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Response of strawberry plants to bio fertilization with methylotrophic bacteria and spray with methanol.

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Abstract

Two field experiments were carried out during the two successive seasons of 2014/2015 and 2015/2016 in private sector farm at El–Dair village, Kalubia governorate in sandy soil to investigate the response of two strawberry cultivars namely Fortuna and Sweet Charlie to bio fertilization and spray with methylotrophic bacteria (10 cm^3/l) as well as methanol (5,10,15 and 20%) on vegetative growth, chemical compostion and productivity of used Strawberry cultivars. Obtained results show that there were significant differences among the studied strawberry cultivars in all measured vegetative growth traits, fruit yield and its components as well as fruit quality. In this respect, cv. Fortuna reflected the highest values of vegetative growth, chemical composition of plant foliage, fruit yield and its components as well as physical fruit quality. Also foliar spraying plants six times with methylotrophic bacteria at 10 cm^3/l starting 20 days from transplanting and every 15 days by intervals during the growth season was superior in total fruit yield and marketable yield. Different tested bio-fertilization (methylotrophic bacteria and methanol) enhanced the vegetative growth, chemical constituents of plant foliage, total produced fruit yield and its components as well as fruit quality. In addition, using methylotrophic bacteria at 10 cm^3/l and foliar spraying plants six times with methanol at 20% reflected the highest values in all studied growth and yield traits of tested cultivars.

Key words: - Strawberry, cv. Fortuna, Sweet Charlie, Methanol, Methylotrophic bacteria, Vegetative growth, fruit yield, fruit quality.

Introduction

Strawberry (*Fragaria X anannasa* Duch.) is one of the most important vegetable crops grown in Egypt for fresh consumption, processing and exportation. It's the unique vegetable crop belong to family *Rosaceae*. according to the statistics of Egyptian Ministry of Agriculture and Land reclamation in 2015-2016 season the total area devoted to grow strawberry in Egypt was increased and reached about 21573.9 fed. from which 16459.21fed. for fresh production with an average yield of 20 t/fed and 5113.12 fed. for frigo production with an average yield of 13.14 t/fed. Moreover, the total exportable fruit yield was 22 thousand ton. Nowadays many farmers used fertilization and spraying with bio fertilizers on plant foliage to improve growth, productivity and yield quality of produced fruits. Also, within the last few years several materials such as methylotrophic bacteria were tested on some vegetable and field crops to improve growth and productivity. Many investigators working on foliar spray of plants with methylotrophic bacteria **(Dhale *et al.* 2010)., Ahmed 2011)., Abd El-Gawad *et al.* 2015)** found that methylotrophic bacteria enhanced growth, productivity and yield quality of produced fruits. Fruit characteristics usually show great variability among the various strawberry cultivars. Fruit size is one of the most important aspects in evaluating strawberry cultivars. large size is especially important for reducing harvest cost many investigators working on foliar spray on strawberry plants **(Mosalem 2010)., EL-Badawy 2014)., Ramandeep and Navprem 2016)., Tomic *et al.* 2016)** found that methylotrophic bacteria enhanced growth, productivity and quality of produced fruits. Nowadays many farmers used fertilization and spraying with bio fertilizers on plant foliage to improve growth, productivity and quality of produced fruits. Also, within the last few years several materials such as methanol were tested on some vegetables and field crops to improve its growth and productivity. Many investigators working on foliar spray of strawberry plants with methylotrophic bacteria among them **Maziar *et al.*(2011), Salehi (2013), Soghani *et al.* (2014)** and **Moemenpour and Karami (2015)** found that methanol enhanced growth, productivity and quality of produced fruits.

Therefore, the present study aims to investigate the response of strawberry cultivars to bio fertilization (spray with methylotrophic bacteria) as well as methanol on vegetative growth, productivity and quality of produced strawberry fruits.

Matarials and Methods

Two field experiments were carried out during the two successive seasons of 2014/2015 and

2015/2016 in private sector farm at El–Dair village, Kalubia governorate. This experiment was carried out to investigate the response of two strawberry cultivars namely Sweet Charlie and Fortuna to bio fertilization and spray with (methylotrophic bacteria and methanol) on vegetative growth, chemical composition, fruit yield and its components as well as fruit quality of tested cultivars. The tested spray substances were added individually at the recommended dose (methylotrophic bacteria at 10 cm^3/l and methanol at 5,10,15,20%), respectively. The texture of the experimental field was sandy soil. Random soil samples were taken before planting for physical and chemical analyses (Table a).The fresh transplants of the used cultivars were obtained from Modern Agriculture Company Pico Egypt. Transplants were dipped in Rhizolex solution at rate of 3g/ l for 20 minutes as recommended by Ministry of Agriculture, sector, pathogens disinfection before transplanting.

Table a. Physical and chemical analyses of the used soil.

Physical analysis		Chemical analysis			
		Cations meq/l		Anions meq/l	
Coarse sand	18 %	Ca^{++}	7.6	$CO3^{--}$	Zero
Fine sand	36.6%	Mg^{++}	3.3	$HCO3^{-}$	3.7
Silt	27.1%	Na^{+}	4.20	Cl^{-}	5.4
Clay	18.3 %	K^{+}	3.9	$SO4^{--}$	7.7
Texture class	sandy				
Soil pH	7.3				
E.C, dS/m	1.65				
Organic matter	2.4%				

Table b. Comparison between the tested two strawberry cultivars Sweet Charlie and Fortuna.

Characteristics	Sweet Charlie	Fortuna
Vegetative growth	medium	medium
Early fruits	very early	very early
Exportable yield	high	Very high
Fruit firmness	low	low
Storability	low	low
Fruit sugars and vitamin C	high	high
Fruit size at the end of the season	small	big
Botrytis infection	high	high

The area of the experimental plot was 10.20 m^2 included three beds each six meters in long and 1.70 meters in width. Each bed included four rows at 25 cm apart and the transplanting was done at 25 cm apart between transplants in the same row Transplanting was done on1st of October in 2014/2015 and 2015/2016. Sprinkler irrigation was used in the first month after transplanting, after that the beds were covered with 40 micron whit plastic mulch. After that the drip irrigation was used after mulching until the end of the growing season. Foliar application treatments were started after 20 days from transplanting and every 15 days by intervals, 6 times through out the growing season.

Methylotrophic bacteria :-

Preparation of pink pigmented facultative methylotrophic (PPFM) bacteria.

Quantification of Indole Acetic Acid (IAA):- Isolates of PPFM were grown in minimal broth medium (DSM 125) in the presence of the auxin precursor (tryptophan, 1mM/L). The inoculated flasks were incubated on the rotary shaker (150 rpm) at 25°C for 4 days in dark. The IAA was quantified, using the colorimetric technique by Salkoweski reagent as described by **Glickmann and Dessaux (1995).** After removing the cells by centrifugation at 10000 x g for 30 min, the culture liquid was mixed 1:1 (v/v) with salkoweski reagent (12g/L $Fecl_3$, 7.9 MH_2SO_4) and incubated for 30 min in dark. Thereafter, the optical density was measured using a spectrophotometer at wavelength 530 nm. Amounts of IAA were calculated according to standard curve of IAA.

