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Performance of some spherical eggplant hybrids under plastic house and open field conditions

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ABSTRACT

Two experiments were conducted during the two winter seasons of 2018/2019 and 2019/2020 at the Agricultural Experimental Station of Faculty of Agriculture Cairo University Giza to investigate the response of four spherical F1 cultivars (Sawad El Laiel, Petra, Amedo and Black Berry) of eggplant (*Solanum melongena* L.) under two different production systems (open field and plastic house), consider the vegetative growth, fruit quality and yield. Plants grown in open field had higher values of number of branches, early and total yield, fruit weight, fruit diameter, fruit total carbohydrate, vitamin C, macro and micro elements and significant increase in leaf dry matter, leaf concentrations of macro and microelements compared with plastic house production. Reversely, planting in plastic house significantly increased plant height, leaf area and fruit dry matter compared with planting in open field. The period from transplanting to first harvest was shorter in plants grown in open field than those grown in plastic house. Meanwhile, there were no significant differences between production systems in leaf chlorophyll, fruit length, fruit contents of TSS, Ca, Mg, niacin and omega3 in both seasons. The analysis showed significant differences among the different eggplant cultivars for all traits. Sawad El Laiel' recorded the highest value of early and total yield, average fruit weight, total carbohydrate, TSS and leaf concentrations of K, Ca and B. On the other hand, 'Amedo' significantly exceeded all other cultivars in chlorophyll reading and leaf concentrations of N, P, Mg, Fe, Mn and Zn as well as fruit diameter, fruit concentrations of N, P, K, Ca, Mg, Fe, Mn, Zn, vitamin C, niacin (B3) Omega 3 and dry matter. 'Petra' was the earliest cultivar, while the 'Black Berry' was the latest one. The interaction between cultivars and production systems had significantly influence on all traits under study.

KEYWORDS: *Solanum melongena*, cultivars, plastic house, open field, fruit quality.

1. INTRODUCTION

Since the start of the 21st century, there has been considerable scientific and media focus on numerous costly episodes of climate changes,including extreme temperatures, like extreme summer heatwaves in Europe in 2003, Russia and Japan in 2010, and North America in 2011, and the cold and snowy winters of 2009/10, 2010/11, and 2013/14 over portions of Eurasia and North America (Johnson *et al*., 2018). Cold stress, which it was defined as the temperature in a range low enough to suppress the growth without causing cellular functions, affect crop productivity because many crops are sensitive and intolerant to low temperature. Usually, chilling stress lead to induce several abnormalities at various levels of cell organization, such as chlorosis, necrosis, membrane damage, changes in cytoplasm viscosity, and changes in enzyme activities leading to death of plants (Atayee and Noori, 2020).

The eggplant is one of the most important solanaceous crops, known for its nutritive benefits due to the abundance of various bioactive compounds, which include proteins, vitamins, minerals, carbohydrates, phenolics, and dry matter content. Eggplant produces secondary metabolites, including glycoalkaloids, antioxidant compounds, and vitamins, which appear to be the major source of its health benefits. It is also a perfect source of minerals especially iron (Sharma and Kaushik, 2021). Because, its tissue extracts have been helped to cure bronchitis, dysuria, cholera, and asthma, while its fruits and leaves were used to lower blood cholesterol; therefore, it is mainly used as food or in traditional medicines. Consequently, it is substantial vegetable crop in temperate and tropical regions of the world (Aied *et al*., 2017). Eggplant is very popular vegetables in Egypt producing 1180240 Tons from 43818 hectare and yield of the hectare is 26.93 tons/ha as was recorded in the latest statistics of Food and Agriculture Organization (FAOSTATA, 2019).

Eggplant is a tropical perennial herbaceous plant often cultivated as a half-hardy annual in temperate climates. The optimal temperature for crop plant growth and fruit development lies between 22ºC and 30°C (Adamczewska-Sowińska and Krygier, 2013). Eggplant is severely affected by weather conditions . The plant productivity is drastically reduced when the temperature reached 36°C (Valadares *et al*., 2019). In contrast, the plant is sensitive to frost and the growth of young plants may be restrict when temperatures are below 16ºC. (**Adamczewska-Sowińska** *et al*., 2016). Cold stress is the most mportant environmental factor limiting the productivity and geographical distribution of eggplants across the world. Low temperatures at a range of 10 − 15°C cause chilling stress damage at any stage of eggplant growth and developmen (Abdel-Aziz and Geeth , 2019). The damage happend due to low temperature stress was alleviated by using some agricultural methods, like plant growth regulators (Orabi et al., 2015; Siddiqi, *et al.*, 2019; Vardhini , 2019), planting in plastic house (Kwon et al., 2012) or through producing cold tolerance cultivars of eggplants (Singh et al., 2015). Eggplant cultivars differed in flowering, flower morphology and fruit setting (Sekara and Bieniasz, 2008), therefore, there is great variability of fruit setting and yielding among different varieties (Kowalska, 2008).

To get the highest yield of eggplant with high quality, many researchers evaluated the performance of many cultivars under different environments (Tripathy *et al*., 2017; Suleiman, 2020; Uddin *et al*., 2021). Great efforts have been conducted to select some varieties adapted to thermal conditions (Valadares *et al.*, 2019; Santhiya et al., 2019; Sangam *et al.*, 2020). At low temperature periods, many countries grew eggplant under unheated plastic tunnels, greenhouses and heated tunnels which causing high in selling prices such as Poland (Caruso *et al.*, 2020). To our knowledge, there is no published studies on evaluation of some eggplant's genotypes under the low temperature conditions. Therefore, the aim of the present research was to assess the performance of four eggplant cultivars for yield and quality under open field conditions during winter time, comparing to crop production in unheated plastic house

2. MATERIALS AND METHODS

2.1. Experimental site:

The study was conducted at the Agricultural Experimental Station of Faculty of Agriculture Cairo University Giza, during the winter growing season of 2018/2019 and 2019/2020. The soil was a clay loam with a pH of 7.6.

Table 1. Chemical and physical properties of the experimental soil.

Chemical characteristics			Physical characteristics	
Character		Value	Character	Value
pH 1:2.5		7.6	Coarse sand	6.0
E.C (ds/m)		4		
Total $CaCO_3$ (%)		3.6		
Soluble anions (meq/L)	HCO_3^-	2.8		
	Cl^-	1	Fine sand	18
	SO_4^{-2}	2.5		
Soluble Cations (meq/L)	Ca^{+2}	1		
	Mg^{+2}	1.8		
	Na^+	2.6	Silt	39
	K^+	0.57		
Plant available microelements (mg/ml)	Mn	11.6		
	Zn	2.46	Clay	37
	Cu	2.06		
	Fe	5.6		
Plant available macro elements (mg/ml)	N	90	Textural class	Clay loam
	P	34		
	K	720		

The experiment consisted of 8 treatments (2 production systems and 4 spherical F_1 hybrid cultivars).

2.2. Production systems:

A. Greenhouse covers with transparent plastic sheet (200 micron thick).

B. Greenhouse without cover (open field)

Plastic cover was removed staring from first week of March to the end of May. Greenhouses dimensions were 2.20 m height, width of 8.5 m, and length of 38.0 m.

2.3. Eggplant spherical F1 hybrid cultivars were as follows:

1. Sawad El Laiel (Seminis, Co., France)
2. Petra (Fito Co., Netherland)
3. Amadeo (Enza Zaden Co., Netherland)
4. Blackberry (Monarch Seed Trade Co., China)

Six-week-old Eggplant transplants were planted on September 12th and 16thin the first and second season, respectively, on double rows per bed with a 0.6 m separation between plants and 30-cm separation between rows. Each plot consisted of a bed (1.5 m width x 9.5 m length x 0.2 m height) had 32 plants.

