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Effect of Fertilization and Rootstocks Type on Vegetative Growth and Nutritional Status of Crimson Grapevine Transplants

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Abstract

This study was carried out during both 2018 and 2019 experimental seasons to cover the influence of the two investigated factors i.e., rootstock grape type (Freedom and Richter) and some bio-stimulants compounds (compost, Bacillus polymyxa, EM and Azotobacter chrococcum) and their possible combinations. The influence was evaluated through the response of some vegetative growth and nutritional status of the treated "Crimson" grape cultivar. The specific effect of rootstock type on vegetative growth, data revealed that, Freedom rootstock was better than the other investigated rootstock (Richter) in this respect. Also, fertilizer with T4 and T5 g/transplant were superiors in this respect whereas able to they were increase significantly vegetative growth as compared with the other different investigated fertilization during both 2018 and 2019 seasons of study. Considering the interaction effect of the two investigated factors i.e., rootstock type and different bio-stimulants (compost, Bacillus polymyxa, EM and Azotobacter chrococcum) on vegetative growth of grape transplants, data show the highest value of vegetative growth were obtained with the combination between Crimson grape transplants grafted on Freedom rootstock and fertilized with T4, T5 and T7 g/transplants. The obtained results clearly show that, all treatments increased nutritional status for both rootstocks (Freedom and Richter) of grapevine **(*Vitis vinifera* L.)** in leaves as compared with control treatment.

Keywords: Freedom, Richter, grape, vegetative growth, nutritional status, compost, Bacillus polymyxa, Azotobacter chrococcum and Effective micro-organisms.

Introduction

Grape is the common name for any of the woody, vining plants belonging to the about 60 species comprising the genus *Vitis* in the flowering plant family Vitaceae. It is also the name for the edible fruit that grows on these perennial and deciduous plants. Some consider grape a common term for all members of the family vitaceae. The grape can be eaten row or used for making Jam, Juice, Jelly wine and grape seed oil, for being of an excellent flavor, nice taste and high nutritional value **(Hulme, 1971).**

Grape cultivation began in Asia Minor which considers the home of *Vitis vinifera* from which all the cultivated grape varieties were derived before the discovery of North America **(Winkler, 1965).**

Grape (*Vitis vinifera*) is considered the first major fruit crop in the production all over the world. In Egypt, grapes ranked the third among fruit crops while citrus being the first and mango the second. The total acreage of grapevines in Egypt exhibited an obvious increase in the recent years till it reached about 188000 feddans with production of 1531418 tons according to the latest **Statistics of Ministry of Agriculture (2019).** The area dedicated to vineyards is increasing by about 2% yearly.

Fertilization is one of the important tools in increasing crop yield. Nitrogen has a pronounced role in improving production and quality of fruits. The efficiency of nitrogen fertilizers under field conditions and surface irrigated soil rarely exceeds 5% and is usually ranged between 30 and 40% **(Sahrawat, 1979).** Such low efficiency may be due to losses of N from soils as nitrate and nitrate by leaching or as nitrogen gases through nitrate reduction by volatilization. Leaching of nitrate and its down ward – movement below the root zone with the flowing water cause may problems such as nitrate pollution of ground water and growing crops. The free nitrogen fixation bacteria such as *Azotobacter chroococcum* and *Azspirillum sp.* can be used as a bio fertilizer to provide some nitrogen requirements to agriculture plants. This method of fertilization was tested to know how much nitrogen and possibly other nutrients can be affected by this bio fertilizer. In this respect, researchers with bio fertilization indicated that this method affect nutrient content in treated plants **(Mahmoud and Mahmoud, 1999)**.

Phosphorus is very important nutrient for crop growth and high yield with good quality. It is play a key role in metabolic process such as the conversion of sugar into starch and cellulose. As a result, phosphorus deficiency causes stunting, delayed maturity and shriveled seeds. In sandy soils, some nutrient problems such as less fertility in general and less a viability of some elements such as phosphorus in case of high PH value can affect plant production. In the context, yield and its components showed a positive response to phosphorus fertilizers. P applications have increased flower formation **(Chatzatheodorou *et al.*, 2004).**

Potassium has a considerable role in improving production and quality of fruit. Potassium had a pertinent role in many metabolic processes, such as carbohydrate synthesis and development of meristematic tissue, as well as encouragements of lignification and regulation of water absorption and transpiration **(Mengel and Ameke , 1982).**

Nowadays, bio fertilization of various grapevines cvs. has called the attention of research workers as an alternative to chemical fertilizers. Bio-fertilization is very safe for human, animal and environment to get lower pollution and reduced soil salinity via decrease using mineral fertilization as well as saving fertilization costs. Bio-fertilizers mainly comprise nitrogen fixers such as Rhizobium, Azotobacter, Phosphate dissolves or VAM and silicate bacteria **(Idso *et al.*, 1995).**

Bio-fertilizers are the most importance for plant production and soil as they play in important role in increasing vegetative growth **(Fayed, 2005b)** on apple. Also, **Hassan and Abou-Rayya (2003)** showed that, all bio-fertilizers (Compost, BC, EM and Az) were effective in improving nutritional status of Anna apple trees.

The main objective of this study is to carry out a using bio fertilizers (Compost, BC, and Az) and organic fertilizer (EM) to improve growth of Crimson transplants grafted on two rootstocks (Freedom and Richter) which grown in sandy loam soil.

Materials And Methods

The present investigation was undertaken throughout the two successive seasons of 2018 and 2019 at Fruit Nursery of Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University Qalyubeia Governorate, Egypt.

Uniform and healthy one-year- old transplants of Crimson cv. grafted on Freedom and Richter rootstocks grape "*Vitis vinifera*, L." were the plant material used in this study. In both seasons of study and during the first week of February, these transplants were planted individually each in plastic pot of 30-cm-diameter filled with about 3.5 kg of sand and loam mixture at equal parts by volume.