Cytokinin Determination: - The isolates of PPFM were grown in K medium with 0.5% methanol (**Doronina and Trotsenko 1994).** Cells were harvested by centrifugation at 10000 x g for 30 min and the supernatant was used for analysis of cytokinins. The technique of **Fletcher and McCullagh (1971**) was adopted. Beta Alfa seeds of Cucumber (*Cucumus sativus L.*) were germinated in Petri dishes in dark at 28°C. After 6 days, the cotyledons were excised in dim green light and placed in 5 cm Petri dishs (10 cotyledons in each) containing 6 ml of the supernatant of each tested culture. The dishes were returned back to the dark at 28°C for 14 h then moved into fluorescent light with an intensity of 220 ft.c. After 3h, the chlorophyll from 10 cotyledons was extracted with cold acetone, brought up to a volume of 10 ml and centrifuged

determined by measuring their absorbance at 665 nm. Amounts of cytokinins were calculated based on standard curve of cytokinins.

Methanol :- Methanol is a commercial product from biochem for laboratory chemicals. Egypt contain; Assay 99.5%.

NPK fertilizers were added at the recommended dose (200kg N +80kg P_2O_5+240kg K_2O/fed) in the form of ammonium sulphate [$(NH_4)_2SO_4$, 20.5% N], phosphoric acid 60% P_2O_5 and potassium sulphate (48%K_2O) were used as a source of nitrogen, phosphorus and potassium, respectively. The amounts of mineral fertilizers were divided into equal portions and were added throught the irrigation water (fertigation) two times per week starting 21 days after transplanting and ended 15 days before the end of harvesting season. All other agricultural treatments required for fresh plantation of strawberry were done as commonly followed in the district.

This experiment included 12 treatments resulted from the combination of two strawberry cultivars, i.e., Fortuna and Sweet Charlie and 6 spray treatments using methylotrophic bacteria and methanol as follows :-

Foliar spray with methylotrophic bacteria at 10 cm^3/l. Foliar spray with methanol (CH_3 OH) at 5%. Foliar spray with methanol at 10%. Foliar spray with methanol at 15%. Foliar spray with methanol at 20%. Foliar spray with distilled water as control treatment. The plants were sprayed six times during the growing season starting 20 days after transplanting and every two weeks by intervals.

Data recorded:-

Vegetative growth characteristics: - Five plants were taken from each experimental plot as a representative sample on January after 110 days from transplanting and the following data were recorded. **Plant height** was measured from the highest point of the plant up to the crown surface. **Fresh weight per plant. Dry weight per plant** five plants were dried in an oven at 70°C for 72 ^{h} until constant weight dry weight per plant was calculated, **number of crowns/plant. Number of leaves/plant and Leaf area** was determined on weight basis where ten discs each of one cm^2 area were taken, and dried in an oven at 70 °C until constant weight. The rest of the leaves were similarly dried. Based on the known dry weight of a known surface area of leaves, i.e., leaf discs, and the total weight of leaves, leaf surface area was determined. **Crown diameter** was measured by using vernier caliber.

Chemical composition of plant foliage:-

Photosynthetic pigments: chlorophyll reading of the fifth mature leaf (full expended leaf) from top was measured at 90 days from transplanting using minolta chlorophyll meter SPAD-502 according to **Yadava (1986). Total nitrogen, phosphorus and potassium** were determined in the digested dry matter of plant foliage according to the methods described by **Kock and McMeckin (1924), Trough and Meyer (1939)** and **Brown and Lilliland (1946)**, respectively. **Total protein:** protein content was calculated by using the conversion factor (N x 6.25) as described by **Pregl (1945). Total carbohydrates** was determined colorimetrically according to method described by **James (1995).**

Fruit yield and its components:

Early fruit yield /fed was determined as weight of all harvested fruits at the ripe stage during November, December and January. **Total fruit yield /fed** was calculated using plot yield and plot area. **Fruit yield / plant** was calculated from fruit yield/plot and number of plants/plot. **Marketable yield /fed** was calculated after discarding the infected fruit. **Un-marketable yield /fed** was calculated as weight of infected fruit during the harvesting season.

Fruit quality :-

Physical quality: A random sample of 10 fruits at marketable stage from each experimental plot was taken to determine the length and diameter using vernier caliber. **Average fruit weight:** weight of the fruit samples was measured using top balance loading to determine the average fruit weight. **Fruit firmness:** was determined in a using Chatillon Penetrometer (N.4., USA) GauGe –R with a needle 3 mm in diameter. **(Qurecky and Bourne, 1968).**

Chemical quality:

Total soluble solids%(T.S.S.%): A random sample of 10 fruits from each experimental plot at full ripe stage was taken to determine the percentage of soluble solids content by using hand refractometer. **Total titratable acidity (T.T.A)** A random sample of 100g of fruit at full ripe stage for each experimental plot was taken to determine T.T.A. of juice by titration with 0.1N NaOH (Sodium hydroxide) solution using phenol phthalin indicator, according to the method described in **A. O. A.C. (1990). L. Ascorbic acid "Vitamin C"** was determined in the same sample taken for acidity measurement using the indicator of 2,6 dichlorophenol indophenol for titration as the method mentioned in **A. O. A. C. (1990). Total sugars:** were determined in dry samples of ripe fruits for each experimental plot color metrically by the method described by **Somogyi (1952) and Nelson (1974). Anthocyanin pigments:** was determined spectrophotometerically as described by **A. O. A.C. (1990). Statistical analysis:** Data were subjected to statistical analysis by the method of Duncan's multiple range test as reported by **Gomez and Gomez (1984).** All statistical analysis was performed with SAS computer software.

Results and Discussion

1. Vegetative growth characteristics:-

a. Effect of cultivar :- Data in Tables 1 and 2 indicate that there were significant differences among the tested cultivars in most studied morphological parameters of strawberry plants during both seasons of growth. In this regard, cv. Fortuna reflected the highest values in all measured growth traits i.e. plant height, number of leaves and crown per plant, crown diameter, average leaf area per plant as well as fresh and dry weight of plant compared with cv. Sweet Charlie. In addition, such increments did not reach the level of significant in case of number of crowns/ plant, crown diameter and dry weight during the first season and plant height, dry weight / plant, number of leaves and crowns per plant as well as crowns diameter during the second one. On the outher hand, Sweet Charlie cultivar showed the highest value of number of leaves per plant during the first season only. Such differences in growth aspects among the used cultivars may be attributed to the difference in genetical structure between such cultivars. Obtained results are in agreement with those reported by **Ahmed (2009)**, **Mosalem(2010), Ragab *et al*.(2012), EL-Badawy (2014) and Asadpoor and Tavallali (2015)** all working on strawberry indicated that there were differences in most studied growth measurements among the tested cultivars.