Surface drip irrigation was used for irrigation and fertilizers fertigation. The DI system consisted of 63 mm Polyethylene pipeline, which was directly connected to the water supply system. Polyethylene pipeline were attached with 16 mm diameter Polyethylene laterals. The lateral was installed 1.5 m apart among the two lines in each block. Each greenhouse contained five laterals. The in line (GR) drippers were placed at 0.5 m spacing in each line. The GR drippers discharge was 4 l/h. The eggplant transplants were planted, 5 cm far from the drippers. During the period of growth, a total of 600 kg ha-^{1} NPK (19-19-19) , 220 kg ha-^{1} urea and 100 KCl were applied. One third of NPK and approximately one-tenth of urea were incorporated into soil before planting. The remaining fertilizer was applied by fertigation every three weeks

2.4. Experimental design:

The experimental design used was a factorial experiment with randomized complete block in four replicates for two production systems and four eggplant cultivars. Least significant difference test (LSD) at 5% level of probability was used to evaluate differences between the means

2.5. Data recoded:

Light intensity (using operation manual digital lux meter (1332B), temperature and humidity using Digital thermo-hygrometer (model, CTH-103), China, were measured in each production system. The maximum and minimum air temperature and relative humidity were measured daily. Three months after transplanting, five plants were taken randomly from each plot to evaluate the following characters:

A-Vegetative growth parameters: Data recorded on growth parameter were (plant height, number of branches and leaf area) and dry matter of leaves. Chlorophyll reading was measured in the most recently fully expanded leaf of the four central plants in each plot using a SPAD-501 plus Minolta Chlorophyll Meter.

B-Yield traits: The following fruit yield traits were recorded:

- Total yield /fed
- early yield (The first two-month harvests were considered as early yield)
- Average fruit weight
- fruit length
- fruit diameter
- TSS (measured by Hand refractometer (C-266 A, England)

C- Chemical composition:

Micro and micro-elements concentrations in eggplant leaves and fruits. Micro and micro-elements concentrations in eggplant leaves and fruits (N, P, K, Ca, Mg, Fe, Mn, B and Zn) were carried out in the dry material, 90 and 145 days after transplanting, respectively. The wet digestion of 0.2g plant material with sulphuric and perchloric acids was carried out by adding concentrated sulfuric acid (5ml) to the samples and the mixture was heated for 10 min. then 0.5 ml perchloric acid was added and heating continued till a clear solution was obtained. The digested solution was quantitatively transferred to a 100 ml volumetric flask using deionized water as reported by Helrich (1990).

Nitrogen: The total nitrogen content of the dried material was determined by using the modified-micro-Kjeldahl method as described by Helrich (1990).

Phosphorus: Phosphorus was determined calorimetrically by using the chlorostannous molybdophosphoric blue color method in sulphuric acid according to Jackson (1973).

Potassium: Potassium concentrations were determined by using the flame photometer apparatus (CORNING M 410, Germany).

Calcium, Magnesium, Iron, Manganese, Boron and Zinc: Concentration of Ca, Mg, Fe, Mn, B and Zn were determined using Atomic Absorption Spectrophotometer with air-acetylene, fuel (Pye Unicam, model SP-1900, US).

Determination of Ascorbic acid and Niacin: Vitamin - C content as ascorbic acid (mg) was estimated in fruit fresh weight, according to Helrich (1990).

Ascorbate is converted to dehydroascorbate by treatment with activated charcoal or bromine. Dehydro ascorbic acid then reacts with 2,4-dinitrophenyl hydrazine to form osazones, which dissolves in sulphuric acid to give an orange-colored solution, whose absorbance can be measured

spectrophotometrically at 540nm. As for niacin was determined calorimetrically in fruit and estimated per 100 ml fresh weight according to Katoch (2011).

Determination of carbohydrates: Carbohydrate content was assessed using the phosphomolybdic acid method, as stated by Helrich (1990). Two grams of sample was crushed with 10 mL 80% ethanol in mortar and pestle, then filtered through Whatman filter paper. The filter and residue were collected separately. The alcohol residue was taken into a 250 mL conical flask and 150 mL distilled water, and 5 mL concentrated HCL was added to it. The residue was left to hydrolyze for 30 min and then cooled to room temperature. Na_2CO_3 was then added slowly until the extract became neutral (pH = 7). The extract was filtered, and the residue was discarded. The filtrate was taken into a conical flask and condensed in a hot water bath for 3–4 min. Distilled water was added to the filtrate, then filtered, residue was discarded, and the volume of filtrate was used for estimating content of reducing sugars. Of this filtrate, 20 mL was taken into a 150 mL conical flask and 2 mL of concentrated HCl was added to it. It was then hydrolyzed for 30 min and cooled at room temperature. Na_2CO_3 was slowly added until the extract became neutral (pH = 7). This extract was filtered, residue was discarded, and the final volume of the filtrate was measured and used for estimating content of total sugars. For the aliquot sample, 0.5 mL was taken into a test tube and 1 mL of Somogyi reagent was added. Test tubes were placed in a boiling water bath for 30 min, cooled to room temperature, and 1 mL of arsenomolybdate reagent was added. The content was mixed and diluted to a volume of 10 mL and its absorbance was spectrophotometrically measured at 560 nm.

Determination of omega3

Methylation of fatty acid: Gas- liquid chromatographic analysis of fatty acid was done on methyl ester which was prepared and purified by the method of **Kinsella** (1966) with some modifications. The methyl ester was prepared by refluxing the liberated fatty acids of Oenothera seeds with sulfuric acid (5 ml 1% v/v) in dried methanol for 30 min at 55 $^{\circ}$C. The fatty acid methyl esters were extracted several times with ether. The combined ether extracts were dried over anhydrous sodium sulfate, filtrated and concentrated at 55 $^{\circ}$C.

GLC of fatty acid methyl esters: Separation of fatty acid methyl esters was carried out using capillary column, which contained 15% diethyl glycol succinate DEGS. The injector port and flame ionization detector were set at 240 $^{\circ}$C. The flow rate of carrier gas, nitrogen, was 10 ml/ minute. The gas chromatograph (Perkin- Elemar model 8310) had a temperature program from 100 to 190 $^{\circ}$C with interment rate of 7 $^{\circ}$C / minute. The initial and final time were identified according to their retention time compared to those of authentic samples.

3. RESULTS AND DISCUSSION

3.1. Air Temperature:

Air temperature in plastic house was about 2- 3^{o}C higher than those in open field. It was reported that air temperature was raised inside plastic house about 1.5-2^{o}C than outside by Faraget *al*. (2010). Inside the plastic house microclimate is different, where rich sunlight gets in via transparency of the plastic cover and gets trapped that makes the conditioned warmer than outside as the cladding material provide thermal insulation (Suleiman, 2020).

Air relative humidity: Plastic house caused an increase in air relative humidity. Air relative humidity in plastic house was increased about 2-8% than open field. It was reported that air relative humidity was raised about 3-6 % inside plastic house than outside by (Farag *et al.,* 2010)

Light intensity: Plastic house caused a decrease in light intensity as compared with open field. Results of Hassanien and Li (2021) showed that showed that the light intensity decreased under the polyethylene cover compared with outside the greenhouses. Polyethylene cover reduced the average indoor light intensity by an average of 25. 8%, as compared with the average outdoor light intensity. The differences in temperature or relative humidity between open field or plastic house was not significant. According to Adamczewska-Sowińska and Krygier (2013), the optimal temperature for crop plant growth and fruit development of eggplant lies between 22ºC and 30°C. Since in both cases (open field and plastic house) the minimum temperature was less than 10^{o}C, then light intensity was the most important variable in production systems in the present study. The present results are in line with those of Papadopoulos and Pararajasingham (1997) who found that light affects the photosynthetic productivity of all crops and is the most important factor affecting productivity in the greenhouse.

