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EFFECT OF FOLIAR SPRAY WITH SOME PLANTS EXTRACTS AND DIFFERENT CALCIUM SOURCES ON PRODUCTIVITY AND QUILTY OF STRAWBERRY FRUITS. I. VEGETATIVE GROWTH , PRODUCTIVITY AND FRUIT QUALITY

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ABSTRACT:

Two pots experiments were conducted in Baramoon Res. Station, Dakahlia Governorate, Egypt during of 2014/2015 and 2015/2016 seasons to study the effect of some exogenous plant extracts and different calcium sources on growth , productivity and fruit quality of strawberry. Three available plants extract namely, green tea, thyme and mushroom at 2 ml /l of each as well as chitosan at 1% and different calcium sources, i.e., calcium chloride (1 %), calcium citrate (2.5 ml/l) and calcium nitrate (0.5 ml /l) were evaluated plus control treatment (spraying with tap water) . The obtained results could be summarized as follows:

All treatments of plant extracts, chitosan and different calcium sources had significantly increased vegetative growth, yield and its components and fruits quality of strawberry than control treatment (sprayed with tap water) in both seasons. Spraying strawberry plants with green tea extract at 2 ml / l gave the maximum values of all vegetative growth parameters, such as plant height, fresh weight/ plant, number of leaves per plant and leaf area, concentrations of chlorophyll a and total chlorophyll in leaf tissues, both number of runners, flowers and crown / plant, crown diameter/plant and total yield/ plant as well as average fruit weight, also the highest fruit quality , i.e., pectin, Vit. C , TSS, total sugars, reducing and nun reducing and lowest values of total acidity, followed by spraying with mushroom extract at 2 ml / l or calcium nitrate at 0.5 ml/l .

The increases in total yield/ plant were about 78.94 and 68.48 % for spraying plants with green tea extract and 55.93 and 62.56 % for spraying plants with calcium nitrate over unsprayed plants (control treatment) in the 1st and 2nd seasons, respectively.

***Conclusively**, from the foregoing results of this study, it could be concluded that, under the same conditions , spraying strawberry plants with plants extracts such as green tea or mushroom extracts at 2 ml / l or calcium nitrate at 0.5 ml/l were the best treatments for increasing growth , yield and gave the best fruits quality .*

Key words: strawberry, plant extract, calcium sources, yield , fruit quality

INTRODUCTION

Strawberry (*Fragaria ananassa* Dutch) is a highly appreciated world wide not only for its unique taste and distinct flavor, but also for its health benefits. Strawberries contain usual nutrients, such as minerals and vitamins, and a diverse range of anthocyanins, flavonoids and phenolic acids with biological properties, such as antioxidant, anticancer, anti-neurodegenerative and anti-inflammatory activities (Seeram *et al*., 2006). The phytochemical composition is influenced through environmental conditions and pre- and post-harvest factors).

The total area harvested in Egypt is about 41.937 fed., which production quantity about 464.958 tons with average of 11.087 tons/feddan (FAO, 2016). The production in Egypt has considerable growth potential because of the definite market windows which is evidenced by its consumption and exports in Europe and Gulf countries increasing each year Egyptian exports of strawberries to Saudi Arabia were estimated at 39,000 tons, valued at some $90 million (FAO, 2017). The high perishability of strawberry, the reason for its relatively short period of harvest, compels the producer to sell his production immediately, evidently prejudicing him with respect to the reduced price due to its sale in large volumes). Due to high moisture (around 90%), sugars (glucose 4%, fructose 5% and saccharose 0.9%) and organic acids (citric 10-18 meq and malic 1-3 meq). Moreover, strawberry fruit have a very short postharvest life, due to microbial load, mechanical injury and desiccation resulted in decay and weight loss. Modified atmospheres with elevated CO_2 levels and low temperatures are effective in reducing the incidence of decay. However, prolonged exposure of berries to high CO_2 concentrations can cause off-flavor development and low temperature alone is not an effective means of control. Although prophylactic field sprays with systemic benzimidazoles are effective in controlling post-harvest fungal infections, there is an increased concern among consumers about the potentially harmful health effects of chemical residues and development of chemical tolerance in post-harvest

pathogens. Thus alternative approaches are necessary to maintain the marketable quality of strawberries.