b. Effect of Foliar spray with methylotrophic bacteria and methanol :- As for the effect of foliar spray with methylotrophic bacteria and methanol on vegetative growth, the same data in Tables 1 and 2 indicate that all the studied growth parameters i.e., plant height, number of leaves and per plant, crown diameter, average leaf area and fresh and dry weight of plant were significantly increased during the two seasons of growth as a result of foliar spraying plants six times with methylotrophic bacteria and methanol during the growth seasons starting at the beginning of flowering and every 15 days intervals, compared with the control treatment. In this connection, using methylotrophic bacteria 10 cm^3/l exhibited the highest values in all studied growth parameters followed by methanol at 5,10,15 and 20%, in ascending order during the first season. while, spraying plants with methanol at 20% reflected the highest value of leaf area during the second season only. Obtained results are true during both seasons of growth except number of crowns per plant during the first season and dry weight per plant and number of crowns per plant during the second season which were not significantly affected by foliar spray treatments. Such increments in growth parameters as a result of using methylotrophic bacteria may be due to that such micro-organisms increased cytokinins and hormones concentration in plant leaves which act as plant growth promotors and consequently positively affect physiological proceses and cell division and elongation which in turn affect tissues formation and consequently vegetative growth of plant. In this regard, **Madhaiyan *et al.* (2005), El-Tohamy *et al*.(2008), Radha *et al* .(2009)**, **Amanullah *et al.* (2010)**, **Puneet *et al.* (2010)**, **Ahmed (2011) and Abd El-Gawad *et al.* (2015)** used yeast extract and methylotrophic bacteria and **Abdel-Al. (1998)**, **Joseph and Kelsey (1999)**, **Saikia *et al.* (2000), Dwivedi *et al.* (2001)**, **Ramadan and Omran(2005), Madhaiyan *et al.* (2006)**, **Mokashi *et al.* (2007)**, **Mirakhori *et al.* (2009)**, **Pineda-Pineda *et al.* (2010)**, **Farajpour *et al.* (2012)**, **Salehi (2013)**, **Rowe *et al*. (2015) and Armand *et al.* (2016 a and b)** used different types of methanol as growth stimulant in the form of foliar spray. They found that treatment of various tested vegetables crops increased the different assayed vegetative growth characteristics.

c. Effect of the interaction :- With regard to the effect of the interaction between the tested cultivars and foliar spraying with studied bio-stimulator on vegetative growth parameters of plant, the same data in Tables 1 and 2 show clearly that spraying the plants of cv. Fortuna with methylotrophic bacteria 10 cm^3/l six times during the growing season starting at the beginning of flowering and every 15 days by intervals reflected the highest values in all measured growth traits followed by spraying the plant with the highest concentration (20%) methanol six times without significant differences among them compared with other interaction treatments during both seasons of study.

Table 1. Effect of cultivars, spray with methylotrophic bacteria and methanol as well as their interaction on vegetative growth characteristics of strawberry plant foliage in 2014/2015 season.

Treatments		2014/2015						
CV	**Spray**	**Plant height (cm)**	**Fresh weight/ Plant (g)**	**Dry weight/ plant (g)**	**Number of Leaves /plant**	**Number of crowns /plant**	**Crown diameter (cm)**	**Leaf area(cm^2)**
Fortuna		19.28 A	16.43 A	4.36 A	8.23 B	1.17 A	1.69 A	1257.10 A
Sweet Charlie		18.55 B	15.71 B	4.29 A	9.403 A	1.06 A	1.63 A	1250.49 B
Fortuna	**bacteria 10 cm^3/l**	19.35 A	16.49 A	4.69 A	9.61 A	1.23 A	1.85 A	1292.19 A
	methanol 5%	18.23 B	16.14 A	4.14 AB	8.46 BC	1.04 A	1.57 BC	1229.15 D
	methanol 10%	19.01 AB	16.19 A	4.23 AB	8.65 BC	1.04 A	1.63 B	1261.33 C
	methanol 15%	19.40 A	16.23 A	4.50 AB	8.90 ABC	1.15 A	1.73 AB	1267.23 C
	methanol 20%	19.66 A	16.28 A	4.51 A	9.18 AB	1.24 A	1.78 AB	1278.52 B
	Control	17.83 C	15.09 B	3.87 B	8.06 C	1.00 A	1.39 C	1194.36 E
	bacteria 10 cm^3/l	19.60 A	16.91 A	4.76 A	8.88 BCD	1.33 A	1.90 A	1293.54 A
	methanol 5%	18.94 AB	16.52 AB	4.16 A	7.80 CD	1.05 A	1.62 ABCD	1247.52 D
	methanol 10%	19.45 A	16.57 AB	4.25 A	8.15 BCD	1.05 A	1.66 ABCD	1252.32 D
	methanol 15%	19.50 A	16.64 A	4.61 A	8.38 BCD	1.25 A	1.77 ABC	1260.68 CD
	methanol 20%	19.83 A	16.67 A	4.52 A	8.73 BCD	1.35 A	1.84 AB	1273.25 BC
	Control	18.38ABC	15.27 BC	3.85 A	7.43 D	1.00 A	1.35 D	1215.31 E
Sweet Charlie	**bacteria 10 cm^3/l**	19.10 A	16.08 ABC	4.64 A	10.38 A	1.13 A	1.80 AB	1290.84 A
	methanol 5%	17.53 BC	15.75 ABC	4.13 A	9.13 ABC	1.03 A	1.53 BCD	1210.79 E
	methanol 10%	18.58ABC	15.79 ABC	4.20 A	9.15 ABC	1.03 A	1.60 ABCD	1270.34 BC
	methanol 15%	19.30 A	15.82 ABC	4.40 A	9.43 AB	1.05 A	1.68 ABCD	1273.78 BC
	methanol 20%	19.50 A	15.88 ABC	4.51 A	9.63 AB	1.13 A	1.73 ABC	1283.79 AB
	Control	17.28 C	14.91 C	3.89 A	8.70 BCD	1.00 A	1.43 CD	1173.40 F

Table 2. Effect of cultivars, spray with methylotrophic bacteria and methanol as well as their interaction on vegetative growth characteristics of strawberry plant foliage in 2015/2016 season.