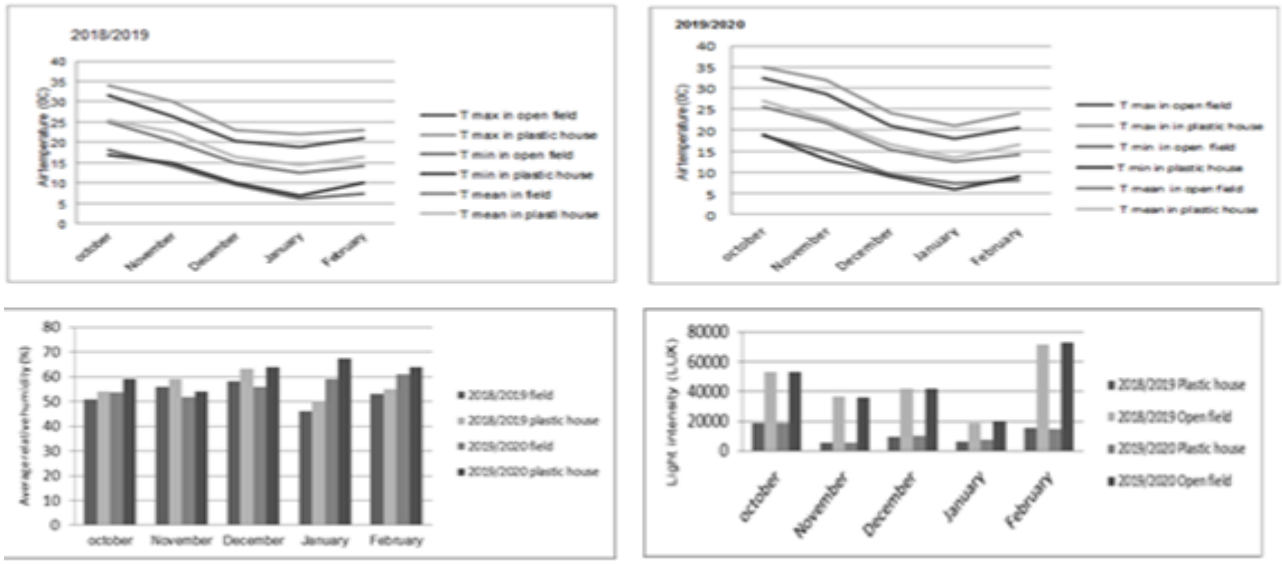

Figure 1. Monthly average air temperature (^{o}C), average relative humidity (%) and Averages light intensity (Lux)

3.2. Effect of production systems, cultivars and their interaction on plant height and number of branches:

Planting in plastic house significantly increased plant height as compared with planting in open field. Reversely, plants grown in open field had a higher number of branches than those grown in plastic house. Similarly, Aied *et al.* (2017) reported that the height of the eggplant grown outside the greenhouse was shorter as compared with those grown inside the greenhouse and Setyorini *et al.* (2018) found the plant height of tomato increased with increasing shading. The increase in the height of the plant under shade may be due to the increase in node length, node number (Gruda and Tanny 2014) and may be resulted from the increase of net of photosynthesis under low light intensity and high temperatures of greenhouse (Aied *et al.* 2017).

With regard to eggplants cultivars, the tallest plant was recorded in 'Amedo' in both seasons, while the shortest plant was recoded in 'Blackberry' in the first season and 'Black Berry' and 'Petra' in the second season. Concerning branches number, there were no significant differences between 'Sawad El Laiel', 'Petra' and 'Amedo', but 'Black Berry' had lowest number of branches. Many researchers recorded genetic variations among eggplant cultivars in the morphology traits (Samlindsujin *et al.*, 2017; Mahmoud and El-Mansy, 2018).

Concerning the interaction between production systems and cultivars, data in the same Table revealed that the tallest plants was registered in 'Amedo' grown in plastic house in both seasons, while the shortest plants was registered in 'Blackberry' grown in open field and in the first season. However, in the second season the shortest plants were registered in 'Blackberry' grown in open field and 'Petra' grown in plastic house. 'Sawad El Laiel' and 'Amadeo' significantly affected by cropping system in both seasons, where the first cultivar was taller in plastic house, and the second cultivar produced more branches in open field. The effect of the cropping system on the plant height of hybrids Amadeo and Blackberry was not constant, while no significant effect was registered concerning cropping system on 'Petra'.

3.3. Effect of production systems, cultivars and their interaction on chlorophyll reading, area and dry matter of eggplant leaves:

There were no significant differences between the two production systems on leaf chlorophyll reading in both seasons. These results are in agreement with those of Hassanien and Li (2021). Plants produced from plastic house had larger leaf area than those produced from open field; however, the difference was significant in the first season only. Similarly, DeGannes *et al.* (2014) and Aied *et al.* (2017) revealed that the high temperature in the greenhouse increases leaf size and leaf expansion. It was reported by Hassanien and Li (2021) that the average leaf area of the shaded strawberry plants by PV was significantly higher than that of the un-shaded plants. The eggplant plants increase their height, leaf area and leaf arrangement in order to maximize their exposure to light (Aied *et al.*, 2017). On the contrary, plants produced from open field had greater leaf dry matter than those produced from plastic house in both seasons.

Table 2. Effect of production systems, cultivars and their interaction on plant height and number of branches per eggplant plant, at 90 days after transplanting during 2018/2019 and 2019/2020 seasons .

Production systems		Plant height (cm)		Number of branches	
		2018/2019	2019/2020	2018/2019	2019/2020
Open field		67.72	73.08	2.47	2.72
Plastic house		81.55	79.25	1.94	1.70
LSD at 0.05		5.44	5.53	0.33	0.31
Cultivars					
Sawad El Laiel		78.89	79.17	2.22	2.56
Petra		70.5	63.61	2.22	2.17
Amadeo		93.83	95.22	2.67	2.56
Blackberry		55.33	66.67	1.72	1.56
LSD at 0.05		7.70	7.83	0.47	0.44
Open field	**Sawad El Laiel**	72.45	73	2.33	3.22
	Petra	66.45	66.56	2.44	2.78
	Amadeo	80.78	92.67	3.45	3.22
	Blackberry	51.22	60.11	1.67	1.67
Plastic house	**Sawad El Laiel**	85.33	85.33	2.11	1.89
	Petra	74.55	60.67	2.00	1.56
	Amadeo	106.9	97.78	1.89	1.89
	Blackberry	59.44	73.22	1.78	1.44
LSD at 0.05		10.89	11.07	0.66	0.62

Table 3. Effect of production systems, cultivars and their interaction on chlorophyll reading, area and dry matter of eggplant leaves at 90 days after transplanting during 2018/2019 and 2019/2020 seasons.