Before the experiment had been conducted in the two seasons, both mechanical and chemical analyses of growing medium were done as shown in Table (1). The physical and chemical properties analysis according to **Jackson (1967).**

Table 1. The physical and chemical analysis of the used sand and loam during two seasons**.**

Soil type	Particle size distribution (%):				E.C. (dS/m)	pH	Cations (meq/L)				Anions (meq/L)		
	Coarse sand	Fine Sand	Silt	Clay			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
Sand	89.03	2.05	0.40	8.52	3.72	7.92	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	90.10	1.95	0.50	7.45	3.74	7.80	19.42	8.33	7.20	0.75	1.60	7.00	27.10
Loam	10.18	46.17	19.53	24.12	3.38	8.09	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	10.30	46.54	18.88	24.28	3.51	8.16	18.00	8.95	20.50	0.85	3.65	10.20	34.45

The bio-fertilizer (BF) used in this study were produced by Ministry of Agriculture. This experiment involved seven treatments:

1) Mineral NPK fertilization program as control (recommended doses "R.D." was annually (8,6,4 gm) in three doses for each dose from ammonium sulphate (20.6 % N), super phosphate (15.5 % P_2O_5) and potassium sulphate (48.0 % K_2O), respectively.
2) 50% NPK (4, 3, 2g) + 25 g compost.
3) 50% NPK (4, 3, 2g) + 50 g compost.
4) 50% NPK (4, 3, 2g) +75 g compost.
5) 50% NPK (4, 3, 2g) +25 g compost + 10 cm bio fertilizer (BC).
6) 50% NPK (4, 3, 2g) +50 g compost + 10 cm bio fertilizer (EM).
7) 50% NPK (4, 3, 2g) +75 g compost + 10 cm bio fertilizer (AZ).

The corresponding amount of each fertilizer treatment was fractionated into three equal doses to be soil applied from mid-March, mid-May and mid-July during both seasons. Whereas, the treatments were arranged in a randomized complete block design with three replicated for each treatment however, each replicate was represented by four grape transplants. On the first week of October during both seasons of study as an experiment was ended. The effect of the different investigated treatments on some vegetative growth measurements and chemical composition were evaluated by the following growth parameters during both seasons as follows:

a. Vegetative growth measurements:

An influence of different treatments in this study on some vegetative growth parameters were evaluated through determining the following:

Stem length (cm.); stem diameter (cm); No. of leaves/plant; No. of lateral shoots, leaf area (cm^2); root length (cm); total weights of fresh and dry plant organs (gm).

On mid-August during both seasons, samples of forty mature leaves at different four sides of each tree were collected by picking the third one from the base of the previously labeled shoots and leaf area was determined. Length and width of lamina of these leaves were measured to find out the average leaf area in spring growth cycle by using of equation of **Chou (1966)**.

Leaf area (cm^2) = ⅔ (leaf length x leaf width).

b. Chemical analysis:

- Leaf chlorophyll content:

An average of twenty eight chlorophyll metter reading for each treatment were recorded by using a portable chlorophyll metter spad 502 according to **Wood *et al*., (1992)**.

- Leaf mineral determination:

Ten full expanded leaves were carefully collected in the second week of August in both seasons of this study from all directions of every transplant canopy, which seemed to be sufficient for giving a reasonable good representation of the transplant. The leaves were taken from third to fifth leaf from the base shoots to preparation for chemical analysis.

As soon as, the leaf samples, were picked, then cleaning with damp cloth to remove any residues that might effect the results **Labanauskas (1966)**, therefore fresh weight was determined and oven dried in a ventilated oven at 70 °C till a constant weight, then weighed and ground with porcelain mortar and pistle, after being ground, the samples were stored in small paper bags until used for the determination of N; P; K; Mg; Fe; Zn and Mn samples of 0.2 gm dried material were dissolved in 5 ml concentrated sulphoric acid. After being cold 2 ml of the digesting mixture (1 : 1 perchloric acid : sulphoric acid) were added then samples were reheated for clearing, then cooled and disputed with deionized water before it had been transformed quantitatively to 50 ml volume with deionized water **(Piper 1958)**. The contents were used for the following determinations.

- Nitrogen content (%):

Total nitrogen was determined by the modified micro-Kjeldahl method as described by **Pregl (1945)**.

- Phosphorus content (%):

Total phosphorus content was determined using a Spekol spectrophotometer at 882.0 U.V. according to the method described by **Murphy and Riely (1962)**.

- K; Ca; Mg; Fe; Zn and Mn contents:

Leaf K; Ca; Mg; Fe; Zn and Mn contents were determined by using the Atomic Absorption Spectrophotometer (3300) according to **Jackson and Ulrich (1959) and Chapman and Pratt (1975).** Leaf nutrient element contents were expressed as a ratio of the dry weight i.e., percentage for the macro-elements (N; P; K and Mg) and part per million (ppm) with micro-nutrient (Fe; Zn and Mn).

- Statistical analysis:

All the obtained data in the two seasons of study were statistically analyzed using the analysis of variance method according to **Snedecor and Cochran (1988)**. However, means were distinguished by the Duncan's multiple range test (**Duncan, 1955)**. Since, capital letters were used for distinguishing means within each column or row that represented the specific effect of any investigated factor, however, the small letters were employed for interaction effect of their combinations.

Results and Discussion

This investigation was carried out to cover the influence of the two investigated factors namely: 1- rootstock grape type (Freedom and Richter), 2- some bio-stimulants compounds (Compost, BC, Az and EM) and their possible combinations on "Crimson" transplants were studied during both 2018 and 2019 seasons. Such influence was evaluated through the response of some vegetative growth and anatomical measurements of the treated "Crimson" grape cultivar.

Therefore, obtained results presented in **Tables (2, 3, 4, 5, 6, 7, 8 and 9)** in this study dealing with any of the abovementioned three aspects are separately during both seasons of study discussed as follows:

- Stem length (cm).

A. Specific effect:

Regarding to the specific effect of rootstock type on stem length (cm) data presented in **Table (2)** cleared obviously that, Freedom rootstock was better than the other investigated rootstock (Richter) in this respect. Concerning the specific effect of the different bio-stimulants (Compost, BC, EM, and Az) on Crimson grape stem length (cm), data represented in **Table (2)** mentioned that, fertilization with (T5) 50% of control at rate (4,3,2) plus 25 g compost and 10 cm bio fertilizer (BC) g/transplant was superior in this respect where it was able to increase significantly stem length (cm) as compared with the different investigated fertilization (Compost, BC, EM, and Az) during both 2018 and 2019 seasons of study. Fertilization with (T4) 50% of control at rate (4,3,2) + 75 g compost and EM at 10 /transplants came in the second rank, we can concluded that, there was positive relationship between stem length of increment crimson grape transplants and amount of fertilizer.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock type and different bio-stimulant (Compost, BC, EM, and Az) on grape transplants stem length (cm), data in **Table (3)** declared that a considerable and statistically effect in two seasons of the study, where the highest stem length was obtained with the combination between Crimson grape transplants grafted on Freedom rootstock and fertilized with T5 (50% control at rate (4, 3, 2) + 25 g compost + 10 cm bio fertilizer (BC) g/transplants, however the lowest value in stem diameter was noticed by Crimson grape grafted on Richter rootstock and fertilizer with mineral element (control) during the two seasons of study.