Treatments		2015/2016						
CV	**Spray**	**Plant height (cm)**	**Fresh weight/plant (g)**	**Dry weight/ Plant (g)**	**Number of Leaves /plant**	**Number of crowns/ plant**	**Crown diameter (cm)**	**Leaf area(cm^2)**
Fortuna		18.95 A	16.99 A	4.42 A	8.79 A	1.15 A	1.63 A	1459.73 A
Sweet Charlie		18.58 A	15.74 B	4.33 A	8.64 A	1.12 A	1.45 A	1303.72 B
Fortuna	**bacteria 10 cm^3/l**	19.38 A	17.08 A	4.73 A	9.48 A	1.29 A	1.83 A	1430.49 AB
	methanol 5%	18.90 A	16.32 A	4.17 A	8.39 AB	1.05 A	1.38 BC	1364.39 C
	methanol 10%	19.09 A	16.59 A	4.32 A	8.56 AB	1.09 A	1.49ABC	1357.61 C
	methanol 15%	19.12 A	16.72 A	4.56 A	8.79 AB	1.16 A	1.60 AB	1406.93 B
	methanol 20%	19.33 A	16.89 A	4.62 A	9.25 A	1.21 A	1.68 AB	1461.63 A
	Control	16.81 B	14.62 B	3.85 A	7.94 B	1.01 A	1.28 C	1357.61 D
Sweet Charlie	**bacteria 10 cm^3/l**	19.58 A	17.83 A	4.88 A	9.50 A	1.30 A	1.78 AB	1477.68 A
	methanol 5%	18.93 A	16.88 AB	4.19 A	8.28 AB	1.03 A	1.20 B	1481.66 A
	methanol 10%	19.25 A	17.27 AB	4.24 A	8.55 AB	1.05 A	1.38 AB	1418.57 B
	methanol 15%	19.25 A	17.44 AB	4.69 A	8.80 AB	1.25 A	1.48 AB	1498.15 A
	methanol 20%	19.35 A	17.59 AB	4.67 A	9.40 A	1.28 A	1.60 AB	1537.80 A
	Control	17.38 B	14.97 CD	3.88 A	8.25 AB	1.03 A	1.30 AB	1344.50 CD
	bacteria 10 cm^3/l	19.18 A	16.32 ABC	4.58 A	9.25 A	1.28 A	1.88 A	1383.31 BC
	methanol 5%	18.88 A	15.76 BCD	4.14 A	8.50 AB	1.08 A	1.55 AB	1247.12 EF
	methanol 10%	18.93 A	15.91 BCD	4.41 A	8.58 AB	1.13 A	1.60 AB	1296.66 DE
	methanol 15%	18.98 A	15.99ABCD	4.44 A	8.78 AB	1.08 A	1.73 AB	1315.72 D
	methanol 20%	19.30 A	16.19 ABC	4.57 A	9.10 AB	1.15 A	1.75 AB	1385.46 BC
	Control	16.25 C	14.26 D	3.82 A	7.63 B	1.00 A	1.25 B	1194.04 F

2. Chemical composition of plant foliage :-

a. Effect of cultivars :- Concerning the effect of tested cultivars on chemical constituents of plant foliage, data in Tables 3 and 4 indicate that chemical composition of plant foliage expressed as total nitrogen, phosphorus, potassium, total crude protein%, total carbohydrates content and chlorophyll reading of plant foliage were significantly differed among the tested cultivars. except P% and chlorophyll reading in the first season and N%, total crude protein% and chlorophyll reading in the second one which the level of differences did not reach the level of significance. In this respect, cv. Fortuna recorded the highest values in most assayed chemical constituents compared with cv. Sweet Charlie during both growth seasons. While cv. Sweet Charlie reflected the highest potassium% during both seasons compared with cv. Fortuna. Obtained results are true during both seasons of study. In this connection, such differences in chemical composition of plant foliage between the studied cultivars are connected with the differences in vegetative growth Tables, 1, 2 and the difference in their nutrient requerments and absorbing ability of different tested cultivars. Also it may be due to the difference in genetic potential for such tested cultivars. In this respect, **Abd El-Aziz (2007)**, **Mosalem (2010)**, **EL-Badawy (2014) and Tomic *et al.*(2016)** indicated that there were significant differences among the studied cultivars in assayed chemical constituents of plant foliage.

b. Effect of Foliar spray with methylotrophic bacteria and methanol :- As for the effect of foliar spray with methylotrophic bacteria and different concentration of methanol i.e 5,10,15 and 20% on chemical constituents of plant foliage, data in the Tables 3 and 4 show clearly that total nitrogen, phosphorus, potassium, total crude protein%, total carbohydrates and chlorophyll reading were significantly increased as a result of a praying the plants with tested foliar spray with methylotrophic bacteria and methanol at different used concentrations compared to the chick treatment. Obtained results were true during both seasons of study. In this connection, the highest values were recorded in case of using foliar spray treatment with methylotrophic bacteria at 10 cm^3/l followed by Foliar spray with methanol at 20,15,10 and 5%, respectively. Obtained results may be due to the increase of enzymatic activities which affect absorption of macro-elements by plant roots sprayed with methylotrophic bacteria and methanol and in turn increase its concentration in plant parts. Plant hormones might be produced by these bacteria **(corpe and Basile,1982)**. The first report on the production of indole acetic acid in significant amounts by methylotrophic bacteria was reported by **Ivanova *et al.* (2001)**. Similar results were recorded by **Amer and El-Assiouty (2004), Abd El-All (2009), Ali (2010) and Abd El-Gawad *et al*. (2015)** used yeast extract and methylotrophic bacteria and **Saikia *et al.* (2000), Ramadan and Omran (2005), Pineda-Pineda *et al.* (2010), Zhao *et al*.(2013) and Armand *et al.* (2016 a and b)** used different concentrations of methanol as growth stimulant in the form of foliar spray. They found that treatment the tested vegetables crops increased the different assayed chemical constituents of plant foliage.

c. Effect of the interaction:-

Regarding the effect of the interaction, the same data in Tables 3 and 4 indicate that plants foliar spray of cv. Fortuna with methylotrophic bacteria at 10 cm^3/l and different concentration of methanol i.e 5,10,15 and 20% six times during the growing season starting at the beginning of flowering and every 15 days by intervals especially with methylotrophic bacteria 10 cm^3/l recorded the highest values of N, P, K, total crude protein%, carbohydrates and chlorophyll reading during the two seasons of study compared with other tested interaction treatments.

3. Fruit yield and its components :-

a. Effect of cultivars :- Concerning the effect of cultivars on total fruit yield and its components expressed as early yield and marketable yield as well as total yield either per plant or feddan and unmarketable yield, data recorded in Tables 5 show that all measured yield parameters were significantly differed among the tested cultivars. In this regard, cv. Fortuna recorded the highest produced total yield and its components. Moreover, the lowest infected yield (unmarketable) was recorded in case of cv. Sweet charlie. Obtained results are true during both seasons of study. Such differences in total produced yield and its components between the tested cultivars are connected with the differences in vegetative growth performance (Tables, 1 and 2) and chemical composition of plant foliage (Tables, 3 and 4) which in turn affect the product ability of plants in each cultivars. Obtained result are in the same line with those reported by **Turemis (2002), Pranckietiene and Pranckietis (2003), Gunduz and Ozdemir (2008), Ahmed (2009), Mosalem(2010), Ragab *et al*.(2012), EL-Badawy(2014), Asadpoor and Tavallali (2015), Kalnina *et al.*(2016) and Ramandeep and Navprem (2016)** all working on strawberry and reported great differences in total fruit yield and its components between the tested cultivars. However, **David and Dill (2003), Aranda *et al.* (2005) and Molinar and yang (2006)** indicated that no significant differences among the tested strawberry cultivars in the early and total yield.

Table 3. Effect of cultivars, spray with methylotrophic bacteria and methanol as well as their interaction on chemical constituents of strawberry plant foliage in 2014/2015 season.

