5%)	0.72 ab	0.84 c	13.41 bc	22.23 ab	2.31 bcd	4.05 bc	67.89 b	51.76 a	9.44 b	36.82 a	2.27 c	9.35 a
T6 (H 2%)	0.71 ab	0.82 c	11.47 cd	20.54 b	2.10 d	4.66 ab	75.40 a	49.75 ab	14.00 a	33.24 a	3.50 ab	7.70 bc
LSD at 0.05	0.055	0.055	2.702	4.136	0.764	0.862	4.257	5.968	3.002	3.904	0.908	1.22
First triad (T1-T3)	0.727	0.908a	15.640 a	18.867b	3.109 a	3.526 b	64.697	43.237	10.438	21.290 b	3.220	6.25 b
Second triad(T4-T6)	0.703	0.831 b	12.640 b	22.723 a	2.279 b	4.714 a	66.613	48.740	11.670	31.888 a	3.118	8.31 a
1st triad V. 2nd triad	N.S	S.	S.	S.	S.	S.	N.S.	N.S.	N.S.	S.	N.S.	S.

Means with different letters within each column are significant at □ 0.05 level and means without letters are not significant. C = control T = treatment K = Kristalon fertilizer 1g/plant H = honey Wt = weight V. = versus

1.3. Stem parameters (Table 2)

1.3.1. Stem diameter (cm)

In comparison to C1, all treatments were associated with increments in both experimental seasons. In comparison to C2, insignificance was the main feature among results in the first season, while the combination of honey with Kristalon gave almost significantly higher results in the second. On comparing the two triads of treatment, the mean value of the first triad was insignificantly higher in the first season, and significantly higher (0.908 versus 0.831cm) in the second. The highest result was recorded with T1 (honey at 1% + Kristalon) in the first season, and with T2 and T3 in the second.

1.3.2. Fresh weight of stem (g)

In comparison to C1, all treatments gave higher results in both seasons. In comparison to C2, irregular results were recorded in both seasons with no clear trend. On comparing the two triads of treatment (the triad of honey with Kristalon in comparison to the triad of honey alone), the mean value was significantly higher with the first triad in the first season, and with the second triad (22.72 versus 18.87 g) in the second season. The highest result was recorded with T1 (honey at 1% + Kristalon) in the first season, and with T4 (Honey alone at 1%) in the second.

1.3.3. Dry weight of stem (g)

All treatments were associated with higher results in comparison to water (C1), as well as to Kristalon (C2) in both seasons. . On comparing the two triads of treatment (the triad of honey with Kristalon in comparison to the triad of honey alone), the mean value was significantly higher with the first triad in the first season, and with the second triad (4.71 versus 3.53g) in the second season. The highest result was recorded with T3 (honey at 2% + Kristalon) in the first season, and with T6 (Honey alone at 2%) in the second.

Generally speaking, shoot growth was enhanced in the presence of honey treatments, whether alone or mixed with Kristalon fertilizer, with either situation swinging alternatively towards the top. This may infer that honey might be used alone to guarantee almost the same degree of shoot enhancement. This, however, should be confirmed by further experiments on different plants, as there are no available studies to be compared to the results of this work.

In this study, the rate of application of diluted honey was every two weeks. Increasing the frequency of application may possibly give better results. Khattab (1997) noticed that increasing the frequency of spraying of a nutrient solution containing Mg, Mn, Cu, Zn, B, Mo and Co onto *Hibiscus sabdariffa* increased plant growth.

Diluted honey may be tried in future studies as a hydroponic nutrient solution. Kang and Iersel (2004) studied the effect of nutrient concentration of the fertilizer Hoagland nutrient solution on growth of salvia and found that shoot growth increased with increasing nutrient solution concentration.

1.4. Root parameters (Table 2)

1.4.1. Root length (cm)

Significantly higher results were recorded with all treatments in the first season in comparison to water (C1), while irregular results were recorded in the second. In comparison to C2, no clear trend was noted in either season. The mean of the second triad (honey alone) was insignificantly higher in both seasons in comparison to the first triad of treatments (honey with Kristalon). The longest root value was recorded with T6 in the first and T5 in the second season.

1.4.2. Fresh weight of roots (g)

In comparison to C1, no remarkable differences were recorded with most treatments in both seasons. In comparison to C2, honey-alone treatments were generally associated with higher results, while the honey-Kristalon combinations had no remarkable associated results. On comparing the two triads of treatments, the honey-alone treatments were associated with higher results in both seasons, with the increments being significant in the second. The heaviest fresh weight of roots was associated with T6 in the first season and T5 in the second.