Alternatively, safer, cheaper and more ecologically friendly methods in the control of the insects were the modern trends that must be taken into consideration (Okunlola and Ofuya, 2013). Researchers are working in the field of natural products extensively as they are less hazardous, low cost and easily available. The dependency on the use of inorganic fertilizers as a source of plant nutrients by farmers and their high cost is further associated with land and soil degradation and environmental pollution (Phiri, 2010). Thus, there is continuous need to search for alternative safe natural sources of plant nutrients, natural growth regulators even for protecting against disease and insects. Plant hormones can be used to increase yield per unit area because they influence every phase of plant growth and development (Prosecus, 2006).Foliar sprays of some plant extracts on strawberry plants have recently received apparent interest. The various positive effects of applying active plant extracts were attributed to its contents of different nutrients, vitamins, hormones, natural plant growth regulators.

Green tea (*Camellia Sinensis*),is a good source of polyphenolic compounds haring strong and antioxidant, property which, proved to exhibit antimicrobial activity against some bacteria (*Chan et al*., 2007). The important polyphenolic compound in tea leaves include catechin,theaflavins and thearubiging. Green tea is proved to exhibit antimicrobial activity against some bacteria and has good antioxidant activity. The beneficial effects of the phenolic compounds are thought to result from their ability to scavenge reactive oxygen and nitrogen species (Gramza *et al*., 2006).

Thyme plant and its essential oil (*Thymus vulgaris* L., Family: Lamiaceae) is known to contain more than 40% of phenolic compositions (thymol and carvacrol), that have strong antiseptics effect. In addition to thymol, caffeic acid and then in existing in essential oil can effectively prevent growth of bacteria, fungus and viruses. The highest value of thymol exists in *Thymus vulgaris*. According to GC analysis, *Thymus captatus* contains carvacrol that researchers pointed to its anti-microbial properties and inhibition activity of the existence of these two compounds (Karimi and Rahemi, 2009).

Chitosan, a deacetylated derivate of chitin, is a high molecular weight cationic linear polysaccharide composed of D -glucosamine and, to a lesser extent, N-acetyl- D -glucosamine with a β-1,4-linkage. Chitosan-based coatings are considered the best edible and biologically safe preservative coatings for different types of fruits, with functional advantages, such as

slower respiration rates, extended storage periods, firmness retention and controlled microbial growth (Romanazzi *et al*., 2015).

Calcium is an important nutrient that plays a key role in the structure of cell walls and cell membranes, fruit growth, and development, as well as general fruit quality (Kadir, 2004).

Therefore, the aim of the present study is to investigate the effects of some natural extracts and different sources of calcium to obtained best growth and high yield as well as good fruit quality of strawberry.

MATERIALS A AND METHODS

Two pots experiments were conducted at the Baramoon Res. Station, Mansoura, Dakahlia Governorate, Egypt during of 2014/2015 and 2015/2016, to study the effect of some plant extracts and some calcium sources on growth, productivity and quality of strawberry.

Plant materials

Fresh transplants of Festival cultivar were obtained from local nursery and dipped in 0.2% Rhizolex solution as fungicide for 20 minutes before planting and transplanted on 8th and 12th October in pots 26 cm in diameter and 25 cm deep it contained mixed substrate (peat moss, clay, sand and vermiculite) (2: 1: 1: 1 v./v.) and was sterilized by sun for 15 days before planting during the 1st and 2nd seasons, respectively.

Plant extracts

Plant materials (green tea leaves, mushroom head, full herb thyme) were obtained from the local market, washed with distillated water and dried in the shad. They were finely grinded to powder. Fifty grams of each plant material in powder form was homogenized by laboratory blender in 200 ml of methanol (96%) and distilled water (20:80 v/v) for 10 min, and then left dark glass bottles for 72 h for complete extraction. The extracts were filtered through thin cheesecloth sheets. The final extracts were collected separately in other dark glass bottles and exposed to 60 °C in water bath for 30 min for methanol evaporation. The collected extracts were then stored in a refrigerator at 5 °C until needed. Plant extracts was subjected to GC-MS analysis using a Gas Chromatograph (Singh *et al*., 2005).

Chitosan: It is commercial product by India. It includes chitosan 90-95%. (2-Amino-2-deoxy-beta-D-glucosamine) at 1%, i.e., 10 g from chitosan dissolved in 0.1 NaOH and completed to 1 liter of distilled water was used.

Table 1: The main compounds identified in the methanol extract of tested plant extracts by using GC-MS.