Treatments		2014/2015					
CV	**Spray**	**N %**	**P %**	**K %**	**Total crude protein %**	**Total Carbohydrats%**	**Chlorophyll reading**
Fortuna		2.55 A	0.75 A	2.33 B	15.95 A	19.35 A	32.61 A
Sweet Charlie		2.43 B	0.74 A	2.44 A	15.19 B	18.29 B	33.19 A
	bacteria 10 cm^3/l	2.58 A	0.78 A	2.49 A	16.09 A	19.92 A	34.31 A
	methanol 5%	2.45 EC	0.72 C	2.35 D	15.28 ED	18.39 D	32.00 C
	methanol 10%	2.48 CD	0.75 B	2.36 D	15.53 CD	18.69 C	33.03 BC
	methanol 15%	2.50 BC	0.76 B	2.38 C	15.65 BC	18.73 C	33.39 AB
	methanol 20%	2.55 AB	0.77 A	2.41 B	15.91 AB	19.21 B	33.84 AB
	Control	2.39 E	0.68 D	2.33 E	14.99 E	17.99 E	30.81 D
Fortuna	**bacteria 10 cm^3/l**	2.65 A	0.79 A	2.46 BC	16.56 A	20.56 A	33.75 AB
	methanol 5%	2.51 B	0.71 E	2.29 H	15.71 B	18.94 C	31.25 CD
	methanol 10%	2.52 B	0.75 CD	2.29 GH	15.75 B	19.27 C	32.91 B
	methanol 15%	2.53 B	0.76 BC	2.33 G	15.78 B	19.30 C	33.31 AB
	methanol 20%	2.59 A	0.78 AB	2.34 F	16.24 A	19.87 B	33.54 AB
	Control	2.51 B	0.68 F	2.28 H	15.69 B	18.13 E	30.89 D
Sweet Charlie	**bacteria 10 cm^3/l**	2.50 B	0.78 AB	2.51 A	15.63 B	19.28 C	34.88 A
	methanol 5%	2.38 C	0.73 D	2.41 D	14.86 C	17.86 E	32.75 BC
	methanol 10%	2.45 B	0.74 D	2.43 D	15.30 B	18.10 E	33.14 AB
	methanol 15%	2.48 B	0.75 CD	2.45 C	15.52 B	18.17 E	33.48 AB
	methanol 20%	2.49 B	0.77 BC	2.48 B	15.58 B	18.55 D	34.14 AB
	Control	2.29 D	0.69 F	2.37 E	14.30 D	17.85 E	30.74 D

Table 4. Effect of cultivars, spray with methylotrophic bacteria and methanol as well as their interaction on chemical constituents of strawberry plant foliage in 2015/2016 season.

Treatments		2015/ 2016					
CV	**Spray**	**N %**	**P %**	**K %**	**Total crude protein %**	**Total Carbohydrats%**	**Chlorophyll reading**
Fortuna		2.37 A	0.78 A	2.34 B	14.81 A	20.20 A	32.78 A
Sweet Charlie		2.36 A	0.65 B	2.53 A	14.73 A	19.47 B	32.94 A
	bacteria 10 cm^3/l	2.51 A	0.74 A	2.57 A	15.69 A	20.39 A	35.03 A
	methanol 5%	2.29 D	0.70 CD	2.38 C	14.36 D	19.52 D	31.31 D
	methanol 10%	2.31 D	0.71 BC	2.41 C	14.46 D	19.71 CD	32.54 C
	methanol 15%	2.37 C	0.72 BC	2.48 B	14.81 C	19.85 BC	33.31 B
	methanol 20%	2.41 B	0.73 AB	2.52 B	15.05 B	20.08 B	33.90 B
	Control	2.28 D	0.69 D	2.26 D	14.27 D	19.46 C	31.08 D
	bacteria 10 cm^3/l	2.52 A	0.82 A	2.51 CD	15.75 A	20.68 A	34.95 AB
	methanol 5%	2.30 D	0.77 CD	2.27 G	14.38 D	20.01 BC	31.00 F
Fortuna	**methanol 10%**	2.32 CD	0.78 BCD	2.29 G	14.47 CD	20.07 BC	32.58 DE
	methanol 15%	2.38 B	0.79 BC	2.39 F	14.85 B	20.19 BC	33.25 CD
	methanol 20%	2.42 B	0.79 AB	2.44 EF	15.09 B	20.34 AB	33.78 C
	Control	2.29 D	0.75 D	2.14 H	14.31 D	19.92 C	31.13 F
	bacteria 10 cm^3/l	2.50 A	0.67 E	2.63 A	15.63 A	20.09 BC	35.10 A
	methanol 5%	2.29 D	0.64 EF	2.49 DE	14.33 D	19.02 F	31.63 EF
Sweet Charlie	**methanol 10%**	2.31 D	0.64 EF	2.53 CD	14.44 CD	19.35 EF	32.50 DE
	methanol 15%	2.37 BC	0.65 EF	2.57 BC	14.78 BC	19.52 DE	33.38 CD
	methanol 20%	2.40 B	0.66 E	2.59 AB	15.00 B	19.83 CD	34.03 BC
	Control	2.28 D	0.62 F	2.38 F	14.22 D	19.00 F	31.03 F

b. Effect of Foliar spray with methylotrophic bacteria and methanol :- With regard to the effect of foliar spray treatments (methylotrophic bacteria and different concentrations of methanol) on total fruit yield and its components i.e., early, marketable as well as total yield per plant or feddan and unmarketable yield, data in Table 5 reveal that foliar spray of strawberry plants six times during the growing season starting at the beginning of flowering and fefteen days by intervals with methylotrophic bacteria at 10 cm^3/l and methanol significantly increased the total produced yield and its components except the unmarketable yield which was decreased compared to the control treatment. In this regard, the highest values of early, marketable and total yield per plant and per feddan were recorded in case of methylotrophic bacteria at 10 cm^3/l followed by spraying the plants with 20,15,10 and 5% methanol with significant differences among them in both seasons of study. On the other hand, foliar spray the plants with both methylotrophic bacteria at 10 cm^3/l and methanol at (5,10,15 and 20%) exhibited the lowest unmarketable yield with significant differences among them compared with the control treatment. The lowest value of unmarketable yield were recorded in case of methylotrophic bacteria at10 cm^3/l followed by foliar spray with methanol at 20%. This result was true during the two seasons of study. The higher yield in case of using methylotrophic bacteria may be attributed to the role of methylotrophic bacteria in translocation of produced photosynthetic assimilates and accumulation of it in storage organs (fruits) and in turn increase the number, weight and size of its fruits which consequently positively affect yield. These effects might be mediated by producing plant growth regulators like ziatin and related cytokinins and auxins **(Omer *et al*, 2004)**. Also such increases are connected with the increase in vegetative growth (Tables, 1 and 2) which connected greatly with the productivity of plant. In this regard, similar results were reported by **Ali (2000), Amer (2004), Amer and El-Assiouty (2004), Shaker and Darwish (2004), Madhaiyan *et al.* (2005), Raja and Sundaram (2006), Radha *et al.* (2009), Ali (2010), Puneet *et al.* (2010) and Abd El-Gawad *et al.*(2015)** who found that preharvest application of yeast and methylotrophic bacteria positively affected fruit yield and its components. Moreover, **Irena and Karczmarczyk (1997), Dwivedi *et al.* (2001), Ramadan and Omran (2005)**, **Mokashi *et al* .(2007), Mirakhori *et al.* (2009), Farajpour *et al* .(2012), Salehi(2013) and Moemenpour and Karami (2015)** recorded similar results on different vegetable fruit crops in case of using different concentrations of methanol on such crops.

c. Effect of the interaction :- As for the effect of the interaction, the data in Table 5 show that, spraying the plants of cv. Fortuna with methylotrophic bacteria at 10 cm^3/l six times during the growing season starting at the beginning of flowering and every 15 days by intervals reflected the highest produced yield and its components except unmarketable yield which was decreased compared with other interaction treatments during both seasons of study.