Production systems		Chlorophyll reading (Spad)		Leaf area (cm^2)		Leaf dry matter (%)	
		2019 2018/	2019/2020	2019 2018/	2019/2020	2019 2018/	2019/2020
Open field		44.72	43.01	13.25	14.4	19.77	20.85
Plastic house		44.36	44.99	15.42	16	18.03	18.76
LSD at 0.05		NS	NS	1.83	NS	0.82	0.64
Cultivars							
Sawad El Laiel		44.78	40.09	14.41	15.42	19.16	19.23
Petra		42.46	43.07	14.22	15.2	18.87	20.08
Amadeo		47.96	51.1	15.08	15.28	19.42	20.72
Blackberry		42.95	41.73	13.64	14.93	18.15	19.19
LSD at 0.05		3.83	3.04	NS	NS	1.15	0.91
Open field	**Sawad El Laiel**	45.5	39.44	13.1	14.53	20.66	20.49
	Petra	43.34	42.44	13.41	14.36	20.27	21.78
	Amadeo	46.62	50.6	14.67	15.33	19.86	20.43
	Blackberry	43.4	39.54	11.83	13.39	18.27	20.7
Plastic house	**Sawad El Laiel**	44.07	40.74	15.73	16.3	17.66	17.98
	Petra	41.57	43.7	15.03	16.03	17.46	18.38
	Amadeo	49.29	51.6	15.48	15.23	18.98	21.01
	Blackberry	42.5	43.92	15.45	16.46	18.02	17.69
LSD at 0.05		5.42	4.3	3.67	NS	1.63	1.29

These may be attributed to the higher temperature inside the plastic house compared with the open field. The high temperatures cause high respiration rate, and consequently, low dry matter accumulation in the leaves. Dry matter was decreased with shading increased (Medany *et al*. 2009).

Regarding cultivars, the highest value of leaf chlorophyll reading was achieved in 'Amedo' planted in open field in both seasons and in 'Sawad El Laiel' planted in open house in the first season, while there were no significant differences among cultivars concerning to leaf area.

The greatest value of leaf dry matter was recorded in 'Amedo', but there was no significant difference among in 'Amedo', 'Petra' and 'Sawad El Laiel' in the first season and between in 'Amedo' and 'Petra' in the second season.

Concerning the interaction between production system and cultivars, 'Amedo' grown in open field or green house had the highest chlorophyll reading in both seasons as well as 'Sawad El Laiel' in the first season. Meanwhile, there were no significant differences in leaf area among all cultivars within any production systems in both seasons. The highest value of leaf dry matter was shown in 'Sawad El Laiel', 'Petra' and 'Amedo' grown in open field in the first season and 'Sawad El Laiel', 'Petra' and 'Black Berry' grown in open field and 'Amedo 'grown in plastic house in the second season.

3.4. Effect of production systems, cultivars and their interaction on micro- elements (N, P, K, Ca and Mg) concentrations in eggplant leaves:

As shown in Table 4, plants grown in open field had greater leaf concentrations of P, K and Mg in both seasons had a greater leaf concentration of N and Ca in the first season as compared with those grown in plastic house. Similarly, potassium, phosphorus, calcium and magnesium showed higher values in rocket (*Diplotaxis tenuifolia* L.-D.C.) leaves in the unshaded control as compared with those grown under shading nets (50% and 79% shading degree) **(**Caruso *et al.*, 2020). Medany *et al.* (2009) found that mineral uptake was negatively influenced by shading as a result of a decrease in transpiration. Meanwhile, there were no significant differences between leaves obtained from open field or plastic house concerning leaf concentrations of N and Ca in the second season.

With regard to cultivars, 'Amedo' had the greatest leaf concentrations of N, P, K, Mg and Ca in both seasons, while there were no significant differences between 'Amedo' and 'Sawad El Laiel' in leaf content of K in both seasons as well as among all cultivars in leaf concentrations of Ca in the second season. Arivalagan *et al.* (2013) and Afful *et al.* (2019) found that significant differences in mineral content of fruit among accessions of *S. melongena*.

Table 4. Effect of production systems, cultivars and their interaction on N, P, K, Ca and Mg in eggplant leaves at 90 days after transplanting during 2018/2019 and 2019/2020 seasons .

Production systems		Leaf N (%)		Leaf P (%)		Leaf K (%)		Leaf Ca (%)		Leaf Mg (%)	
		2018/ 2019	2019/ 2020	2018/ 2019	2019 /2020	2018 /2019	2019/ 2020	2018 /2019	2019/ 2020	2018/ 2019	2019 /2020
Open field		3.85	4.05	0.34	0.36	3.94	4.23	1.01	1.03	0.29	0.32
Plastic house		3.61	3.79	0.30	0.33	3.83	4.02	0.94	0.96	0.26	0.27
LSD at 0.05		0.08	0.26	0.01	0.03	0.09	0.18	0.03	0.14	0.01	0.03
Cultivars											
Sawad El Laiel		3.91	4.08	0.34	0.36	4.19	4.39	1.01	1.03	0.27	0.29
Petra		3.59	3.74	0.29	0.31	3.59	3.97	0.93	0.97	0.25	0.27
Amadeo		4.03	4.27	0.38	0.42	4.30	4.49	1.08	1.08	0.35	0.37
Blackberry		3.38	3.60	0.26	0.28	3.44	3.65	0.88	0.92	0.23	0.25
LSD at 0.05		0.12	0.36	0.02	0.04	0.13	0.25	0.04	0.20	0.02	0.04
Open field	**Sawad El Laiel**	3.99	4.11	0.37	0.4	4.24	4.45	1.06	1.07	0.28	0.3
	Petra	3.73	3.86	0.31	0.32	3.71	4.25	0.96	0.99	0.26	0.29
	Amadeo	4.19	4.48	0.39	0.43	4.32	4.53	1.12	1.13	0.38	0.4
	Blackberry	3.49	3.73	0.28	0.29	3.48	3.68	0.90	0.94	0.26	0.27
Plastic house	**Sawad El Laiel**	3.83	4.04	0.31	0.32	4.15	4.32	0.96	0.99	0.26	0.28
	Petra	3.45	3.62	0.27	0.3	3.47	3.69	0.91	0.94	0.24	0.25
	Amadeo	3.87	4.05	0.37	0.41	4.27	4.45	1.04	1.03	0.33	0.33
	Blackberry	3.26	3.46	0.24	0.27	3.41	3.62	0.86	0.89	0.21	0.22
LSD at 0.05		0.17	0.51	0.03	0.06	0.18	0.35	0.06	0.28	0.03	0.06

Concerning the interaction between production system and cultivars, leaves of 'Amedo' obtained from plants grown in open field in both seasons and also leaves of 'Sawad El Laiel' and 'Amedo 'obtained from plants grown in plastic house in the second season had the highest concentrations of N. Regarding leaves concentration of P, 'Amedo' grown in any production systems and 'Sawad El Laiel' grown in open field recoded the highest concentration of P in both seasons. Concerning

leaves concentration of K, leaves obtained from 'Amedo' and 'Sawad El Laiel' grown in any production systems in both seasons as well as 'Petra' grown in open field in the second season had the highest concentration of K. With regard to leaves concentrations of Ca and Mg, 'Amedo' planted in open field showed the highest concentrations of Ca and Mg, while there were no significant differences among all cultivars in leaves concentration of Ca in the second season.

3.5. Effect of production systems, cultivars and their interaction on micro- element (Fe, Mn, Zn and B) concentrations in eggplant leaves:

Concerning production systems, leaves production in open field were significantly greater in leaves concentrations of Fe, Mn, B and Zn. Nevertheless, the differences between the two-production system concerning leaves concentration of B were significant only in the second season. Our results are in harmony of those of Medany *et al.* (2009) who reported that mineral uptake was negatively influenced by shading as a result of a decrease in transpiration.