Green tea extract		Mushroom extract		Thyme extract	
Compounds	**Concentration mg/g**	**Compounds**	**Concentration (%)**	**Compounds**	**Concentration**
Teanin	2.19	Organic matter	60	Thymol	30.0%
Theobromin	2.83	Carbon	33.4	Carvacrol	3.10%
Caffeine	26.74	Total Nitrogen	2.7	Camphor	0.82%
Gallocatechin	3.19	Carbon:Nitogen Ratio	12:1	Geraniol	0.64
Gallocatechinepigallocatechin	40	Total Nitrogen	2.7	α-terpineol	1.22%
Catechin	1.89	Organic Nitrogen	2.6	Linalool	2.25%
Epicatechin	12.59	Ammonium Nitrogen	0.08	1,8-cineole	1.83%
Epigallocatechingallate	112.26	Phosphate P_2O_5	1.6	p-Cymene	29.54%
		Potash K_2O	2.9	Sabinene	4.18%
		Calcium	5.9	Limonene	0.62%
		Sulfur	2.0		

Treatments

This experiment contains eight treatments as foliar spray as follows:

Green tea, thyme and mushroom extracts at 2 ml/l, chitosan solution at 1%, calcium chloride at 1%, calcium citrate at 2.5 ml/l, calcium nitrate at 0.5 ml/l and control treatment (tap water).

The strawberry plants were sprayed with plant extracts, chitosan and different calcium sources three times i.e., at the beginning of runners formation, beginning of fruits coloring and half fruits coloring, untreated plants were left as a control treatment and sprayed with tap water.

The agricultural practices concerning cultivation, irrigation, fertilization with macro and micro nutrients and insect as well as disease control were conducted according to the recommendation by the Ministry of Agriculture for strawberry commercial production.

Experimental design

These treatments were arranged in a randomized complete block design with three replicates, each treatment contain four pots. This experiment included 96 pots, i.e., 8 treatments x3 reps. x4 pots =96 pots

Data Recorded.

A random sample of two pots from each replicate was taken after 120

days from transplanting in the two growing seasons for measuring the vegetative growth, and leaf pigments as follows:

Vegetative growth parameters:

Plant height (cm), fresh weight (g) ,number of leaves / plant and leaf area $(cm)^2$ were evaluated.

Flowering parameters

Number of runners per plant**,** number of flower / plant, number of crown plant and crown diameter / plant (cm).

Photosynthetic pigments

Disc samples from the fourth upper leaf were randomly taken from every plot and determine chlorophyll a, b, (a+b) and carotenoids in both seasons, according to the method described by **Wettestein (1957**).

Yield and its Components

Two other pots were used to measure the yield parameters and fruit quality.

Number of fruits / plant, fruit set percentage, average fruit yield / plant, total yield (g) was recorded from each pots all over the harvested season up to the mid of May.

Fruit quality:

They were measured after six weeks from the first harvest as follows:

Total soluble solids contents (TSS),total titratable acidity (TA %):

Samples of 100g fruits from each experimental pots at full ripe stage were randomly chosen to determine the total titratable acidity of juice by titration with 0.1 NaOH soluation, using phenol phthalein indicator, according to the method described in **A.O.A.C. (2000**).

Anthocyanin content

It was determined according the method described by (Geza, *et al*., 1984).

Total, reducing and non-reducing sugars (%) were determined as described by **Forsee (1938**).

Pectin was quantified in juice, through McCready and McComb (1952) method and Bitter and Muir (1962) technique was used for dosage, and the results were expressed in mg of polygalacturonic acid per 100 g of fresh fruit.

Statistical analysis

Statistical analysis was conducted for all collected data. The analysis of variance was calculated according to Snedecor and Cochran (1980), means separation were done according to LSD at 0.05 level**.**

RESULTS AND DISCUSSION

Vegetative growth parameters

Data in Table (2) show that spraying strawberry plants with different plant extracts, i.e., green tea, thyme, and mushroom extracts at 2 ml/l of each and chitosan 1% and different sources of calcium such as calcium chloride at 1 % , citrate calcium at 2 ml/l and nitrate calcium at 0.5 % had significant effects on plant height, fresh weight, number of leaves per plant and leaf area than unsprayed plants in both growing seasons under pots experiment. Moreover, spraying plants with green tea and mushroom extracts exhibited significant effect in all traits compared to other treatments and control without any significant differences between them in both seasons.