4. Fruit quality:-

4.1. Fruit physical quality:-

a. Effect of cultivars:- Regarding the effect of cultivars on physical fruit quality of strawberry, data recorded in Table 6 show that fruit physical quality expressed as average fruit weight, diameter and fruit firmness were significantly differed among the studied cultivars during both growth seasons. In addition, fruit length was not significantly affected as a result of used genotypes during the first seasons only. In this regard, fruits produced by cv. Fortuna show the highest fruit weight, length, diameter and firmness compared with those produced by cv. Sweet Charlie but there is no significantly difference in fruit length during the first season only. This increments in morphological characters of fruits in case of cv. Fortuna may be due to the vigorous vegetative growth (Tables 1 and 2) and high contentes from chemical composition of plant foliage (Tables, 3 and 4) which in turn affect size of produced fruits. Such differences among the tested cultivars in fruit physical quality traits may be attributed to the effect of genetic factors affecting fruit physical quality parameters. Obtained results are similar to those reported by **Aranda *et al.*(2004), Faedi and Baruzzi (2004), Ahmed (2009), Mosalem (2010), Ragab *et al.*(2012), EL-Badawy(2014), Asadpoor and Tavallali (2015), Kalnina *et al.*(2016) and Ramandeep and Navprem (2016).**

b. Effect of Foliar spray with methylotrophic bacteria and methanol:- Concerning the effect of foliar spray with methylotrophic bacteria at 10 cm^3/l and methanol at different tested concentrations (5,10,15 and 20%) data in Table 6 indicate that spraying strawberry plants with all aforementioned treatment significantly increased all measured fruit physical parameters compared with the control treatments during the two seasons of the experiment. In this concern, spray plants with methylotrophic bacteria at 10 cm^3/l reflected the highest values in average fruit length, diameter, weight and fruit firmness with significantly differences. However, fruit length and diameter in the first season and fruit length in the second one did not reach the level of 5% significance.

Table 5. Effect of cultivars, spray with methylotrophic bacteria and methanol as well as their interaction on fruit yield of strawberry plant in 2014/2015 and 2015/2016 season.

Treatments		2014/2015					2015/2016				
CV	**Spray**	**Total yield (g/plant)**	**Early yield (ton/fed)**	**Marketable yield (ton/fed)**	**Unmarketable yield (kg/fed)**	**Total yield (ton/fed)**	**Total yield (g/plant)**	**Early yield (ton/fed)**	**Marketable yield (ton/fed)**	**Unmarketable yield (kg/fed)**	**Total yield (ton/fed)**
Fortuna		495.67 A	7.15 A	24.39 A	642.74 A	24.98 A	513.60 A	7.85 A	25.20 A	681.69 A	25.89 A
Sweet Charlie		464.08 B	6.13 B	22.99 B	533.24 B	23.52 B	479.09 B	7.47 B	23.57 B	580.77 B	24.15 B
	bacteria 10 cm³/l	560.86 A	7.52 A	27.62 A	424.06 F	28.05 A	582.26 A	8.45 A	28.89 A	450.86 F	29.35 A
	methanol 5%	446.35 E	6.20 E	21.84 E	654.05 B	22.49 E	457.11 E	7.09 E	22.31 E	729.12 B	23.04 E
	methanol 10%	459.66 D	6.40 D	22.70 D	627.34 C	23.17 D	471.50 D	7.51 D	23.11 D	658.11 C	23.76 D
	methanol 15%	472.18 C	6.62 C	23.25 C	551.86 D	23.80 C	485.49 C	7.81 C	23.89 C	585.16 D	24.47 C
	methanol 20%	510.58 B	7.08 B	25.25 B	488.94 E	25.73 B	530.94 B	8.05 B	26.23 B	534.96 E	26.76 B
	Control	441.74 E	6.01 F	21.48 E	781.67 A	22.26 E	450.78 E	7.04 E	21.89 E	829.18 A	22.72 E
Fortuna	**bacteria 10 cm³/l**	591.05 A	8.02 A	29.32 A	471.91 G	29.79 A	621.35 A	8.76 A	30.82 A	495.80 I	31.32 A
	methanol 5%	453.03 F	6.68 F	22.07 G	766.08 B	22.83 F	464.79 EF	7.25 F	22.63 FG	791.21 C	23.42 EF
	methanol 10%	468.56 E	6.88 E	23.28 EF	664.71 C	23.62 E	472.95 E	7.71 E	23.13 EF	661.62 E	23.84 E
	methanol 15%	479.90 D	7.13 C	23.57 ED	618.97 D	24.19 D	493.49 D	7.94 CD	24.21 D	707.06 D	24.87 D
	methanol 20%	537.80 B	7.63 B	26.58 B	528.07 F	27.10 B	572.38 B	8.25 B	28.26 B	587.11 G	28.85 B
	Control	443.72 GF	6.56 G	21.56 HG	806.67 A	22.36 F	456.65 FG	7.19 F	22.17 GH	847.38 A	23.02 FG
Sweet Charlie	**bacteria 10 cm³/l**	520.61 C	7.02 D	25.93 C	376.21 I	26.31 C	543.17 C	8.14 BC	26.97 C	405.91 K	27.38 C
	methanol 5%	439.67 G	5.73 J	21.62 HG	542.02 F	22.16 F	449.42 G	6.94 G	21.99 H	667.04 E	22.65 G
	methanol 10%	450.75 F	5.93 I	22.13 G	589.97 E	22.72 F	470.06 E	7.31 F	23.08 EF	609.17 F	23.69 E
	methanol 15%	464.46 E	6.11 H	22.93 F	484.74 G	23.41 E	477.49 E	7.68 E	23.56 E	508.70 H	24.07 E
	methanol 20%	483.37 D	6.54 G	23.92 D	449.82 H	24.51 D	489.50 D	7.86 DE	24.19 D	482.82 J	24.67 D
	Control	439.77 G	5.46 K	21.41 H	756.67 B	22.16 F	444.91 G	6.89 G	21.62 H	810.99 B	22.43 G

Table 6. Effect of cultivars, spray with methylotrophic bacteria and methanol as well as their interaction on physical fruit quality of strawberry in 2014/2015 and 2015/2016 seasons.