As shown in Table 5, there were significant variation in leaves concentrations of Fe, Mn, Zn and B among eggplant cultivars. 'Amedo' markedly exceeded all other cultivars in leaves concentrations of Fe, Mn and Zn in both seasons, while there were no significant differences between 'Amedo' and 'Sawad El Laiel' in leaves concentration of Fe in the second season and between 'Petra' and 'Amedo 'in leaves contents of Mn in the second season. Concerning leaves content of B, 'Sawad El Laiel' recoded the highest leaves concentrations of B in both seasons as well as 'Petra' and 'Amedo' in the second season.

Table 5. Effect of production systems, cultivars and their interaction on Fe, Mn, Zn and B in eggplant leaves at 90 days after transplanting during 2018/2019 and 2019/2020 seasons .

Production systems		Leaf Fe (ppm)		Leaf Mn (ppm)		Leaf Zn (ppm)		Leaf B (ppm)	
		2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020
Open field		130.9	134.1	29.02	30.80	28.75	28.81	19.05	20.35
Plastic house		125.8	127.3	27.61	28.49	20.83	21.76	18.27	19.43
LSD at 0.05		2.18	5.49	1.11	1.74	1.48	2.18	NS	0.84
Cultivars									
Sawad El Laiel		130.6	131.9	26.42	28.53	26.01	26.12	19.71	21.61
Petra		124.8	127.4	28.71	30.17	21.61	22.45	16.67	19.43
Amadeo		137.9	138.1	31.11	32.54	28.95	29.67	20.36	20.01
Blackberry		120.1	125.6	27.02	27.33	22.59	22.9	17.91	18.51
LSDat 0.05		3.09	7.76	1.56	3.87	2.09	3.08	2.73	1.19
Open field	**Sawad El Laiel**	132.6	134.5	23.06	26.98	29.45	29.29	19.68	22.14
	Petra	127.3	129.7	30.47	31.74	24.98	27.21	16.82	20.31
	Amadeo	139.8	139.9	30.64	31.68	33.5	32.61	19.89	18.41
	Blackberry	124	132.5	31.91	32.79	27.06	26.14	19.81	20.53
Plastic house	**Sawad El Laiel**	128.5	129.3	29.78	30.08	22.57	22.95	19.75	21.08
	Petra	122.2	125.1	26.95	28.6	18.24	17.69	16.52	18.55
	Amadeo	136	136.4	31.58	33.4	24.4	26.74	20.82	21.62
	Blackberry	116.3	118.6	22.14	21.86	18.12	19.65	16	16.49
LSD at 0.05		4.36	10.97	2.21	5.48	2.95	4.36	3.87	1.69

The interaction between production systems and cultivars on leaves concentrations Fe, Mn, Zn and B was significant. 'Amedo' production within any production systems showed the highest value of leaves content of Fe.

Concerning leaves concentrations of Mn, 'Amedo' grown in plastic house achieved the greatest value of leaves content of Mn, while there were no significant differences among Petra', 'Amedo' and 'Blackberry' grown in open field and 'Sawad El Laiel' and 'Amedo' grown in plastic house in leaves content of Mn. With regard to leaves concentrations of Zn, 'Amedo' grown in open field significantly exceeded all other cultivars within any production systems. Concerning concentrations of B, 'Sawad El Laiel' and 'Black Berry' grown in open field and 'Sawad El Laiel' and 'Amedo' grown in plastic house recorded the greatest leaves content of B.

3.6. Effect of production systems, cultivars and their interaction on early, medium, late and total yield and days number from transplanting to first harvest of the eggplant cultivars:

As shown in Table 6, growing plants in open field caused a significant increase in early, medium and total yield, but a significant lower late yield as compared with those grown in plastic house. The increase in the eggplant yield under open field condition, as compared to plastic house condition, may be attributed to pollination condition, where pollination in the open field is more frequent and aided with natural pollinators such as bees and wind (free air movement). In contrast, in the plastic house system, limited aeration and no aid from natural pollinators are introduced in this controlled environment. According to Kowalska (2008), there are many factors that make difficult or impossible to self-pollinate the eggplant's flowers; therefore, the efficiency of three procedures have been presented to increase fruit setting: bunch vibrating, flower harmonization, and natural pollinating by bumblebees. On the other hand, the shading in the plastic house might also contribute in the low yield inside plastic house during harvesting time which took place during winter months. In this regard, Cockshull *al.* (1992) reported that during the growing season, a 1% increase in light caused a 1% increase in tomato yield for light intensities and that increased yield was affected largely by an increase in mean fruit size. Suleiman (2020) recorded a higher mean value for yield and yield components in open field production as compared with glasshouse condition and attributed the high yield under open field conditions to a reimbursement for the vegetative deficiency under glasshouse conditions. In contrast, the late yield (from April and May) was significant higher in plastic house, as compared with open field. Because of the higher temperature inside the plastic house, the plastic cover of the greenhouse was removed starting up the first week of March. All the plants were similar concerning subjecting to the environmental condition and bees' pollination. Under this condition the plants planted in plastic house gave a higher yield as compensation for the previous period, when the yield was low. The period from transplanting to first harvest was shorter in plants grown in open field (from 77.5 to 78.25 days) than those grown in plastic house from 105.5 to 108.5 days). Increasing of period from transplanting to first harvest in plastic house may be attributed to low light density. Cockshull *et al.* (1992) and Uzun (2007) found that low light significantly delays time to flowering.

With regard to eggplant cultivars, 'Sawad El Laiel' recorded the highest value of early (8.02 - 8.28 ton/fed) and total yield (24.51 - 29.15 ton/fed). Nevertheless, there was no significant differences in total yield between 'Sawad El Laiel' and 'Petra' in the first season and among 'Sawad El Laiel', 'Petra' and 'Amedo' in the second season. In contrast, 'Blackberry' was the worst concerning early (0.35 - 0.49 ton/fed) and total yield (10.72 - 10.99 ton/fed). On the other hand, there was no significant differences among 'Sawad El Laiel', 'Petra' and 'Amedo' concerning medium and late yield, but 'Blackberry" recoded the lowest value of medium and late yield. These results indicated that 'Sawad El Laiel', 'Petra' and 'Amedo' are very economic under Egyptian condition, where their total yield ranged from 22.08 to 29.15 ton /fed; i. e. 53 to 70 ton/ha. Notably, Sekara (2010) recommended the 'Epic' F1 hybrid for field production in temperate climatic zone, as this cultivar achieved a mean marketable yield of 40 t/ha: the early production (first four harvests) accounted for 13.5% of the total yield. Several researchers observed significant difference among different eggplant cultivars for early and total yield (Cocker *et al.*, 2018; Suleiman, 2020; Quamruzzaman *et al.*, 2020). 'Sawad El Laiel' and 'Petra' showed minimum number days from transplanting to first harvest.

The interaction effect between production systems and cultivars on early and total yield and days number from transplanting to first harvest was significant. The maximum early yield was found in 'Sawad El Laiel' grown in open field in both seasons and the maximum medium yield was found in 'Amedo' grown in open field, while the maximum late yield was found in 'Sawad El Laiel' and 'Petra' grown in plastic house. On the other hand, maximum total yield was recorded in ' Amedo' in grown in open field then 'Sawad El Laiel' grown in any production systems in both seasons as well as 'Petra' in grown in open field in the second season. 'Petra' grown in open field recorded minimum number days from transplanting to first harvest, there were no noticeable differences in the number days from transplanting to first harvest among 'Petra' 'Sawad El Laiel' and 'Amedo' that grown in open field as well as 'Petra' grown in plastic house in both seasons.