This results is agreement with that reported by **Mahmoud and Mahmoud (1999)** and **El-Akkad (2004).**

Table 2. Effect of mineral and bio-organic fertilizers on stem length (cm) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	**Stem length (cm)**					
Rootstocks / **Treatments**	**Freedom**	**Richter**	**Mean****	**Freedom**	**Richter**	**Mean****
	First season; 2018			**Second season; 2019**		
T1. Control (R.D) NPK at rate (8, 6, 4g).	83.00h	89.17f	**86.08C**	87.50fg	81.17h	**84.33E**
T2. 50% control at rate (4,3,2) + 25 g compost.	90.33ef	69.33i	**79.83D**	88.00ef	87.00fg	**87.50D**
T3. 50% control at rate (4,3,2) + 50 g compost.	89.33f	93.00d	**91.17B**	91.50d	86.33g	**88.92C**
T4. 50% control at rate (4,3,2) + 75 g compost.	94.00cd	95.00c	**94.50A**	94.33c	92.00d	**93.17B**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	103.0a	87.33g	**95.17A**	100.7a	88.33ef	**94.50A**
T6. 50% control at rate (4,3,2) + 50 g compost + 10 cm bio fertilizer (EM).	91.00e	69.67i	**80.33D**	87.00fg	88.00ef	**87.50D**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	91.33e	98.00b	**94.67A**	96.00b	89.00e	**92.50B**
Mean*	**91.71A**	**85.93B**		**92.15A**	**87.40B**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

- Stem diameter (cm).

A. Specific effect:

Referring the specific effect of rootstock type on stem diameter (cm) data presented in **Table (3)** obviously that, Freedom rootstock was better than the other investigated rootstock (Richter) in this respect. Concerning the specific effect of the different bio-stimulants (Compost, BC, EM, and Az) on Crimson grape stem diameter, data presented in **Table (3)** revealed that, fertilization with both T3 and T7 were superiors treatments in this concern during both 2018 and 2019 seasons. (T3) 50 g compost g/transplant combined with mineral NPK at 50 % R.D. was superior in this respect where they were able to increase significantly stem diameter (cm) as compared with the different investigated fertilization (Compost, BC, EM, and Az) during both 2018 and 2019 seasons. Fertilization with (T4) 75 g compost mineral NPK at 50 % R.D./transplants came in the second rank with non-significant in first season only. Also, there was a positive relation between stem diameter of increment crimson grape transplants and amount of fertilizer.

Table 3. Effect of mineral and bio-organic fertilizers on stem diameter (cm) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	Stem diameter (cm)					
Rootstocks / Treatments	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	0.880d	0.840e	0.860C	0.850g	0.800h	0.825D
T2. 50% control at rate (4,3,2) + 25 g compost.	0.767f	0.740g	0.753D	0.760i	0.730j	0.745E
T3. 50% control at rate (4,3,2) + 50 g compost.	1.080a	0.940b	1.010A	1.050c	0.930e	0.990B
T4. 50% control at rate (4,3,2) + 75 g compost.	1.080a	0.920c	1.000AB	1.100b	0.910ef	1.005B
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	0.780f	0.950b	0.865C	0.750ij	0.960d	0.855C
T6. 50% control at rate (4,3,2) + 50 g compost + 10 cm bio fertilizer (EM).	0.780f	0.940b	0.860C	0.770i	0.890f	0.830D
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	1.080a	0.910c	0.995B	1.153a	0.900f	1.027A
Mean*	0.921A	0.891B		0.919A	0.874B	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

B. Interaction effect:

Considering the interaction effect of the two investigated factors i.e., rootstock type and different bio-stimulant (Compost, BC, EM, and Az) on grape transplants stem diameter (cm), data tabulated in **Table (3)** reported that a considerable and statistically effect in both seasons of the study, where the highest stem diameter was obtained with the combination between Crimson grape transplants grafted on Freedom rootstock and fertilized with 50 g compost plus 50 % R.D. NPK /transplants, while the lowest value in stem diameter was noticed by Crimson grape grafted on Richter rootstock and fertilizer with T2 50 % R.D. NPK plus 25 g compost with Richtet transplant during the two seasons of study.

This results is agreement with that reported by **Mahmoud and Mahmoud (1999); El-Akkad (2004); Ahmed-Ebtsam and Abd El Aal *et al*., (2019).**

- Number of leaves.

Concerning the specific effect of the two investigated factors i.e., rootstock type (Freedom and Richter) and the different fertilization treatments on number of leaves of Crimson grape, number of leaves of the two investigated rootstocks (Freedom and Richter), data presented in **Table (4)** indicated that Freedom rootstock gave the highest values of the investigated parameter (number of leaves) as compared with the other investigated rootstock (Richter) during both seasons of study.

Regarding the specific effect of different fertilization treatments (Compost, BC, EM and Az) on number of leaves, data presented in **Table (4)** revealed that, the investigated parameter took the dissimilar trend where their values were significantly increased when the transplants were fertilized with both ("T4" 50% R.D. and T7 mineral NPK + 75 g compost) in the first season and ("T7" 50% R.D. mineral NPK at rate (4, 3, 2) + 75 g compost + 10 cm bio fertilizer (AZ) at g/ transplant) in the second one, respectively for number of leaves per transplant.

B. Interaction effect:

Concerning the interaction between rootstock type (Freedom and Richter grapevine) and different biofertilizers (Compost, BC, EM and Az) on number of leaves per transplant, data are recorded in **Table (4)** it is quite clear from data that, the best result in significantly regarding number of leaves was obtained with Freedom grape rootstock combined with fertilized with rate Compost at 25 + 10 cm bio-fertilizer (BC) g/ transplant in the two seasons, respectively. The combination between Richter grapevine rootstock with control treatment had the lowest effect regarding number of leaves during both seasons of study.