Treatments		2014/2015				2015/2016			
CV	**Spray**	**Fruit weight (g)**	**Fruit length (cm)**	**Fruit diameter (cm)**	**Fruit firmness (g/cm^2)**	**Fruit weight (g)**	**Fruit length (cm)**	**Fruit diameter (cm)**	**Fruit firmness (g/cm^2)**
Fortuna		18.03 A	4.37 A	3.72 A	92.27 A	19.10A	4.63 A	3.90 A	94.79 A
Sweet Charlie		16.88 B	4.24 A	3.38 B	74.00 B	17.06B	3.71 B	3.41 B	73.25 B
	bacteria 10 cm^3/l	17.90 AB	4.46 A	3.66 A	90.00 A	19.75A	4.48 A	3.89 A	92.50 A
	methanol 5%	17.05 BC	4.20 A	3.48 A	78.13 C	17.31CD	4.18 A	3.61 AB	78.75 B
	methanol 10%	17.45 AB	4.21 A	3.54 A	81.13 BC	17.83 BC	4.10 A	3.65 AB	80.63 B
	methanol 15%	17.68 AB	4.40 A	3.59 A	85.63 AB	18.45 ABC	4.03 A	3.68 AB	86.88 A
	methanol 20%	18.27 A	4.46 A	3.64 A	87.13 A	19.03 AB	4.30 A	3.80 A	87.88 A
	Control	16.37 C	4.09 A	3.40 A	78.13 C	16.13 D	3.93 A	3.29 B	77.50 B
Fortuna	**bacteria 10 cm^3/l**	18.60 A	4.50 A	3.83 A	100.00 A	20.50 A	4.98 A	4.10 A	107.50 A
	methanol 5%	17.43ABCD	4.20 A	3.65 AB	87.50 BCD	19.00 AB	4.78 AB	3.95 ABC	87.50 D
	methanol 10%	18.12 ABC	4.30 A	3.68 AB	92.50 ABC	19.28 AB	4.58 ABC	3.95 ABC	90.00 CD
	methanol 15%	18.34 AB	4.50 A	3.75 AB	95.00 AB	19.43 AB	4.38 ABCD	3.98 ABC	97.50 BC
	methanol 20%	18.57 A	4.55 A	3.80 A	96.25 A	19.68 AB	4.73 ABC	4.03 AB	98.75 B
	Control	17.13 BCD	4.15 A	3.60 AB	85.00 CDE	16.75 CD	4.33 ABCD	3.40 BCD	87.50 D
Sweet Charlie	**bacteria 10 cm^3/l**	17.21 BCD	4.43 A	3.50 AB	80.00 DEF	19.00 AB	3.98 BCD	3.68 ABCD	77.50 E
	methanol 5%	16.68 DE	4.20 A	3.30 AB	68.75 H	15.63 D	3.58 D	3.30 D	67.50 F
	methanol 10%	16.79 CDE	4.13 A	3.40 AB	69.75 H	16.38 CD	3.63 D	3.35 CD	71.25 EF
	methanol 15%	17.03 BCD	4.30 A	3.43 AB	76.25 FGH	17.48 BCD	3.68 D	3.38 CD	76.25 E
	methanol 20%	17.98ABCD	4.38 A	3.48 AB	78.00 EFG	18.38 ABC	3.88 CD	3.58 ABCD	77.00 E
	Control	15.61 E	4.03 A	3.20 B	71.25 GH	15.50 D	3.53 D	3.18 D	70.00 EF

Such increments in fruit length, diameter and weight in case of methylotrophic bacteria and methanol at different concentrations may be due to the effect of such foliar spray with methylotrophic bacteria and methanol on water content of fruit which affect cell formation and cell size in fruit receptacle and in turn on fruit parameters. These effects might be mediated by the production of synthesis of plant hormones **(Omer *et al*, 2004)**. Obtained results are in accordance with those reported by **Abd El-All (2009), Markus Verginer *et al.* (2010), Dhale *et al.* (2010) and Abd El-Gawad *et al.*(2015)** in case of using yeast extract, methylotrophic bacteria and **Hartz *et al.*(1994), Abdel-Al (1998) and Dhale *et al.* (2010)** in case of using methanol.

c. Effect of the interaction :- As for the effect of the interaction between tested cultivars, spray with methylotrophic bacteria as well as methanol at different concentrations. the same data in Table 6 reveal that the highest values in average fruit parameters (length, diameter and weight) were recorded as a result of foliar spraying the plants of cv. Fortuna by methylotrophic bacteria at 10 cm^3/l followed by those foliar sprayed with methanol at 20% with the same cultivar during the two seasons of study. Moreover, methanol treatment via cv. Fortuna exhibited the highest values of fruit firmness during both seasons of study. Such increase in fruit firmness in case of using methylotrophic bacteria may be due to methanol is the main constituent of cell wall and in turn increased its solidity.

4.2. Fruit chemical quality :-

a. Effect of cultivars :- With regard to the effect of cultivars, data in Table 7 show that chemical fruit quality expressed as total soluble solids, vitamin C, total sugars as well as anthocyanin concentration were significantly differed among the tested cultivars during both seasons of growth. In this respect, cv. Sweet Charlie exhibited the highest concentration of total soluble solids, vitamin-C, total acidity, total sugars and anthocyanin. Whereas vitamin-C and total acidity in the first season and total acidity in the second one did not reach the level of significance. Such results are true during both seasons of growth. The superiority of cv. Sweet Charlie in total sugars and vitamin-C content may be due to the highest total soluble solids which in turn might be effected by photo assimilation rate. In this connection, such differences in concentration of estimated mineral and organic constituents of produced fruits are connected with the differences in growth rate (Tables, 1 and 2), differences in chemical composition of plant foliage (Tables, 3 and 4) and the difference in their nutrient requirements and absorbing ability of different tested cultivars. Also, such differences in fruit chemical quality characters between the studied cultivars may be attributed to the genetic stracture of such cultivars. Obtained results are in agreement with theose reported by **Hakala *et al.*(2002), Zmuda *et al.*(2004), Ahmed (2009), Ragab *et al*.(2012), Talento *et al.*(2012), EL-Badawy(2014), Asadpoor and Tavallali (2015), Kalnina *et al.*(2016), Ramandeep and Navprem (2016) and Tomic *et al.*(2016)**. All working on strawberry.

b. Effect of Foliar spray with methylotrophic bacteria and methanol :- Regarding the effect of foliar spray with methylotrophic bacteria and methanol at different tested concentration, data recorded in Table 7 show that spraying the plants with methylotrophic bacteria and methanol at the different tested concentrations statistically affected fruit contents of total soluble solids, vitamin-C, total acidity, total sugars as well as anthocyanin compared to the control treatment. In addition, foliar spray of strawberry plants with methylotrophic bacteria at 10 cm^3/l followed by methanol at the highest used concentration (20%) gave the highest values for all aforementioned chemical constituents without significant differences among them. Obtained results were similar during the two seasons of study except total soluble solids in the first season which did not reach the level of significance. In this concept **Saleh (2004) and Abd El-Gawad *et al.*(2015)** in case of using yeast extract and methylotrophic bacteria and **Hartz *et al.*(1994), Abdel-Al (1998), Ramadan and Omran(2005) and Nadali *et al.*(2010)** in case of using methanol indicated that applying such foregoing growth stimulants reflected positive effect on all measured chemical fruit quality for such tested vegetable crops.

c. Effect of the interaction :- As for the effect of the interaction between studied cultivars and foliar spray with methylotrophic bacteria as well as methanol at different concentrations, data in Table 7 indicate that spraying the plants six times during the growing season starting at the beginning of flowering and every 15 days by intervals with methylotrophic bacteria reflected the highest fruit content of T.S.S., vitamin-C., total acidity, total sugars and anthocyanin especially in case of cv. Sweet Charlie compared with the control treatment. However, There were no no significant differences noticed between foliar spray of strawberry plants with each of methylotrophic bacteria or methanol at 20% with cv. Sweet Charlie for most chemical fruit quality under study.