1.4.3. Dry weight of roots (g)

In comparison to C1, half of the treatments (T2, T4, and T6) had significantly higher results, while the other treatments showed no remarkable differences in the first season. The honey-alone treatments had significantly higher results in the second season compared to C1. In comparison to C2, only T2 treatment had a significantly higher result in the first season, while all the honey-alone treatments had significantly higher results in the second season. Comparison of the two triads revealed a higher first triad in the first season and a significantly higher second triad (the honey-alone treatments) in the second season. The heaviest roots were recorded with T2 in the first season and T5 in the second.

2. Chemical constituents in leaves (Table 3)

2.1.Pigments {mg/g in fresh weight (F.W.) of leaves}

2.1.1. Chlorophyll (A)

In comparison to C1, almost all treatments had higher results in both seasons. In comparison to C2, the results of all treatments were lower in the first season, while they demonstrated significant increments with T5 and T6 in the second season. The honey-Kristalon triad of treatments was insignificantly higher than the honey-alone triad in the first season, while the honey-alone triad was significantly higher (0.88 versus 0.78 mg/g) in the second season. The highest record of chlorophyll a was that with Kristalon alone in the first season, while it was with honey 2% alone in the second season.

2.1.2. Chlorophyll (B)

Most of the treatments gave higher results in comparison with C1 and lower results in comparison with C2 in both seasons. The first triad of treatments had higher results than the second triad in both seasons, with insignificance in the second season. The highest records of chlorophyll b content were those with Kristalon alone in the first season, and equally with Kristalon alone and honey 2% + Kristalon in the second season.

2.1.3. Carotenoids

Almost all treatments were associated with decreased results in comparison to both controls in both seasons. In addition, no significant differences were recorded between the results of the honey-Kristalon treatments and the honey-alone treatments in both seasons. The highest content of carotenoids was recorded with Kristalon alone in the first season, and with water alone or with honey 2% + Kristalon in the second season.

Utriainen and Holopainen (2001) studied the influence of nitrogen and phosphorus availability on Norway spruce seedlings and concluded that chlorophyll a &b as well as carotenoids increased significantly in response to the nitrogen and phosphorus treatment. On the other hand, Doncheva *et al* (2001), on pepper, detected drop in pigment content with nitrogen deficiency, with the conclusion that, nitrogen plays an important role in the synthesis of chloroplast.

Table 3. Chemical constituents: pigment content (mg/g) in fresh leaves of Syngonium plant in response to honey in the first and second seasons

Treatment	Chlorophyll a		Chlorophyll b		*Carotenoids*	
	1st	2nd	1st	2nd	1st	2nd
C1:water	0.86 d	0.76 d	0.30 cd	0.24 bc	0.41 ab	0.31 a
C2:Kristalon	1.13 a	0.81 c	0.38 a	0.28 a	0.44 a	0.30 a
T1:K+H1%	0.95 c	0.76 d	0.37 a	0.26 ab	0.38 b	0.29 a
T2:K+H1.5%	0.89 d	0.79 cd	0.32 bc	0.28 a	0.25 d	0.24 b
T3:K+H2%	1.06 b	0.78 cd	0.35 ab	0.27 ab	0.40 b	0.31 a
T4: H 1%	0.96 c	0.79 cd	0.32 bc	0.26 ab	0.34 c	0.30 a
T5: H 1.5%	0.89 d	0.89 b	0.30 cd	0.22 c	0.27 d	0.25 b
T6: H 2%	0.93 c	0.95 a	0.32 bc	0.26 ab	0.33 c	0.29 a
LSD at 0.05	0.031	0.034	0.034	0.034	0.036	0.034
1st triad:T1−T3	0.97	0.78 b	0.35 a	0.27	0.34	0.28
2nd triad:T4−T6	0.93	0.88 a	0.31 b	0.25	0.31	0.28
1st triad V. 2nd triad	N.S.	S.	S.	N.S.	N.S.	N.S.

Means with different letters within each column are significant at $P < 0.05$ level and means without letters are not significant LSD = least significant difference. C=Control T=Treatment K=Kristalon H= Honey V. = Versus.