Chemical compounds found in green tea and mushroom that are useful for the growth of agricultural (Table 1) epigallocatechingallate 112.26 mg/g gallated 158.18 mg/g epigallocatechin 40.34 mg/g in green tea extract from mevalonic acid which has similar effect to GA_3 in reducing complex compounds to simple ones utilized by plants to build new proteins necessary for growth (Babilie *et al*., 2015). In addition, magnesium (main element in mushroom) plays a role in increasing foliage growth, cell division, and biological plant activities (Moses *et al*., 2002). Mercy *et al*. (2014) found that the application of fruit peel powder and extract increased the growth of plants (rice, rye, mustard and fenugreek) and gave the higher yields.

Photosynthesis pigments

Data in Table (3) show that, all treatments had significant effect on all photosynthesis pigments such as chlorophyll a, b , total (a+b) and carotenoides in leaf tissues than control treatment in both seasons. However, spraying strawberry plants with green tea and mushroom extracts at 2 ml/l gave the highest values of chlorophyll a , total chlorophyll and carotenoides in leaf tissues without significant differences with Ca citrate or Ca nitrate concerning total chlorophyll. On the other side , spraying strawberry plants with Ca nitrate recorded the highest value of chlorophyll b in leaf tissues.

The plant extracts rich Mg. In plant Mg is a central component of chlorophyll and vital for photosynthesis and S is important for amino synthesis.

Flowering parameters

Data in Table (4) show that, spraying green tea and mushroom extracts increased significantly number of runners and flowers/ plant**,** number of crown/plant, crown diameter/plant compared with the other treatments or control treatment.

The observed increment on number of runners and number of flower due to green tea and mushroom extracts that are rich in combined manure with

Table (2): Effect of foliar spray with some plant extracts and some sources of calcium on vegetative growth of strawberry plants during 2014/2015 and 2015/2016 seasons

Treatments	Plant height (cm)		Fresh weight (g)		Number of leaves/ plant		Leaf area $(cm)^2$	
	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
Green tea	18.99	18.90	19.25	19.05	11.10	11.45	887.82	890.80
Thyme	18.60	18.62	18.83	18.55	8.63	9.22	630.80	640.88
chitosan	18.80	18.70	16.84	16.64	8.58	9.38	798.15	773.32
Mushroom	18.95	18.88	19.12	18.85	10.80	11.18	889.15	887.24
$CaCl_2$	18.54	18.50	18.27	18.18	7.75	8.35	866.74	869.04
Ca citrate	18.45	18.40	18.52	18.08	8.50	8.60	825.94	845.00
$Ca(NO_3)_2$	18.40	18.32	16.58	16.33	7.66	7.86	602.89	632.65
Control	18.08	18.12	15.22	15.42	7.00	7.22	583.13	600.02
LSD at 0.05 level	**0.14**	**0.13**	**0.22**	**0.25**	**0.35**	**0.33**	**20.14**	**18.94**

Table (3): Effect of foliar spray with some plant extracts and some sources of calcium on photosynthetic pigments (mg/g DW) of strawberry plants during 2014/2015 and 2015/2016 seasons

Treatments	Chlorophyll a		Chlorophyll b		Total Chlorophyll		Carotenoids	
	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
Green tea	1.60	1.60	0.89	0.95	2.49	2.65	1.35	1.36
Thyme	1.30	1.30	0.75	0.80	2.05	2.15	1.22	1.15
chitosan	1.33	1.33	0.70	0.75	2.03	2.16	1.31	1.19
Mushroom	1.60	1.60	0.89	0.95	2.49	2.65	1.35	1.36
$CaCl_2$	1.46	1.46	0.82	0.88	2.28	2.41	1.29	1.20
Ca citrate	1.52	1.52	0.86	0.92	2.38	2.59	1.28	1.32
$Ca(NO_3)_2$	1.55	1.55	0.94	0.98	2.49	2.71	1.31	1.27
Control	1.18	1.20	0.65	0.68	1.83	1.88	1.02	1.01
LSD at 0.05 level	**0.09**	**0.04**	**0.09**	**0.04**	**0.17**	**0.25**	**0.13**	**NS**

potassium and boron (Table 1). These extracts when used as foliar spraying might be related to the improvement of physical conditions of the soil and supplying plant with nutrients for a longer period thorough the season of growth, as reported by Arancon *et al*. (2004). In addition, the role of potassium is necessary for the activation of some enzyme systems, the translocation of carbohydrates and osmosis regulation. Furthermore, boron

Table (4): Effect of foliar spray with some plant extracts and some sources of calcium on flowering parameters of strawberry plants during 2014/2015 and 2015/2016 seasons