Table 6. Effect of production systems, cultivars and their interaction on early and total yield and days number from transplanting to first harvest of eggplatn during 2018/2019 and 2019/2020 seasons

Production systems		Early yield (ton/feddan)		Medium yield (ton/feddan)		Late yield (ton/feddan)		Total yield (ton/feddan)		Days from transplanting to first harvest	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Open field		8.91	6.73	11.81	11.34	4.63	4.74	25.34	22.81	78.3	77.5
Plastic house		1.67	1.18	9.14	7.73	9.29	8.17	20.1	17.08	108.5	105.5
LSD at 0.05		1.43	1.49	2.34	2.18	2.86	1.46	3.36	3.03	15.6	12.9
Cultivars											
Sawad El Laiel		8.21	8.02	12.28	9.56	8.66	6.93	29.15	24.51	89.2	80
Petra		6.74	4.45	11.33	10.94	9.24	6.69	27.3	22.08	67.5	66
Amadeo		5.71	3.02	11.54	12.45	6.19	7.02	23.43	22.49	99.8	110
Blackberry		0.49	0.35	6.74	5.19	3.76	5.18	10.99	10.72	117	110
LSD at 0.05		2.03	2.10	3.32	3.09	4.04	2.06	4.76	4.29	22.0	18.4
Open field	**Sawad El Laiel**	15.15	15.33	10.03	7.72	4.93	3.57	30.11	26.63	69.0	69
	Petra	8.96	5.55	13.96	15.65	4.92	4.75	27.83	25.94	66.0	66
	Amadeo	10.93	5.70	16.29	16.87	4.91	5.47	32.13	28.05	75.0	75
	Blackberry	0.59	0.35	6.94	5.10	3.76	5.18	11.28	10.64	103.0	100
Plastic house	**Sawad El Laiel**	1.27	0.71	14.54	11.40	12.39	10.28	28.2	22.4	109.3	91
	Petra	4.52	3.34	8.707	6.22	13.56	8.63	26.78	18.21	69.0	66
	Amadeo	0.49	0.33	6.787	8.03	7.46	8.56	14.74	16.93	124.7	145
	Blackberry	0.40	0.34	6.54	5.27	3.76	5.18	10.7	10.8	131.0	120
LSD at 0.05		2.86	2.98	4.69	4.36	5.71	2.92	6.73	6.06	31.1	25.9

3.7. Effect of production systems, cultivars and their interaction on physical characters of eggplant fruit:

Concerning production system, fruits produced in open field had greater weight and diameter than produced in green house in both seasons.

On the other hand, there were no noticeable differences between different production systems concerning fruit length. High light intensity result in higher fruit weight than lower one (Cockshull *et al.* 1992; Uzun 2007) and the lowest eggplant fruit weight was formed due to the combination of the lowest light and temperature (Uzun 2007)

With regard to cultivars, 'Sawad El Laiel' and 'Amedo' produced larger fruit weight than all other cultivars in both seasons. 'Amedo' produced thickest fruit diameter in both seasons, while there were no significant differences in fruit length among 'Petra', ' Amedo' and 'Blackberry'in the first season and among all cultivars in the second season. Many researchers recorded genetic verbality in physical characters of eggplant fruit among cultivars by Samlindsujin *et al.* (2017), Mahmoud and El-Mansy (2018), and Quamruzzaman *et al.* (2020).

Table 7. Effect of production systems, cultivars and their interaction on physical characters of eggplant fruit at145 days after transplanting during 2018/2019 and 2019/2020 seasons .

Production systems		Fruit weight (g)		Fruit diameter (cm)		Fruit length (cm)	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Open field		445.4	390.2	10.32	9.60	13.63	14.04
Plastic house		316.8	270.4	9.04	8.71	13.53	13.57
LSD at 0.05		44.64	28.44	0.57	0.53	NS	NS
Cultivars							
Sawad El Laiel		485.5	406.9	10.58	9.92	13.02	14.38
Petra		351	313.5	9.13	8.48	13.7	13.5
Amadeo		498.2	422.2	12.33	11.27	13.42	13.8
Blackberry		189.6	178.6	6.67	6.95	14.2	13.55
LSD at 0.05		63.13	40.22	0.81	0.76	1.14	NS
Open field	**Sawad El Laiel**	528.7	477	11.67	11.03	12.57	13.93
	Petra	440.7	363	9.70	8.63	15.17	14.53
	Amadeo	617	548.7	13.10	11.83	13.4	14.93
	Blackberry	195.3	172.2	6.80	6.90	13.4	12.77
Plastic house	**Sawad El Laiel**	442.4	336.8	9.50	8.80	13.47	14.83
	Petra	261.3	264	8.57	8.33	12.23	12.47
	Amadeo	379.3	295.7	11.57	10.70	13.43	12.67
	Blackberry	184	185	6.53	7.00	15	14.33
LSD at 0.05		89.28	56.87	1.14	1.07	1.61	NS

Regarding the interaction between production system and cultivars, the greatest fruit weight and fruit diameter were noticed in 'Amedo' planted in open field in both seasons and in 'Sawad El Laiel' planted in open field in the first season and in the second season, respectively. On the other hand, the least fruit weight and fruit diameter were noticed in 'Blackberry' within any production systems. The longest fruits were produced by 'Petra' grown in open field and 'Blackberry' grown in plastic house in the first season, while there were no significant differences among cultivars in the second season.

3.8. Effect of production systems, cultivars and their interaction on N, P, K, Ca and Mg concentrations in eggplant fruits:

A shown in Table 8, fruits obtained from open field had significantly greater concentrations of N, P and K in both seasons as compared with those obtained from plastic house. There were no significant differences between production systems in fruit concentrations of Ca and Mg. The greater concentration of N, P and K in the fruits harvested from open field resulted from the greater elements uptake, which was also recorded in the leaves (Table 5). Regarding cultivars effect on fruit concentrations of N, P, K, Ca and Mg, fruit of 'Amedo' showed the highest values of N, P, K, Ca and Mg, but there were no significant differences between 'Sawad El Laiel' and 'Amedo' in fruit concentrations of Ca and Mg in the second season. The finding is consistent with the study by Nino-Medina et al. 2014 and Quamruzzaman *et al.* (2020) who proved presence of genetic variation among types of eggplant cultivars in fruit contents of N, P, K, Ca and Mg.

The interaction between production systems and cultivars showed significant influence on fruit contents of N, P, K, Ca and Mg. 'Amedo' produced in open field exhibited the highest fruit

Table 8. Effect of production systems, cultivars and their interaction on N, P, K, Ca and Mg in eggplant fruits at 145 days after transplanting during 2018/2019 and 2019/2020 seasons.

Production systems		Fruit N (%)		Fruit P (ppm)		Fruit K (ppm)		Fruit Ca (ppm)		Fruit Mg (ppm)	
		2018/ 2019	2019/ 2020	2018/ 2019	2019 /2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020
Open field		0.26	0.28	125.6	126.6	115.7	115.1	42.38	43.26	71.40	72.00
Plastic house		0.22	0.24	121.1	122.2	112.4	112.5	41.98	42.81	70.25	70.6
LSD at 0.05		0.03	0.03	1.11	1.82	1.20	2.54	NS	NS	NS	NS
Cultivars											
Sawad El Laiel		0.27	0.26	124.3	126.3	114	114.2	42.96	44.96	71.92	72.4
Petra		0.20	0.22	119.8	121	112.2	110.4	39.79	40.33	69.37	68.37
Amadeo		0.33	0.38	130.8	131.8	118.5	119.6	47.42	47.67	74.39	76.06
Blackberry		0.18	0.20	118.5	118.3	111.5	111.1	38.55	39.18	67.62	68.35
LSD at 0.05		0.04	0.04	1.57	2.57	1.70	5.01	2.07	4.53	2.39	5.45
Open field	**Sawad El Laiel**	0.28	0.27	127.3	129.5	115.9	116.5	43.09	45.69	71.67	73.33
	Petra	0.21	0.22	121.3	122.4	113.7	111.2	39.64	41.05	69.91	69.29
	Amadeo	0.37	0.43	133.7	134.1	119.6	120.5	48.07	46.82	75.61	75.79
	Blackberry	0.19	0.21	120.3	120.2	113.4	112.3	38.72	39.49	68.43	69.58
Plastic house	**Sawad El Laiel**	0.25	0.24	121.3	123.1	112.1	111.8	42.83	44.22	72.16	71.48
	Petra	0.18	0.21	118.4	119.6	110.6	109.6	39.94	39.62	68.83	67.45
	Amadeo	0.28	0.32	127.8	129.5	117.3	118.6	46.78	48.51	73.17	76.33
	Blackberry	0.17	0.18	116.8	116.5	109.6	109.9	38.38	38.87	66.81	67.12
LSD at 0.05		0.06	0.06	2.22	3.63	2.40	7.09	2.93	6.40	3.39	7.71