2.2. Nitrogen percentage (Table 4)

In comparison to C1, no characteristic differences were recorded, as both seasons were associated with higher, lower or almost equal results. In comparison to C2, higher results were recorded with all treatments in the first season, while the second was associated with irregular differences. Comparison of the two triads of treatments revealed almost equal results in the first season, and significantly higher first triad results (1.31 versus 1.21 %) in the second season. The highest nitrogen content was recorded with honey 1.5% + Kristalon in both seasons.

Table 4. Chemical constituents: N., P., K. and carbohydrate percentages in dry leaves of Syngonium plant in response to honey in the first and second seasons

Treatments	Nitrogen		Phosphorus		Potassium		Carbohydrate	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
C1:Water	1.11 bc	1.30 b	0.43 c	0.37 bc	1.56 b	1.66 a	30.26 c	35.66
C2:Kristalon	1.06 c	1.27 bc	0.51 ab	0.38 b	1.42 d	1.60 a	37.81 ab	32.66
T1:K+ H1%	1.09 bc	1.20 cd	0.45 bc	0.31 cd	1.36 e	1.62 a	39.09 ab	34.67
T2:K+ H1.5%	1.46 a	1.39 a	0.52ab	0.16 e	1.58 b	1.15 d	37.63 d	31.97
T3:K+ H2%	1.07 bc	1.33 ab	0.38 c	0.52 a	1.76 a	1.44 b	38.56 ab	33.24
T4: H 1%	1.41 a	1.14 d	0.58 a	0.34 bc	1.22 f	1.38 b	28.39 c	33.00
;:H 1.5%	1.14 b	1.20 cd	0.25 d	0.27 d	1.13 g	1.38 b	39.95 a	36.37
T6: H 2%	1.09 bc	1.28 b	0.52 ab	0.36 bc	1.48 c	1.26 c	39.59 ab	36.18
D at 0.05	0.08	0.08	0.08	0.05	0.05	0.09	2.14	N.S
1st triad: T1–T3	1.21	1.31 a	0.45	0.33	1.57 a	1.40	38.43	33.29
2nd triad: T4–T6	1.22	1.21 b	0.45	0.32	1.28 b	1.34	35.98	35.18
t triad 2nd triad	N.S.	S.	N.S.	N.S.	S.	N.S.	N.S.	N.S.

Means with different letters within each column are significant at $P < 0.05$ level and means without letters are not significant LSD = least significant difference. C=Control T= Treatment K=Kristalon H=Honey V. =Versus

2.3. Phosphorus percentage (Table 4)

No clear trend was observed in either season, on comparing different treatments with either of the two controls. Almost the same mean values were also recorded with the honey-Kristalon combination treatments and with the honey-alone treatments. The highest phosphorus percentage in dry leaves was that with 1% honey alone in the first season, and with 2% honey + Kristalon in the second.

2.4. Potassium percentage (Table 4)

No common Table differences were recorded with different treatments in comparison to either control in either season. The honey-Kristalon triad of treatments had higher mean values in both seasons in comparison to the honey-alone triad, with the difference being significant only in the first season. The highest potassium percentage in dry leaves was that with the 2% honey + Kristalon treatment in the first season, and with the 1% honey + Kristalon treatment in the second.

2.5. Total carbohydrate percentage

Regarding comparison with C1, almost all treatments gave higher results in the first season, while only T5 and T6 had higher results in the second. In comparison to C2, most of the treatments were slightly higher in both seasons. The mean value of carbohydrate percentage was insignificantly higher with the first triad of treatments in the first season 38.43 versus 35.98 %), and with the second triad in the second season 35.18 versus 33.29 %). The highest result was recorded with honey at 1% in both seasons.

In general, the lowest concentration of 1% honey was in most of the results the more effective one, compared to the higher 1.5 and 2% concentrations.

Dilute glucose solutions were used by Gharib and Hanafy (2005), for spraying pea plants with resulting increase in leaf area, number of leaves and plant height.

Propolis is another bee product which is a resinous substance collected by honeybees from leaf buds and cracks in the bark of various plants. It is composed of 50% resin (composed of flavonoids and related phenolic acids), 30% wax, 10% essential oils, 5% pollen and 5% various organic compounds (Pietta *et al*, 2002). *Propolis* extract was used by Rady (2002) to pre-soack seeds/grains of wheat, sugar beet, maize and sorghum, under different soil conditions, with resulting highest germination percentage and improved vegetative parameters.