Treatments	Number of runners/ plant		Number of flowers /plant		Number of crowns / plant		Crown diameter/ plant (cm)	
	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
Green tea	2.67	2.33	13.34	12.92	1.90	1.86	2.55	2.40
Thyme	1.33	2.33	10.25	10.15	1.33	1.28	1.43	1.30
chitosan	2.00	2.00	12.24	12.26	1.67	1.60	2.20	2.00
Mushroom	2.33	2.33	12.94	12.95	1.88	1.84	2.25	2.25
$CaCl_2$	1.67	2.67	12.01	11.42	1.17	1.20	1.85	1.85
Ca citrate	2.00	2.67	12.15	11.24	1.25	1.24	1.70	1.80
$Ca(NO_3)_2$	1.33	2.00	12.86	12.46	1.13	1.10	2.01	2.00
Control	1.00	2.33	11.15	11.35	1.00	1.00	1.25	1.20
LSD at 0.05 level	**0.45**	**NS**	**0.42**	**0.38**	**0.13**	**0.12**	**0.28**	**0.25**

plays a role in cell differentiation and carbohydrate metabolism (Wang and Lins, 2002).

Yield and its components

Data in Table (5) indicate that, spraying strawberry plants with different plant extracts and different sources of calcium had significant effect on number of fruits/ plant, fruit set percentage, average fruit weight and total yield / plant than unsprayed plant , moreover, spraying plants with green tea extract or calcium nitrate proved to be the superior treatments in this respect in both seasons.

The increases in total yield/ plant were about 78.94 and 68.48 % for spraying plants with green tea extract and 55.93 and 62.56 % for spraying plants with calcium nitrate over unsprayed plants (control treatment) in the 1st and 2nd seasons, respectively.

Plant extracts are rich in amino acids, vitamins and growth stimulating photo-hormones that increases the activity of apical meristem tissue resulting in cell division and elongation (Elfalleh *et al*., 2011 and Singh. 2013). The above findings agreed with those reported by Nasser *et al*., (2014), they found that spraying fenugreek plants with licorice extract led to more absorption of nutrients from the soil, which accelerated growth and increased their production. The tannin-rich ellagitannins and phenolic acids (Table 1) of *Punicagranatum* peel have antibacterial activity (Supayang *et al*., 2005), which turned on productivity.

Table (5): Effect of foliar spray with some plant extracts and some sources of calcium on yield of strawberry plants during 2014/2015 and 2015/2016 seasons

Treatments	Number of fruits / plant		Fruit set percentage		Average fruit weight (g)		Total yield / plant (g)	
	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
Green tea	11.00	10.70	90.53	87.56	26.07	25.95	286.89	277.74
Thyme	8.50	7.49	82.88	73.72	20.88	24.96	177.57	186.87
chitosan	10.18	10.18	83.17	83.03	21.21	21.60	215.94	219.78
Mushroom	10.46	10.80	89.10	90.38	21.33	21.06	223.23	227.49
$CaCl_2$	10.01	9.45	83.35	82.75	22.44	24.21	224.49	228.87
Ca citrate	11.04	10.89	82.76	76.49	22.41	23.01	247.35	250.62
$Ca(NO_3)_2$	10.15	10.40	78.93	83.47	24.63	25.77	249.99	267.99
Control	8.00	8.50	71.75	68.86	18.84	19.08	160.32	164.85
LSD at 0.05 level	**0.31**	**0.29**	**1.78**	**3.47**	**1.23**	**1.85**	**12.38**	**16.04**

Fruit quality

Data in Table (6) reveal that, spraying plants with different plant extracts and calcium sources had significant improve of anthocyanin, vitamin C, acidity, TSS content of strawberry fruits than unsprayed plants in both seasons.

In general, the plants which sprayed with green tea gave the highest values of vitamin C and lowest values of total acidity in fruits , while mushroom extract gave the highest anthocyanin contents in fruits. TSS content in fruit was the highest with thyme extract in both seasons .

These results could be attributed to the effect of plant extract on the increase of nutrient absorption and photosynthesis process that lead to more accumulation of metabolites in reproductive organs which in turn improve fruits quality of strawberry (Wang and Lins, 2002; Hagreaves*et al*., 2009). Adding potassium and boron as foliar spraying plays a key role in improve size of fruits and stimulates fruits color. It is necessary for the translocation.