The present result is in harmony with those found by **Mostafa (2008) and Seleem-Basma and Telep (2008); Ahmed-Ebtsam (2008) and Abd El Aal *et al*., (2019).**

Table 4. Effect of mineral and bio-organic fertilizers on No. of leaves/plant of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	No. leaves/transplant					
Rootstocks / **Treatments**	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			**Second season; 2019**		
T1. Control (R.D) NPK at rate (8, 6, 4g).	26.00f	28.00e	**27.00E**	22.00h	26.00g	**24.00F**
T2. 50% control at rate (4,3,2) + 25 g compost.	34.00c	34.00c	**34.00B**	32.00e	35.00d	**33.50C**
T3. 50% control at rate (4,3,2) + 50 g compost.	31.00d	31.00d	**31.00C**	31.3e	30.00f	**30.67D**
T4. 50% control at rate (4,3,2) + 75 g compost.	38.00b	37.00b	**37.50A**	36.00d	38.00c	**37.00B**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	41.00a	19.00g	**30.00D**	45.00a	22.00h	**33.50C**
T6. 50% control at rate (4,3,2) + 50 g compost + 10 cm bio fertilizer (EM).	26.00f	27.00ef	**26.50E**	25.00g	26.00g	**25.50E**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	41.00a	35.00c	**38.00A**	36.00d	42.00b	**39.00A**
Mean*	**33.86A**	**30.14B**		**32.48A**	**31.29B**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

- No. of lateral shoot.

Concerning the specific effect of the two investigated factors i.e., rootstock type (Freedom and Richter) and the different fertilization treatments on No. of lateral shoot of Crimson grape, No. of lateral shoot of the two investigated rootstocks (Freedom and Richter), data tabulated in **Table (5)** indicated that Freedom rootstock gave the highest values of the investigated parameter (No. of lateral shoot) as compared with the other investigated rootstock (Richter) during the two seasons of study.

Referring the specific effect of different fertilization treatments (Compost, BC, EM and Az) on No. of lateral shoot, data in **Table (5)** obvious that, the investigated parameter took the dissimilar trend where their values were significantly increased when the transplants were fertilized with ("T4"; "T5" and "T7") and ("T5" and "T7" at g/ transplant) during both seasons, respectively for No. of lateral shoot per transplant.

B. Interaction effect:

Concerning the interaction between rootstock type (Freedom and Richter grapevine) and different biofertilizers (Compost, BC, EM and Az) on No. of lateral shoot per transplant, data are recorded in **Table (4)** it is quite clear from data that, the best result in significantly regarding No. of lateral shoot was obtained with Freedom grape rootstock combined with fertilized with rate "T7" Compost at 75 + 10 cm bio-fertilizer (Az) plus 50 % R.D. mineral NPK at rate (4, 3, 2) g/transplant in the first and second seasons, respectively. The combination between Richter grapevine rootstock with control treatment had the lowest effect regarding No. of lateral shoot during both seasons of study.

The present result is in harmony with those found by **Mostafa (2008) and Seleem-Basma and Telep (2008); El-Sabagh *et al*., (2011); El-Salhy *et al*., (2011).**

Table 5. Effect of mineral and bio-organic fertilizers on No. of lateral shoot of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	No. of lateral shoot					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	10.00f	5.00j	7.50C	8.00h	6.00j	7.00F
T2. 50% control at rate (4,3,2) + 25 g compost.	13.00c	6.00i	9.50B	14.00c	5.00k	9.50D
T3. 50% control at rate (4,3,2) + 50 g compost.	11.00e	9.00g	10.00B	12.00d	10.00f	11.00C
T4. 50% control at rate (4,3,2) + 75 g compost.	15.00b	12.00d	13.50A	15.00b	11.00e	13.00B
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	13.00c	13.00c	13.00A	14.00c	14.00c	14.00A
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	8.00h	6.00i	7.00C	9.00g	7.00i	8.00E
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	18.00a	8.00h	13.00A	17.00a	11.00e	14.00A
Mean*	12.57A	8.43B		12.71A	9.14B	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

- Average leaf area (cm^2)

The average leaf area of crimson grape was estimated in cm^2 in relation to the specific effect of rootstock type (Freedom and Richter) and the different fertilization (Compost, BC, EM and Az), in addition to the interaction effect of their combination.

A. Specific effect:

Regarding the specific effect of the rootstock type (Freedom and Richter rootstocks) and different fertilization (Compost, BC, EM and Az) beside the control on the average leaf area (cm^2) of crimson grape, data in **Table (6)** revealed that, Freedom rootstock had a greater value of leaf area (62.45 and 61.93 cm^2) than the other investigated rootstock (Richter) (62.18 and 60.51 cm^2) during both seasons of study, respectively.

Regarding the specific effect of different fertilization (bio and organic fertilizer) on average leaf area (cm^2), data presented in **Table (6)**, indicated that all the investigated fertilization significantly increased average leaf area (cm^2) of Crimson grape as compared with "T4" 50 % control at rate (4,3,2) + 75 g compost g per transplant (65.69 and 64.79 cm^2). Control fertilization treatment gave the lowest value of the average leaf area (cm^2) in both seasons of study.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock type (Freedom and Richter rootstocks) and different fertilization (Compost, BC, EM and Az) on average leaf area (cm^2) of Crimson grape transplants presented in **Table (6)** showed variable response of the two rootstocks to the different combination of fertilization treatments.

The most increment of leaf area was that combination between Freedom grapevine rootstock and the lowest fertilization rate (Compost at 25 g + 10 cm "BC" + 50 % (R.D.) NPK at rate 4, 3, 2 g per transplant). On the other hand, the lowest value in the average of leaf area was detected by Crimson grape on Richter rootstock and control treatment during both seasons of study. The other combinations were in between.

The obtained result is confirmed by those previously mentioned by **Fathi *et al*., (2002); Eissa-Fawzia *et al*., (2007 b); Seleem-Basma and Telep (2008); El-Sabagh *et al*., (2011); El-Salhy *et al*., (2011) and Abd El Aal *et al*., (2019).**

Table 6. Effect of mineral and bio-organic fertilizers on leaf area (cm2) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	Leaf area (cm^2)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	58.0g	54.32h	56.16G	56.30f	52.90g	54.60G
T2. 50 % control at rate (4,3,2) + 25 g compost.	62.62d	61.60e	62.11E	63.20b	60.63d	61.92D
T3. 50 % control at rate (4,3,2) + 50 g compost.	64.11c	63.83c	63.97C	65.27a	60.77d	63.02C
T4. 50 % control at rate (4,3,2) + 75 g compost.	66.17a	65.20b	65.69A	65.90a	63.68b	64.79A
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	58.62g	66.93a	62.78D	56.80f	65.20a	61.00E
T6. 50% control at rate (4,3,2) + 50 g compost + 10 cm bio fertilizer (EM).	61.44e	59.92f	60.68F	60.77d	58.30e	59.54F
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	66.18a	63.48cd	64.83B	65.30a	62.10c	63.70B
Mean*	62.45A	62.18A		61.93A	60.51B	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

- Root length (cm).