Table 7 . Effect of cultivars, spray with methylotrophic bacteria and methanol as well as their interaction on chemical fruit quality of strawberry in 2014/2015 and 2015/2016 season.

treatments		2014/2015					2015/2016				
CV	**Spray**	**T. S.S %**	**Vit.C (mg/100g f.w)**	**Acidity (mg/100g f.w)**	**Total sugars %**	**Total Anthocyanin (mg/100g f.w)**	**T.S.S %**	**Vit. C (mg/100g f.w)**	**Acidity (mg/100g f.w)**	**Total sugars %**	**Total Anthocyanin (mg/100g f.w)**
Fortuna		9.78 B	51.08 A	1.55 A	7.63 B	82.76 B	8.12 B	51.62 B	1.51 A	8.52 B	85.83 B
Sweet Charlie		10.75 A	51.60 A	1.55 A	7.75 A	84.28 A	9.52 A	52.30 A	1.53 A	8.65 A	87.29 A
Fortuna	**bacteria 10 cm^3/l**	10.56 A	52.12 A	1.60 A	7.78 C	85.48 A	9.05 A	52.40 A	1.55 A	8.77 B	87.33 AB
	methanol 5%	10.00 A	50.84 BC	1.59 A	7.64 E	82.22 E	8.65 AB	51.70 AB	1.49 AB	8.51 E	85.71 C
	methanol 10%	10.13 A	51.20 ABC	1.55 A	7.72 D	83.14 D	8.75 AB	52.00 AB	1.56 A	8.59 D	86.14 BC
	methanol 15%	10.26 A	51.69 AB	1.59 AB	7.86 B	83.69 C	8.91 AB	52.13 AB	1.56 A	8.68 C	86.74 ABC
	methanol 20%	10.63 A	51.88 A	1.60 A	7.93 A	84.81 B	9.08 A	52.23 A	1.61 A	8.80 A	87.79 A
	Control	10.00 A	50.32 C	1.35 B	7.22 F	81.78 F	8.48 B	51.29 B	1.33 B	8.17 F	85.67 C
Fortuna	**bacteria 10 cm^3/l**	10.13 ABC	51.73 ABC	1.65 A	7.65 F	84.47 C	8.43 B	52.13 AB	1.52 D	8.65 E	88.00 AB
	methanol 5%	9.50 C	50.28 CD	1.37 E	7.62 G	81.39 H	7.95 B	51.45 AB	1.57 C	8.48 G	84.93 DE
	methanol 10%	9.63 C	50.79 BCD	1.52 C	7.68 F	82.48 FG	8.00 B	51.58 AB	1.52 D	8.55 F	85.53 CDE
	methanol 15%	9.78 BC	51.66 ABC	1.57 B	7.85 D	82.95 EF	8.13 B	51.73 AB	1.53 D	8.66 E	86.27 ABCDE
	methanol 20%	10.13 ABC	51.99 AB	1.60 A	7.91 B	83.96 CD	8.40 B	51.77 AB	1.60 B	8.75 C	87.48 ABC
	Control	9.50 C	50.05 D	1.30 E	7.10 I	81.33 H	7.83 B	51.05 B	1.30 F	8.05 I	84.71 E
Sweet Charlie	**bacteria 10 cm^3/l**	11.00 AB	52.51 A	1.55 B	7.89 BC	86.48 A	9.68 A	52.68 A	1.57 C	8.89 A	88.58 A
	methanol 5%	10.50 ABC	51.40 ABCD	1.55 B	7.66 F	83.05 E	9.35 A	51.96 BA	1.40 E	8.55 F	86.49 ABCDE
	methanol 10%	10.63 ABC	51.62 ABC	1.58 B	7.77 E	83.81 D	9.50 A	52.43 A	1.60 B	8.65 E	86.74 ABCDE
	methanol 15%	10.75 ABC	51.73 ABC	1.60 A	7.88 C	84.44 C	9.70 A	52.53 A	1.60 B	8.70 D	87.21 ABCD
	methanol 20%	11.13 A	51.78 AB	1.60 A	7.96 A	85.66 B	9.75 A	52.69 A	1.63 A	8.85 B	88.11 AB
	Control	10.50 ABC	50.59 BCD	1.40 D	7.33 H	82.23 G	9.13 A	51.53 AB	1.35 F	8.29 H	86.62 ABCDE

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إستجابة نباتات الفراولة للتسميد الحيوي بالبكتريا الممثلة للميثانول والرش بكحول الميثانول

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الملخص العربي

أجريت تجربتان حقليتان خلال موسمى الزراعه 2014- 2015 و2015-2016م فى مزرعة خاصة بقرية الدير- محافظه القليوبية في أرض رملية لدراسة استجابة صنفين من أصناف الفراولة وهما فرتونا وسويت شارلى للتسميد الحيوي بالبكتريا الممثلة للميثانول ورش المجموع الخضري للنباتات بالبكتريا الممثلة للميثانول بتركيز 10سم^3/لتر وكحول الميثانول بتركيز 5 و 10 و 15 و20% وتأثير ذلك على النمو الخضرى والتركيب الكيميائى للمجموع الخضرى للنبات والمحصول الثمرى ومكوناته وكذلك أيضًا جودة الثمار الناتجه.

وقد أظهرت النتائج المتحصل عليها وجود إختلافات بين الأصناف المستخدمه في الدراسة في جميع صفات النمو الخضري والمحصول ومكوناته وكذلك جوده الثمار الناتجه. وفي هذا الشأن أعطت نباتات الصنف فرتونا أعلي نمو خضري وأعلى محتوي من المكونات الكيماوية للمجموع الخضري للنباتات تحت الدراسة وأعلى محصول ومكوناته وأفضل جودة طبيعية للثمار كذلك أدي رش المجموع الخضري للنبات بالبكتريا الممثلة للميثانول بتركيز 10سم^3/لتر ست مرات بعد شتل النباتات بـ 20 يوم وعلى فترات كل 15 يوم أثناء موسم النمو الى تحسن في التركيب الكيماوي للمجموع الخضري والمحصول الثمرى وصفات الجودة للثمار الناتجه. وقد أدى إستخدام البكتريا الممثلة للميثانول بمعدل 10 سم^3/لتر الى الحصول على أفضل النتائج فى النمو الخضرى والمحصول والجودة للأصناف المستخدمه.

الكلمات الدالة:-

الفراولة – فرتونا – سويت شارلى – التسميد الحيوي – البكترياالممثلة للميثانول – كحول الميثانول – النمو الخضري – المحصول الثمرى – جودة الثمار.