Chemical composition in fruit

The obtained results in Table (7) indicate that, all spraying treatments significantly increased the percentage of pectin, total sugars, reducing and non reducing sugars in fruit as compared with the control treatment in the two seasons, however, spraying plants with green tea extract was the best treatment for increasing the content of pectin in fruits (2.42 and 2.35 %), total

Table (6): Effect of foliar spray with some plant extracts and some sources of calcium on quality of strawberry plants during 2014/2015 and 2015/2016 seasons

Treatments	Vitamin C (mg/100ml Juice)		Anthocyanin (mg/100ml Juice)		Total acidity (mg/100ml Juice)		TSS (%)	
	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
Green tea	43.30	41.70	80.40	79.36	0.43	0.45	10.16	10.50
Thyme	36.30	35.70	81.13	80.38	0.50	0.48	10.83	10.83
Chitosan	42.70	43.30	82.08	81.35	0.50	0.52	10.00	10.00
Mushroom	39.50	39.30	89.71	88.41	0.60	0.58	10.00	10.00
$CaCl_2$	42.00	41.30	80.32	78.85	0.52	0.52	10.16	10.05
Ca citrate	39.30	40.70	80.77	78.87	0.43	0.47	10.16	10.00
$Ca(NO_3)_2$	42.00	41.60	81.58	80.83	0.48	0.48	10.33	10.00
Control	31.70	15.30	85.33	65.93	0.58	0.58	9.16	8.10
LSD at 0.05 level	**2.04**	**1.67**	**0.39**	**0.23**	**0.06**	**0.04**	**0.21**	**0.61**

Table (7): Effect of foliar spray with some plant extracts and some sources of calcium on chemicals of strawberry plants during 2014/2015 and 2015/2016 seasons

Treatments	Pectin (%)		Total sugars (%)		Reducing sugars (%)		Non reducing sugars (%)	
	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
Green tea	2.42	2.35	8.95	8.87	2.62	2.58	6.33	6.29
Thyme	1.91	1.79	7.51	7.98	2.00	1.80	5.51	6.18
chitosan	2.17	2.08	8.1 2	8.42	2.05	2.00	6.07	6.42
Mushroom	2.36	1.27	8.53	8.79	2.51	2.37	6.02	6.42
$CaCl_2$	1.62	1.47	7.22	7.31	2.17	2.13	5.05	5.18
Ca citrate	1.72	1.67	7.49	8.08	2.32	2.00	5.17	6.08
$Ca(NO_3)_2$	2.03	1.84	8.01	8.37	2.19	1.90	5.82	6.47
Control	1.02	1.09	4.65	6.16	1.38	1.00	3.27	5.16
LSD at 0.05 level	**0.17**	**0.09**	**0.19**	**0.32**	**0.10**	**0.08**	**0.25**	**0.25**

sugars (8.95 and 8.87 %), reducing sugars (2.62 and 2.58 %) , non reducing sugars (6.33 and 6.29 %) against (1.02 and 1.09 %), (4.65 and 6.16

%), (1.38 and 1.0 %), (4.78 and 3.65 %) for control treatment in the 1st and 2nd seasons, respectively.

Sugar and formation of carbohydrates consequence increase fruits quality. These results are in agreement with reported by Velez Ramos *et al*. (1991).

Conclusively, from the foregoing results of this study, it could be concluded that, under the same conditions , spraying strawberry plants with plants extracts such as green tea or mushroom extracts at 2 ml / l or calcium nitrate at 0.5 ml/l were the best treatments for increasing growth , yield and gave the best fruits quality .

REFERENCES

A.O.A.C. (2000). *Association of Official Agricultural Chemists* . 17th. Ed. A.O.A.C., Wash., D.C

Arancon, N. Q., C. A. Edwards, P. Bierman, C. Welch and J. D. Metzger (2004). Influences of vermicomposts on field strawberries: 1. Effects on growth and yields. *Biores. Tech*., (**93**) 2: 145 -153.

Babilie, R., M. Jbour and B. Abu Trabi (2015). Effect of foliar spraying with licorice root and seaweed extracts on growth and seed production of onion (*Allium cepa* L.). *Inter. J. Chem. Tech. Res*., 8 (**11**): 557-563.

Bitter, V. and H. M. Muir (1962). A modified uronic acid carbazole reaction. *Analytical Biochemistry*, 4(4): 330-334.

Chan E.W., Y.Y.Lim and Y.L. Chew (2007). Antioxidant activity of *Camellia sinensis* leaves and tea from a lowland plantation in Malaysia. *Food Chem*. ;102:1214–22.