Data during 2018 and 2019 seasons concerning the specific and interaction effects of the two investigated factors on root length of grape are tabulated in **Table (7).**

A. Specific effect:

Referring the specific effect of rootstock type on root length (cm) data in **Table (7)** revealed that, Freedom rootstock was greater than the other investigated rootstock (Richter) (81.95 and 82.69 cm) in both seasons, respectively in this respect. Concerning the specific effect of the different bio-stimulants (Compost, BC, EM and Az) on Crimson grape root length, data tabulated in **Table (7)** showed that, fertilizer with "T4" 50% control at rate (4, 3, 2) + 75 g compost g/transplant was superior (98.07 & 95.23 cm) in both seasons, respectively, where it was able to increase significantly root length as compared with the different investigated fertilization (Compost, BC, EM and Az) during both seasons of study.

Table 7. Effect of mineral and bio-organic fertilizers on root length (cm) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	Root length (cm)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	49.51g	47.97g	48.74F	45.40j	43.20k	44.30F
T2. 50% control at rate (4,3,2) + 25 g compost.	85.46c	80.43e	82.95D	83.10fg	81.00h	82.05DE
T3. 50% control at rate (4,3,2) + 50 g compost.	85.10cd	83.15d	84.13D	84.46ef	82.30gh	83.38D
T4. 50% control at rate (4,3,2) + 75 g compost.	100.00a	96.13b	98.07A	98.00b	92.45c	95.23A
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	80.00e	100.20a	90.10C	82.30gh	100.10a	91.20C
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	73.50f	72.92f	73.21E	85.45de	76.35i	80.90E
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	100.10a	85.04cd	92.57B	100.10a	87.04i	93.57B
Mean*	81.95A	80.83B		82.69A	80.35B	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock type and different bio-stimulant (Compost, BC, EM and Az) on grape transplants root length (cm), data represented in **Table (7)** show a considerable and statistically effect in both seasons of the study, where the highest root length was obtained with the combination between Crimson grape transplants grafted on Freedom and Richter rootstocks and fertilized with "T4" and "T5" compost at 75 g plus 50 % R.D. and 25 compost + 10 cm bio-fertilizer (BC) g/transplants (100.0 & 100.2 cm) in the first season and "T7" and "T5" in the second one; however the lowest value in root length was noticed by Crimson grape grafted on Freedom or Richter rootstocks and fertilizer with mineral element (control) (49.51 & 47.97 cm) and (45.40 & 43.20 cm) during the both seasons, respectively.

The present result is in harmony with those found **Dessouky (2002); Fathi *et al*., (2002); Fayed (2005b); Eissa-Fawzia *et al*., (2007 b); Seleem-Basma and Telep (2008); El-Kady (2011) and Abd El Aal *et al*., (2019).**

- Total weights of fresh and dry plant organs (gm).

The total weights of fresh and dry plant organs of crimson grape was estimated in gm in relation to the specific effect of rootstock type (Freedom and Richter) and the different fertilization (Compost, BC, Az and EM), in addition to the interaction effect of their combination.

A. Specific effect:

Regarding the specific effect of the rootstock type (Freedom and Richter rootstocks) and different fertilization (Compost, BC, EM and EM) beside the control on the total fresh and dry plant organs (gm) of Crimson grape, data in **Tables (8 & 9)** revealed that, Freedom rootstock had a greater value of total fresh and dry plant organs (gm) (92.25 & 89.44 gm) and (60.10 & 57.81 gm) than the other investigated rootstock (Richter) (88.74 & 84.57 gm) and (59.08 & 56.88 gm) during both seasons of study, respectively.

Regarding the specific effect of different fertilization (bio and organic fertilizer) on total fresh and dry plant organs (gm), data presented in **Tables (8 & 9)**, indicated that all the investigated fertilization significantly increased total fresh and dry plant organs (gm) of Crimson grape as compared with control which was fertilized with 50 % mineral NPK plus compost at 75 g per transplant (99.07 & 95.66 gm) and (68.28 & 65.90 gm) both during two seasons, respectively. Control fertilization treatment gave the lowest value of the total fresh and dry plant organs (gm) in both seasons of study.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock type (Freedom and Richter rootstocks) and different fertilization (Compost, BC, EM and Az) on total fresh and dry plant organs (gm) of crimson grape transplants presented in **Tables (8 & 9)** showed variable response of the two rootstocks to the different combination of fertilization treatments.

The most increment of total fresh and dry plant organs (gm) were the combination between Freedom grapevine rootstock and the lowest fertilization rate ("T4" Compost at 75 g + , 50 % control at rate (4, 3, 2) g per transplant). On the other hand, the lowest value in the total fresh and dry plant organs (gm) were detected by crimson grape on Richter rootstock and control treatment during both seasons of study. The other combinations were in between.

The obtained result is confirmed by those previously mentioned by **Eissa-Fawzia *et al*., (2007 b); Seleem-Basma and Telep (2008); El-Sabagh *et al*., (2011); El-Salhy *et al*., (2011) and Abd El Aal *et al*., (2019).**

Table 8. Effect of mineral and bio-organic fertilizers on total fresh weight plant organs (g) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons**.**

Parameter	Total fresh weight transplant organs (g)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	81.45j	85.51i	83.48F	77.76j	79.85i	78.81E
T2. 50% control at rate (4,3,2) + 25 g compost.	85.17i	87.32h	86.24E	81.40h	82.46gh	81.93D
T3. 50% control at rate (4,3,2) + 50 g compost.	93.29d	92.38de	92.83B	91.70c	87.20ef	89.45B
T4. 50% control at rate (4,3,2) + 75 g compost.	106.7a	91.50ef	99.07A	103.4a	87.92e	95.66A
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	90.76f	85.48i	88.12D	90.18d	83.15g	86.66C
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	99.19b	82.26j	90.72C	95.33b	79.46i	87.40C
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	89.21g	96.70c	92.96B	86.34f	91.98c	89.16B
Mean*	92.25A	88.74B		89.44A	84.57B	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