concentrations of N and P, while 'Black Berry' grown in any production systems showed the lowest fruit concentrations of N, while 'Blackberry' grown in plastic house showed the lowest fruit concentrations of P. Concerning fruit concentrations of K, Ca and Mg, 'Amedo' grown in any production systems were significantly superior all other cultivars, while there were no significant differences between 'Sawad El Laiel' grown in open field and 'Amedo' grown in any production systems in fruit concentration of K in the second season as well as between 'Sawad El Laiel' and 'Amedo' that cultivated within any production systems in fruit concentrations of Ca and Mg in the second season.

3.9. Effect of production systems, cultivars and their interaction on Fe, Mn, Zn and B of eggplant fruits:

Data presented in Table 9, revealed that fruits produced from open field had significantly greater concentrations of Mn, Zn and B in both seasons and greater concentration of Fe in the first season.

With regard to cultivars, fruit of 'Amedo' showed the highest concentrations of Fe, Mn and Zn in both seasons and the highest concentrations of B in the second season, but there were no significant differences between 'Sawad El Laiel' and 'Amedo' in fruit concentrations of Zn and B in the second season. This variation in mineral content of fruit concentrations due to genetic variation among types of eggplant cultivars was observed by Nino-Medina *et al.* (2014) and Quamruzzaman *et al.* (2020). On the contrary, Adamczewska-Sowinska and Krygier (2013) reported that eggplant cultivars grown in open-field conditions in western Poland, being 0.28 phosphorus, 3.70 potassium, 0.18 magnesium, and 0.13 calcium.

Concerning the interaction between production systems and cultivars, 'Amedo' cultivated in open field showed the highest concentrations of Fe and Mn, but there were no significant differences between Amedo' grown in open field or that grown in plastic house in fruit concentration of Fe in the second season. Regarding fruit content of Zn, 'Amedo' and 'Black Berry' grown in open field showed the greatest value of Zn concentrations in both seasons. With regard to B concentration, fruits obtained from 'Sawad El Laiel', 'Amedo' and 'Black Berry' grown in open field recorded the highest value of B in both seasons as well as 'Amedo' grown in plastic house in the second season.

Table 9. Effect of production systems, cultivars and their interaction on Fe, Mn, Zn and B in eggplant fruits at 145 days after transplanting during 2018/2019 and 2019/2020 seasons

Production systems		Fruit Fe (ppm)		Fruit Mn (ppm)		Fruit Zn (ppm)		Fruit B (ppm)	
		2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020
Open field		1.18	1.30	1.25	1.38	0.67	0.71	0.005	0.007
Plastic house		1.15	1.29	1.14	1.27	0.61	0.65	0.003	0.005
LSD at 0.05		0.01	0.03	0.02	0.04	0.01	0.05	0.001	0.001
Cultivars									
Sawad El Laiel		1.14	1.27	1.16	1.30	0.62	0.67	0.004	0.006
Petra		1.14	1.27	1.15	1.28	0.62	0.65	0.004	0.005
Amadeo		1.25	1.39	1.29	1.43	0.69	0.72	0.004	0.007
Blackberry		1.13	1.27	1.17	1.29	0.64	0.67	0.005	0.006
LSD at 0.05		0.01	0.04	0.03	0.06	0.02	0.07	0.001	0.001
Open field	**Sawad El Laiel**	1.13	1.25	1.20	1.35	0.64	0.69	0.005	0.007
	Petra	1.16	1.29	1.17	1.29	0.65	0.67	0.004	0.006
	Amadeo	1.27	1.39	1.38	1.53	0.70	0.73	0.005	0.008
	Blackberry	1.15	1.28	1.23	1.35	0.69	0.73	0.007	0.008
Plastic house	**Sawad El Laiel**	1.16	1.28	1.12	1.25	0.60	0.64	0.003	0.005
	Petra	1.11	1.24	1.13	1.26	0.59	0.62	0.003	0.004
	Amadeo	1.23	1.38	1.19	1.33	0.67	0.71	0.003	0.006
	Blackberry	1.11	1.25	1.10	1.23	0.59	0.61	0.003	0.003
LSD at 0.05		0.02	0.06	0.04	1.38	0.03	0.10	0.002	0.002

3.10. Effect of production systems, cultivars and their interaction on dry matter, vitamin C, niacin, omega 3 and total carbohydrate in eggplant fruits:

As shown in Table 10, the effect of production systems was significant on dry matter percentage, vitamin C and total carbohydrates in eggplant fruit. In this respect, fruits harvested from open field had significantly higher percentage of dry matter, vitamin C and total carbohydrates in both seasons than in those harvested from plastic house. These results are in accordance with those presented by Murariu et al. (2021), who reported that the crop system had a major influence on vitamin C content and dry matter in tomato fruits, being recorded the highest value in the case of organic tomatoes from the field, with statistically significant differences compared to varieties cultivated in the plastic tunnel. The Whitley et al. (2011) reported that changes in temperature from day to night influence metabolic rate, resulting in differential effects on carbohydrate metabolism and respiration. During dark respiration, sugars, as well as other nutrients, are utilized for metabolic processes. Respiration is slowed when temperatures are lower, resulting in less sugar being used at night. Because the temperatures in open field in the present study were less than measured inside effect, this led to greater concentration of carbohydras in eggplant fruits produced in open field as compared to produced inside the greenhouse.

Amazingly, San José et al. (2014) recorded no stable effect for the production systems on fruit content of the carbohydrate traits (TSS, glucose, fructose, starch and fibre), where there were significant differences between planting in open field and greenhouse, being higher in open field in first season, and non significant differences in the second season. In contrast, production systems had no significant effect on niacin and omega 3 in both seasons in eggplant fruits.

Omega 3 (ω3) acids are essential fatty acids for humans, because mammalian cells shortage the enzymes necessary for their synthesis, so this is polyunsaturated must be got from dietary sources and are consequently is termed essential fatty acids. Omega-3 fatty acid (linolenic) is useful in the protection and treatment of atherosclerosis, lower levels of triglycerides, increasing HDL cholesterol and can reduce blood pressure in case of hypertension (Zimmermann, 2001), omega 3 (ω3) acids also other offer various health benefits include improvements to insulin sensitivity, inflammation, hepatic steatosis and cardiovascular disease (CVD) risk factors (Lane et al, 2021).

Niacin is a B vitamin that's made and used by your body to turn food into energy. It helps to protect your nervous system, digestive system and skin healthy. This family of compounds is necessary

Table 10. Effect of production systems, cultivars and their interaction on dry matter, vitamin C, niacin, omega 3 and total carbohydrate in eggplant fruits at145 days after transplanting. during 2018/2019 and 2019/2020 seasons .