Elfalleh, W., N. Tlili, N. Nasri, Y. Yahia, H. Hannachi, N. Chaira, M. Ying and A. Ferchichi (2011). Antioxidant capacities of phenolic compounds and tocopherols from Tunisian pomegranate (*Punica granatum*) fruits. *J. Food Sci*., 76:707-713.

FAO (2016 & 2017). Food and Agriculture Organization of the United Nations

Forsee, W. T., Jr.1938. Determination of sugar in plant materials A photometeric method. *Indus. Eng. Chem. Anal. Ed*., **10**:411-418.

Geza, H.; G.F. Parsons and L.R. Mattick 1984. Physiological and biochemical events during development and maturation of grape berries. *Am. J. Enol. Vitic.*, **35** (4): 220 – 227.

Gramza, A., S. Khokhar, S. Yoko, A. Gliszczynska-Swiglo, M. Hes and J. Korczak, (2006). Antioxidant activity of tea extracts in lipids and correlation with polyphenol content. *Eur. J. Lipid Sci. Technol*., 108: 351-362.

Hagreaves, J. C., M. S. Adl and P. R. Warman (2009). The effects of municipal solid waste compost and compost tea on mineral element uptake and fruit quality of strawberry. *Compost Sci. Utilization*, 17 (2): 85 -94.

Kadir, S.A. (2004). Fruit quality at harvest of 'Jonathan' apple treated with foliar applied calcium chloride. J Plant Nutro., 27: 1991– 2006.

Karimi Z. and M. Rahemi (2009). Comparison extract oils of thymol and caryophyllus and imazalill fungicidies on thev decay penicillium italicum citrus fruits in cold storage. *J. Sci. Agri. Techniquies,* 12 (45) (In Persian)

McCread, P. M. and E. A. McComb (1952). Extraction and determination of total pectin materials. Analytical Chemistry, 24 (12): 1986- 1988.

Mercy S., B. S. Mubsira and I. Jenifer (2014). Application of different fruit peels formulations as a natural fertilizer for plant growth. *Inter. J. Sci. & Techn. Res.* , 3(1):300-307.

Moses, T. N., W. A. Abdul-Jabbar and A. N. Elwy (2002). A study of some local licorice root powder components (*Glycyrrihiza glabra* L.). *Iraqi J. Agric. Sci.,* 33 (4): 30-38.

Nasser, N.S., M.W. Mahdi and S.S. Abdullah (2014). The effect of spraying with licorice extract and organic fertilization of poultry in the growth of fenugreek plant (*Trigonella foenum-graecum* L.). *Swedish J. Sci. Res*., 1 (6): 36-42.

Okunlola, A.I. and T.I. Ofuya, (2013). Effect of mixed cropping and plant extracts on the growth, yield and pest control of jute (*Corchorus olitorius* L.). *Folia Horticulturae*, 25: 49-60.

Phiri, C. (2010). Influence of *Moringa olifera* leaf extracts on germination and early seeding developmen t of major cereals. *Agric. Biol. J. N. Amer.*, 1 (5):774-777

Prosecus P. (2006). Biosynthesis-plant hormones and growth regulators: Chemistry and Biology. *Biosynth Ag. Co*., Switzerland**.**

Romanazzi, G., E.Feliziani, B.S. Bautista and D. Sivakumar (2015). Shelf life extension of fresh fruit and vegetables by chitosan treatment. Crit. Rev. Food Sci. Nutr. 57 (3): 579-601.

Seeram, N.P., L.S. Adams, Y. Zhang, R. Lee, D. Sand, H.S. Scheuller, and D. Heber (2006). Blackberry, black raspberry, blueberry, cranberry, red raspberry, and strawberry extracts inhibit growth and stimulate apoptosis of human cancer cells *in vitro*. *J. Agric. Food Chem*., 54: 9329-9339.

Singh G., P. Marimuthu ,C.S. Heluani and C.Catalan (2005). Chemical constituents and antimicrobial and antioxidant potentials of essential oil and acetone extract of Nigella sativa seeds. J. *Food Sci. Agric*., 85: 2297-2306.

Singh, J. **(2013)**. Effect of zinc, boron, calcium and GA_3 on growth, yield and quality of strawberry (*Fragaria ananassa* Duch.) cv. Douglas. Birsa Agricultural University, Kanke, Ranchi, Jharkhand Publisher, Ph. D. Thesis, 184 pp.