Table 9. Effect of mineral and bio-organic fertilizers on total dry weight plant organs (g) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	Total dry weight transplant organs (g)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	54.89h	54.24h	54.57F	51.13f	51.53f	51.33F
T2. 50% control at rate (4,3,2) + 25 g compost.	52.68i	57.38g	55.03F	51.33f	55.36e	53.34E
T3. 50% control at rate (4,3,2) + 50 g compost.	62.04e	64.34c	63.19B	58.78d	61.14c	59.96C
T4. 50% control at rate (4,3,2) + 75 g compost.	73.24a	63.31d	68.28A	71.40a	60.41c	65.90A
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	54.52h	58.28fg	56.40E	52.01f	55.31e	53.66E
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	64.51bc	50.56j	57.53D	61.30c	48.98g	55.14D
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	58.80f	65.43b	62.11C	58.73d	65.40b	62.07B
Mean*	60.10A	59.08B		57.81A	56.88B	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

2- Effect of rootstock type and different biofertilizers on leaf mineral composition:

Leaf macro-element (nitrogen, phosphorus and potassium as percentages) and micro-nutrient (Fe, Zn and Mn as ppm) contents in response to specific and interaction effects of (Freedom and Rtkhtar rootstocks grape) and the different fertilizers (Compost, BC, EM and Az) and their possible combinations between them were investigated. Data obtained during both 2018 and 2019 seasons are presented in **Tables (10, 11, 12, 13, 14 and 15)**.

1- Leaf nitrogen content.

A. Specific effect:

Considering the specific effect of the rootstock type (Freedom and Richter rootstocks) and different fertilization (Compost, BC, EM and EM) beside the control on the N (%) of Crimson grape, data in **Table (10)** obviously that, Richter rootstock had the highest values of N (%) than the other investigated rootstock (Freedom) during both seasons of study, respectively.

With respect to the specific effect of different fertilization (bio and organic fertilizer) on N (%), data in **Table (10)**, mentioned that all the investigated fertilization significantly increased N (%) of Crimson grape as compared with control which was fertilized with “T3 and T4” 50 % mineral NPK plus compost at 50 or 75 g per transplant in the first season, while “T5” treatment 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC) in the second one.

Table 10. Effect of mineral and bio-organic fertilizers on nitrogen (%) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	**N (%)**					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	1.39d	1.25e	**1.32D**	1.42fg	1.32h	**1.37E**
T2. 50% control at rate (4,3,2) + 25 g compost.	1.59c	1.73b	**1.66B**	1.44ef	1.77b	**1.61C**
T3. 50% control at rate (4,3,2) + 50 g compost.	1.39d	2.08a	**1.74A**	1.43fg	2.16a	**1.80B**
T4. 50% control at rate (4,3,2) + 75 g compost.	1.39d	2.08a	**1.74A**	1.51de	2.18a	**1.85AB**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	1.29e	2.08a	**1.69B**	1.57cd	2.19a	**1.88A**
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	1.39d	1.39d	**1.39C**	1.59c	1.35gh	**1.47D**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	1.39d	1.39d	**1.39C**	1.63c	1.38f-h	**1.51D**
Mean*	**1.40B**	**1.71A**		**1.51B**	**1.76A**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

B. Interaction effect:

Regarding the interaction effect of the two investigated factors i.e., rootstock type and the different rates of biofertilizers on leaf N content, data presented in **Table (10)** clear obviously that the most simulative combination enhanced in leaf N contents was that combination between Richter grape rootstock and the biofertilizers with (T5; T4 and T3) g/transplant during the two seasons. Moreover, the lowest decrease in leaf N content was detected by Freedom rootstock biofertilizer with "T5" 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC) and "T1" control treatment (mineral element) during 2018 and 2019 seasons. On the other hand, other combinations treatments were in between in this respect.

Such results are in general agreement with **Fathi, *et al*., (2002)**; **Hassan and Abou-Rayya (2003); El-Salhy *et al*., (2006); El-Sabagh *et al*., (2011) and Salhy *et al*., (2011) and Gomaa (2018).**

2- Leaf phosphorus content.

A. Specific effect:

Table (11) displays that, leaf phosphorus content did not response specifically to the investigated rootstock type. Hence, the statistically differences were in between the two investigated rootstocks (Freedom and Rtkhtar grape) when leaf phosphorus contents were concerned. With respect to the specific effect of the different fertilizers treatments on leaf phosphorus content, data presented in Table (11) revealed that, as the rate 50% control at rate (4, 3, 2) + 75 g compost + 10 cm bio fertilizer (AZ) and 50% control at rate (4, 3, 2) + 50 g compost + 10 cm bio fertilizer (EM) g/transplant fertilizers increased in leaf phosphorus content increased during both seasons of study. On the contrary, control fertilization treatment gave the lowest value of the phosphorus content in both seasons of study.

B. Interaction effect:

Results tabulated in **Table (11)** show the effect of the interaction between rootstock type and the different fertilizer treatments on leaf phosphorus contents. These results revealed that, leaf phosphorus was significantly affected by the interaction between the two investigated factors involved in this study. On the other hand, the highest value of leaf phosphorus content was that combination between Freedom & Richter rootstock and fertilizer treatments with T7 "50% control at rate (4, 3, 2) + 75 g compost + 10 cm bio fertilizer (AZ)" g/transplant, whereas the lowest value effect on leaf phosphorus content was detected with control treatment combined with fertilizers treatments. Moreover, other combinations were in between in this respect. These results are in congeniality with the findings previously detected by **Fayed (2005); Eissa-Fawzia (2007 b); El- Sabagh (2011) and Abd Aal *et al*., (2019).**

Table 11. Effect of mineral and bio-organic fertilizers on phosphorus (%) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	**P (%)**					
Treatments \ Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	0.183g	0.190g	**0.187E**	0.191f	0.192f	**0.192E**
T2. 50% control at rate (4,3,2) + 25 g compost.	0.215f	0.224ef	**0.220D**	0.219e	0.231de	**0.225D**
T3. 50% control at rate (4,3,2) + 50 g compost.	0.225ef	0.237e	**0.231D**	0.229de	0.242d	**0.236D**
T4. 50% control at rate (4,3,2) + 75 g compost.	0.254d	0.261d	**0.258C**	0.261c	0.264c	**0.263C**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	0.270cd	0.281bc	**0.276B**	0.278bc	0.283ab	**0.281B**
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	0.288ab	0.294ab	**0.291A**	0.291ab	0.296ab	**0.294A**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	0.299a	0.300a	**0.300A**	0.300a	0.302a	**0.301A**
Mean*	**0.248A**	**0.255A**		**0.253A**	**0.259A**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

3- Leaf potassium content.