Production systems		Fruit dry matter (%)		Vitamin C (mg\100g)		Niacin (B3) mg\100g)		Omega 3 Fatty acids (mg\100g)		Total Carbohydrates (g\ F.W)	
		2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020
Open field		7.63	7.22	1.66	1.81	0.60	0.69	9.01	9.38	0.045	0.047
Plastic house		6.71	6.78	1.61	1.75	0.59	0.68	9.05	9.43	0.037	0.041
LSD at 0.05		0.27	0.32	0.04	0.05	NS	NS	NS	NS	0.007	0.005
Cultivars											
Sawad El Laiel		7.03	6.51	1.62	1.76	0.62	0.72	8.84	9.21	0.048	0.054
Petra		7.16	7.20	1.37	1.52	0.51	0.56	8.74	9.11	0.031	0.034
Amadeo		7.45	7.35	1.83	2.00	0.66	0.81	9.54	9.91	0.054	0.057
Blackberry		7.04	6.95	1.72	1.85	0.60	0.65	9.02	9.39	0.033	0.031
LSD at 0.05		0.38	0.45	0.09	0.10	0.02	0.07	0.34	0.34	0.010	0.010
Open field	**Sawad El Laiel**	7.65	6.61	1.68	1.83	0.63	0.73	8.73	9.10	0.048	0.052
	Petra	7.22	7.14	1.41	1.57	0.56	0.61	8.78	9.16	0.046	0.044
	Amadeo	8.35	8.07	1.86	2.02	0.66	0.81	9.58	9.96	0.049	0.055
	Blackberry	7.31	7.05	1.70	1.83	0.56	0.61	8.95	9.32	0.037	0.035
Plastic house	**Sawad El Laiel**	6.41	6.40	1.57	1.69	0.60	0.70	8.95	9.32	0.047	0.055
	Petra	7.09	7.26	1.33	1.48	0.46	0.51	8.69	9.06	0.016	0.024
	Amadeo	6.56	6.62	1.80	1.97	0.65	0.80	9.49	9.87	0.058	0.059
	Blackberry	6.77	6.85	1.74	1.87	0.65	0.70	9.09	9.45	0.028	0.026
LSD at 0.05		0.54	0.64	0.12	0.14	0.03	0.10	0.48	0.48	0.01	0.01

for our body to convert food to energy and store it. It helps keep your skin and tissues, too. Vitamin B3 has important role to improve the serum HDL levels which is good cholesterol and decrease the levels of LDL which is bad cholesterol; therefore, vitamin B3 is cardioprotective agent. Therefore, suitable amount of vitamin B3 in our diet can be useful in protective agent from myocardial infarction and cardiovascular disorders (Memoni 2021).

Regarding cultivars, fruits of 'Petra' and 'Amedo' recorded the highest percentage of dry matter, while 'Sawad El Laiel' and ‘Amedo' recorded the highest total carbohydrate in both seasons. On the other hand, fruits of 'Amedo' significantly exceeded all other cultivars in their content of vitamin C, niacin and omega 3. According to Oladosu et al. (2021) the amount of niacin in eggplant fruits is 0.649 mg/100 g DW. Whitley et al. (2011) detected significant differences among the different peanut varieties in niacin concentrations, being ranged from 13.9 to 20.7 mg/100g DW. This variation in fruit content of vitamin C among types of eggplant cultivars was recorded by Nino-Medina et al. (2014) and Quamruzzaman et al. (2020). Similarly, variation in fruit content of eggplant cultivars in carbohydrate was recorded by Quamruzzaman et al. (2020).

The interaction effect indicated that fruits of 'Amedo' grown in open field recorded the highest percentage of dry matter, while fruit of ‘Sawad El Laiel' grown in plastic house recorded the lowest percentage of dry matter. Fruits of 'Amedo' grown by any production systems contained the highest content of vitamin C, niacin and omega 3 in both seasons and also fruits of 'Black Berry' grown in plastic house system contained the highest content of vitamin C and niacin in the first season. fruits of 'Sawad El Laiel’ and 'Amedo' within any production systems achieved the highest value of total carbohydrate.

4. CONCLUSION

To obtain high eggplant yield in the period from November to May in Giza Governorate, we recommend planting Sawd EL-laiel Hybrid in the open field, while hybrid Amedo grown in open field may be recommended for obtaining the highest nutritional value.

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اداء بعض أصناف هجن الباذنجان الكروية تحت ظروف الصوب البلاستيكية والحقل المفتوح

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أجريت تجربتان خلال موسمي الشتاء ٢٠١٨ /٢٠١٩ و ٢٠١٩/٢٠٢٠ فى محطة بحوث كلية الزراعة جامعة القاهرة محافظة الجيزة لدراسة استجابة أربعة أصناف كروية F1 (سواد الليل ، البترا ، أميدو ، وبلاك بيري) من الباذنجان (*Solanum melongena* L) تحت نظامين إنتاجيين مختلفين (الحقل المفتوح والصوبة البلاستيكية). بالنظر للنمو الخضري وجودة الثمار والمحصول، فأن النباتات المزروعة في الحقول المفتوحة ، حصلت على أعلى قيم لعدد الأفرع ، والمحصول المبكر والإجمالي ، ووزن الثمرة ، وقطر الثمرة ، والكربوهيدرات الكلية للثمار ، وفيتامين ج ، والعناصر الكبرى والصغرى ، وزيادة معنوية في المادة الجافة للأوراق ، وتركيزات الأوراق من العناصر الكبرى والصغرى مقارنة مع تلك المنتجة من الصوب البلاستيكية، لكن بشكل عكسي ، أدت الزراعة في الصوبةالبلاستيكية إلى زيادة معنوية في ارتفاع النبات ، ومساحة الأوراق ، و الوزن الجاف للثمار مقارنة بالزراعة في الحقل المفتوح، كانت الفترة من الشتل إلى الحصاد الأول أقصر في النباتات المزروعة في الحقل المفتوح عن تلك التي تمت زرعتها في الصوبة البلاستيكية ، بينما لم تكن هناك أى فروق معنوية بين أنظمة الإنتاج في كلوروفيل الأوراق ، طول الثمار ، ومحتوى الثمار من المواد الصلبة الذائبة ، الكالسيوم ، المغنيسيوم ، النياسين والأوميجا ٣ في كلا الموسمين. بينما أظهرت التحليلات فروق معنوية بين أصناف الباذنجان المختلفة لجميع الصفات. سجل سواد الليل أعلى قيمة للمحصول المبكر والإجمالي ، ومتوسط وزن الثمرة ، والكربوهيدرات الكلية ، والمواد الصلبة الذائبة وتركيزات الأوراق من البوتاسيوم والكالسيوم و البورون. ومن ناحية أخرى ، فاق صنف أميدو جميع الأصناف الأخرى في قراءة الكلوروفيل، وتركيزات الأوراق من N وP وMg و Fe و Mn و Zn وكذلك قطر الثمار وتركيزات الثمار من N و P و K و Ca و Mg و Fe و Mn و Zn وفيتامين C والنياسين (B3) أوميجا ٣ والمادة الجافة ، كانت "البترا" أبكر صنف ، بينما كان "بلاك بيري" أكثر الأصناف تأخرا. كان للتفاعل بين الأصناف وأنظمة الإنتاج تأثير كبير على جميع الصفات قيد الدراسة.

الكلمات المفتاحية: الباذنجان، أصناف، الصوب البلاستيكية، الحقل المفتوح وجوده الثمار