Snedecor, G.W. and W.G. Cochran (1980). *Statistical Methods*.7th ed., Iowa State Univ., Press, Ames., Iowa, U.S.A.

Supayang, P. V., S. Treechada, L. Surasak, S. Thanomjit, I. Tetsuya and H. Takeshi (2005). Inhibitory effects of active compounds from *Punica granatum* pericarp on verocytotoxin production by enterohemorrhagic *Escherichia coli* O157:H7. *J. Health Sci*., 51:590-596.

Velez-Ramos, A., M. Goyal and A. J. Beale (1991). Levels and methods of potassium fertilization on tomato cv. Ducky yield. J. *Agric. Univ*., *Puerto Rico*, 75 (2): 111-117.

Wang, S. Y. and M. Lins (2002). Compost as soil supplement enhanced plant growth and fruit quality of strawberry. *J. Plant Nutr*., 23: 2243-2259.

Wettestein, D. (1957). Chlorophyll. Lethale under Submikroskopische Formwechsel der Plastiden. *Exp. Cell Reso*, **12**: 427-506.

تأثير الرش الورقى ببعض المستخلصات النباتية ومصادر مختلفة من الكالسيوم على انتاجية وجودة ثمار الفراولة.
أ. النمو الخضري، الإنتاجية وجودة الثمار

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أجريت تجربتان أصص فى محطة بحوث البساتين بمحافظة الدقهلية ، مصر اثناء موسمى ٢٠١٤/٢٠١٥ و ٢٠١٥ /٢٠١٦ لتقدير تأثير الاضافات الخارجية لبعض المستخلصات النباتية ومصادر مختلفة من الكالسيوم على النمو و الانتاجية

وجودة ثمار الفراولة. تم الرش ببعض المستخلصات النباتية والتي تشمل: الشاي الأخضر، الزعتر والمشروم بمعدل ٢ ملليتر /لتر يالإضاقة إلي الشيتوزان بتركيز (١%) ، ومصادر مختلفة من الكالسيوم: كلوريد كالسيوم (١%) ، سترات كالسيوم (٢.٥ ملليتر/لتر) و نترات الكالسيوم (٠.٥ ملليتر / لتر) بالإضافة إلي معاملة الكنترول (ماء الصنبور). ويمكن تلخيص أهم النتائج كالتالى

سجلت كل معاملات الرش بالمستخلصات النباتيه والمصادر المختلفة من الكالسيوم زيادة معنويه فى صفات النمو الخضرى والمحصول وصفات الجودة للثمار مقارنه بمعامله المقارنه (الرش بالماء فقط) فى كلا موسمى الدراسه.

شجل الرش الورقي بمستخلص الشاي الاخضر بمعدل ٢ ملليتر/ لتر زيادة معنوية فى كل صفات النمو الخضرى ممثله فى ارتفاع النبات ، الوزن الطازج للنبات ، عدد الاوراق على النبات ،المساحة الورقية للنبات ، تركيز كل من كلوروفيل ا، والكلوروفيل الكلى فى انسجة أوراق الفراوله ، عدد كل من المدادات والازهار على / النبات ، المحصول الكلى للنبات ومتوسط وزن الثمرة وكذلك زيادة صفات جودة الثمار متمثله فى محتواها من البكتين و فيتامين ج ، المواد الصلبة الذائبه الكلية ، والسكريات الكلية ، والمختزلة وغير المختزلة وأقل محنوى من الحموضة الكليه ، يليها الرش بمستخلص المشروم بمعدل ٢ ملليتر/ لتر أوالرش بنترات الكالسيوم بمعدل ٠.٥ ملليتر/ لتر.

وكان مقدار الزيادة فى محصول النبات حوالى ٧٨.٩٤ ، ٦٨.٤٨ % لمعاملة الرش بمستخص الشاى الاخضر ، ٥٥.٩٣ ، ٦٢.٥٦ % لمعاملة الرش بنترات الكالسيوم عن معامله المقارنه فى الموسم الاول والثانى على التوالى.

التوصية: هذا ويستخلص من الدراسه تحت نفس الظروف المشابه لهذا البحث باستخدام لرش الورقى بمستخلص الشاى الاخضر أو مستخلص المشروم بمعدل ٢ ملليتر / لتر أو الرش بنترات الكالسيوم بمعدل ٠.٥ ملليتر لزيادة النمو و المحصول وجودة الثمار.