A. Specific effect:

Considering the specific effect of the rootstock type (Freedom and Richter rootstocks) and different fertilization (Compost, BC, EM and EM) beside the control on the K content of Crimson grape, data in **Table (10)** obviously that, Richter rootstock had the highest values of K content than the other investigated rootstock (Freedom) during both seasons of study, respectively.

With respect to the specific effect of different fertilization (bio and organic fertilizer) on K content, data in **Table (10)**, mentioned that all the investigated fertilization significantly increased K content of Crimson grape as compared with control which was fertilized with "T3 and T5" 50 % mineral NPK plus compost at 50 or compost at 25 g + 10 cm bio fertilizer

(BC) per transplant in the first and second seasons, respectively.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock type and the different rates of fertilizers on leaf K content, data presented in **Table (12)** show obviously that, the most spurious combination enhanced leaf K contents was that combination between Richter grape rootstock and the fertilizers with T5 (50% control at rate (4, 3, 2) + 25 g compost + 10 cm bio fertilizer (BC) / transplant and EM at 30 g/transplant treatments during the two seasons respectively. Moreover, the lowest decrease in leaf K content was detected by Richter grape rootstock fertilizers with control transplants treatment during 2018 and 2019 seasons. On the other hand, other combinations treatments were in between in this respect.

The present results are in partial agreement with the findings of **Mengel and Arneke (1982); El-Akkad (2004); Ahmed-Ebtsam *et al*., (2008); Gawad *et al.,* (2012) and Khalil (2012).**

Table 12. Effect of mineral and bio-organic fertilizers on potassium (%) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	K (%)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	0.40k	0.45j	**0.42F**	0.36j	0.45h	**0.41F**
T2. 50% control at rate (4,3,2) + 25 g compost.	0.49h	0.47i	**0.48E**	0.51g	0.45h	**0.48E**
T3. 50% control at rate (4,3,2) + 50 g compost.	0.87d	0.89c	**0.88A**	0.76c	0.77c	**0.77B**
T4. 50% control at rate (4,3,2) + 75 g compost.	0.67e	0.34l	**0.51D**	0.76c	0.38i	**0.57C**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	0.53g	1.18a	**0.86B**	0.58e	1.16a	**0.87A**
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	0.30m	0.63f	**0.47E**	0.34k	0.71d	**0.53D**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	0.47i	1.13b	**0.80C**	0.55f	0.98b	**0.77B**
Mean*	**0.53B**	**0.73A**		**0.55B**	**0.70A**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

4- Leaf iron content.

A. Specific effect:

Referring the specific effect of rootstock type on leaf Fe content of crimson grape as a scion and the two investigated rootstocks respectively, data obtained in **Table (13)** clearly show that leaf Fe content was not significantly affect of the two investigated rootstocks in the first season. Whereas, leaf Fe content was greatly affected by rootstock type. Leaf Fe content of Freedom rootstock was statistically higher than that recorded with Richter grape rootstock in the second season.

As for the specific effect of the fertilizers on leaf Fe content, data presented in **Table (13)** revealed that leaf Fe content took the same trend, whereas the highest leaf Fe content was remarked with the rootstocks bio-fertilized with 50 % NPK plus 75 g compost + 10 cm bio fertilizer (AZ) treatment. Meanwhile, the lowest value of Fe content in leaf Fe content was associated with the untreated treatment (control) during 2018 and 2019 seasons, respectively.

B. Interaction effect:

As for the interaction effect of the two investigated factors i.e., rootstock types and the biofertilization on leaf Fe content, data tabulated in **Table (13)** showed obviously the variable response to the different combinations during 2018 and 2019 seasons. Freedom grape rootstock combined with 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ) g/transplant was the best combination where it raised leaf Fe content to the maximum level as compared with the other tested combinations during both seasons of study. On the other hand, leaf Fe content reached the minimum value when Freedom and Richter grapes as rootstocks and with control treatment. The other combinations were in between during both seasons of study.

Table 13. Effect of mineral and bio-organic fertilizers on Fe (ppm) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	Fe (ppm)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	141.0n	149.0m	**145.0G**	142.0k	138.0l	**140.0G**
T2. 50% control at rate (4,3,2) + 25 g compost.	173.0k	153.0l	**163.0F**	189.0i	140.0kl	**164.5F**
T3. 50% control at rate (4,3,2) + 50 g compost.	189.0i	177.0j	**183.0E**	203.0h	163.0j	**183.0E**
T4. 50% control at rate (4,3,2) + 75 g compost.	203.0g	199.0h	**201.0D**	217.0f	210.0g	**213.5D**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	226.0f	236.0d	**231.0C**	250.0e	270.0d	**260.0C**
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	230.0e	250.0c	**240.0B**	248.0e	278.0c	**263.0B**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	294.0a	283.0b	**288.5A**	325.0a	288.0b	**306.5A**
Mean*	**208.0A**	**206.7B**		**224.9A**	**212.4B**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

5- Leaf zinc content.

A. Specific effect:

Regarding the specific effect of rootstock type (Freedom and Richter grape) and fertilizers (Compost, BC, EM and Az) on leaf zinc content of Crimson grape content of both investigated rootstocks, data in **Table (14)** clearly show that there was high significant differences between two rootstocks under study in leaf zinc content of Crimson either grafting on Freedom or Richter grapes rootstocks. Richter grape rootstock was the highest significant value during both seasons of study.

Concerning the specific effect of the fertilizers on leaf zinc content, data presented in Table (14) revealed that as the fertilizers treatment T7 (50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ) the highest value in leaf zinc significantly increased during the two seasons of study.

B. Interaction effect:

As for the interaction effect of the two investigated factors i.e., rootstock type and the fertilizers on leaf zinc content of Crimson as a scion of Freedom and Richter grape rootstocks. Data tabulated in **Table (14)** obviously clear that the highest leaf zinc content was coupled with Richter grape rootstock fertilized with 50% control at rate (4, 3, 2) + 75 g compost + 10 cm bio fertilizer (AZ) g/transplant. On the contrary the lowest value of both rootstocks in leaf zinc content was detected by using Freedom grape as a rootstock fertilized control treatment (mineral element) during both seasons of study.