The overall analyzed results of this study indicate that, regular spraying of diluted honey for *Singonium podophyllum* plants with, or even without Kristalon was associated with adequate growth of the above ground plant parts, with fluctuation of superiority between the use of honey alone or its use combined with the chemical fertilizer, Kristalon. Being a source of many essential plant nutrients and trace elements, honey can thus represent a highly nutritious fortifying bio-fertilizer, that may be used alone or in conjunction with another fertilizer, with almost the same, or slightly different results. However, the amount of available information is in need of further studies on different plants, using honey with /or alternative to different fertilizers to portrait a more clear picture of this bio-fertilizer in plant life.

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دراسة استطلاعية لاستكشاف تأثير عسل النحل كسماد حيوي على الصفات المورفولوجية والمكونات الكيميائية لنبات السنجونيوم.

صفية حمدي محمود الحنفى
قسم بساتين الزينة – كلية الزراعة – جامعة القاهرة- مصر

تعد نباتات الزينة الورقية مكوناً رئيسياً فى عمليات التنسيق الداخلي. وغنى عن التعريف أن التسميد ضروري لنموها والحفاظ على حيويتها. ونبات السينجونيوم يعتبر نبات ظل ورقى معمر متسلق يتميز باختلاف مظهر أوراقه تبعاً لمراحل تطوره. يمثل عسل النحل منتجاً معقداً جداً من منتجات النحل غنياً بالعناصر الرئيسية إضافة إلى النادرة، والتى تعتبر بعضها من مكونات العصير الخلوي النباتي، إذ تمتصه النحلة في صورة رحيق.

و تهدف هذه الدراسة إلى استكشاف الآثار الناجمة عن رش تحضيرات مخففة من عسل النحل كسماد حيوي على النمو والتركيب الكيميائي لنبات السينجونيوم بودوفيللم.

أجريت تلك التجربة خلال موسمين متعاقبين (٢٠٠٣/٢٠٠٤، ٢٠٠٤/٢٠٠٥) بمشتل قسم بساتين الزينة بكلية الزراعة ، جامعة القاهرة .

تمت زراعة عقل طرفية لنبات السنجونيوم فى أصص وقسمت إلى ثمانية مجموعات إثنان منها لتمثل معاملة المقارنة عوملت إحداها بالماء فقط والأخرى بسماد الكريستالون (١جم/ نبات). تمت إضافة سماد الكريستالون للمعاملات الثلاث الأولى بالإضافة إلى رشهما بمحلول مخفف من العسل بتركيزات ١، ١,٥، ٢٪ بينما رشت المعاملات الثلاث الأخرى بالعسل فقط بنفس التركيزات السابق.

- تركت النباتات لفترة شهر من النمو قبل بداية المعاملات التى أجريت بعد ذلك بانتظام كل أسبوعين ولمدة سبعة أشهر.

وفى نهاية كل موسم تم تسجيل البيانات المورفولوجية التالية:
ارتفاع النبات – عدد الأوراق – مساحة الورقة الخامسة معدودة من القاعدة – الوزن الطازج والجاف للأوراق – قطر الساق – الوزن الطازج والجاف للساق – طول الجذر – الوزن الطازج والجاف للجذر.
كذلك أجريت التحاليل الكيميائية
لتقدير محتوى الأوراق الطازجة من الصبغات (كلوروفيل أ ، ب والكاروتينويدات) والنسبة المئوية بالأوراق الجافة لكل من عناصر النيتروجين والفوسفور والبوتاسيوم والكربوهيدرات الكلية.

من خلال تحليل النتائج المجلة تبين أن الرش المنتظم بمحلول مخفف من عسل النحل مع سماد الكرستالون (١ جم / نبات) أو حتى بدونه صاحبه نمو ملائم للمجموع الخضري، مع تأرجح التفوق بين استخدام العسل منفرداً أو مجتمعاً مع السماد الكيميائي "كريستالون". وحيث أن عسل النحل يحتوى على كثير من المتطلبات الضرورية والعناصر النادرة فإنه يمكن أن يمثل سماداً حيوياً مغذياً قد يضاف للنبات بمفرده أو مصحوباً بسماد آخر للحصول على نفس النتيجة تقريباً أو باختلاف ضئيل.
مع ذلك فإن المعلومات المتوفرة فى حاجة لمزيد من الدراسة على نباتات مختلفة مع استعمال العسل مصحوباً بأسمدة مختلفة أو كبديل لها لرسم صورة أكثر وضوحاً لذلك السماد الحيوي في حياة النبات .