Table 14. Effect of mineral and bio-organic fertilizers on Zn (ppm) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	Zn (ppm)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	46.00f	59.00d	**52.50D**	51.00h	68.00e	**59.50D**
T2. 50% control at rate (4,3,2) + 25 g compost.	46.00f	61.00cd	**53.50D**	51.00h	79.00c	**65.00C**
T3. 50% control at rate (4,3,2) + 50 g compost.	47.00f	64.00b	**55.50C**	55.00g	83.00b	**69.00B**
T4. 50% control at rate (4,3,2) + 75 g compost.	39.00g	46.00f	**42.50F**	52.00h	51.00h	**51.50E**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	41.00g	51.00e	**46.00E**	61.00f	56.00g	**58.50D**
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	60.00d	63.00bc	**61.50B**	79.00c	60.00f	**69.50B**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	64.00b	80.00a	**72.00A**	71.33d	94.00a	**82.67A**
Mean*	**49.00B**	**60.57A**		**60.05B**	**70.14A**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

6- Leaf manganese content.

A. Specific effect:

Concerning the specific effect of rootstock type on leaf Mn content of Crimson grape as a scion and the two to examine rootstocks, respectively. Data obtained in **Table (15)** obviously that leaf Mn content was not affected by any of the two investigated rootstocks during the first season of study. Whereas the second one leaf Mn content was greatly affected by rootstock type. Leaf Mn content of Freedom rootstock was statistically higher than that recorded with Richter grapevine rootstock.

Regarding the specific effect of the fertilizers on leaf Mn content, data presented in **Table (15)** clearly that leaf Mn content took the same trend, whereas the highest leaf Mn content was remarked with the transplants fertilized with Compost, BC, EM+ Az at 10 g/transplant. Meanwhile, the lowest value of Mn content in leaf was associated with the control treatment (mineral fertilizer) during 2018 and 2019 seasons, respectively.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock types and the fertilization on leaf Mn content, data tabulated in **Table (15)** showed obviously took the same trend to the different combinations during both seasons. Freedom grapevine rootstock combined with Compost, BC, EM+ Az at 10 g/ transplant treatment was the best combination where it raised leaf Mn content to the maximum level as compared with the other tested combinations during both seasons of study. On the other hand, leaf Mn content reached the minimum value when Richter grape as rootstock and control treated. The other combinations were in between during both seasons of study.

This trend of response is in general agreement with the findings of **El-Akkad (2004) Ahmed-Ebtsam *et al*., (2008); Gawad *et al*., (2012); Khalil (2012) and Abd El-Aal (2019).**

Table 15. Effect of mineral and bio-organic fertilizers on Mn (ppm) of Crimson grape transplants grafted on both Freedom and Richter rootstocks during both 2018 and 2019 seasons.

Parameter	Mn (ppm)					
Treatments / Rootstocks	Freedom	Richter	Mean**	Freedom	Richter	Mean**
	First season; 2018			Second season; 2019		
T1. Control (R.D) NPK at rate (8, 6, 4g).	54.00i	58.00h	**56.00F**	61.00i	54.00j	**57.50G**
T2. 50% control at rate (4,3,2) + 25 g compost.	69.00g	79.00f	**74.00E**	71.00h	73.00g	**72.00F**
T3. 50% control at rate (4,3,2) + 50 g compost.	70.00g	86.00e	**78.00D**	76.00f	93.00d	**84.50E**
T4. 50% control at rate (4,3,2) + 75 g compost.	86.00e	97.00d	**91.50C**	85.00e	98.00c	**91.50D**
T5. 50% control at rate (4,3,2) + 25 g compost + 10 cm bio fertilizer (BC).	98.00d	106.0b	**102.0B**	99.00c	99.00c	**99.00C**
T6. 50% control at rate (4,3,2) + 50 g compost+ 10 cm bio fertilizer (EM).	103.0c	109.0a	**106.0A**	108.0a	104.0b	**106.0B**
T7. 50% control at rate (4,3,2) + 75 g compost + 10 cm bio fertilizer (AZ).	106.0b	106.0b	**106.0A**	109.0a	108.00a	**108.50A**
Mean*	**83.71B**	**91.57A**		**87.00B**	**89.86A**	

* and ** means refer to specific effect of root stock type and different treatments of bio-stimulants soil applied, respectively. Values within the same column or row for any of two investigated factors followed by the same letter/s were not significantly at 5 % level where capital letter/s, were used for distinguishing specific effect value of each investigated factor but small letters for interaction of their combination.

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تأثير التسميد ونوع الأصل على النمو الخضري والحالة الغذائية لشتلات العنب صنف (الكريمسون) المطعومة

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أجريت هذه الدراسة خلال موسمين متتاليين هما 2018 و2019 في مشتل قسم البساتين بكلية الزراعة – جامعة بنها على شتلات عنب كريمسون عمرها سنه مطعومة على أصلى ريختر وفريدوم لدراسة استجابة النمو الخضري والحالة الغذائية لهذه الشتلات للتسميد المعدني والحيوي والعضوي. وقد أجريت على الشتلات المعاملات الآتية:

1– تسميد الشتلات (الإضافة الأرضية) بسلفات الامومونيوم والسوبر فوسفات و سلفات البوتاسيوم بمعدل 8 و 6 و4 جرام لكل شتلة على التوالي (المقارنة).

2– تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و3 و2 جرام لكل شتلة + الكمبوست بمعدل 25 جرام لكل شتلة.

3– تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و3 و2 جرام لكل شتلة + الكمبوست بمعدل 50 جرام لكل شتلة.

4– تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و3 و2 جرام لكل شتلة + الكمبوست بمعدل 75 جرام لكل شتلة.

5– تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و3 و2 جرام لكل شتلة + الكمبوست بمعدل 25 جرام لكل شتلة + 10 سم من السماد الحيوي الباسياليس بوليميكس (BC).

6– تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و3 و2 جرام لكل شتلة + الكمبوست بمعدل 50 جرام لكل شتلة + 10 سم من السماد الحيوي الكائنات الحية الدقيقة (EM).

7– تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و3 و2 جرام لكل شتلة + الكمبوست بمعدل 50 جرام لكل شتلة + 10 سم من السماد الحيوي الأزوتوباكتركروكوكم (AZ).

وقد قسمت هذه الكميات على ثلاث مرات بالتساوي وأضيفت في منتصف مارس و مايو و يوليو في كل موسم من موسمي الدراسة.

وتم دراسة استجابة الشتلات للمعاملات المختلفة من خلال القياسات التالية:

أولا: قياسات النمو الخضري مثل: ارتفاع الساق – سمك الساق – عدد الأوراق/شتلة – عدد التفرعات – مساحة الورقة – طول الجذر – الوزن الطازج والجاف الكلي لأجزاء الشتلة.

ثانيا: الحالة الغذائية (نتروجين، فوسفور بوتاسيوم) و(حديد، زنك ومنجنيز) بالورقة لشتلات العنب الكريمسون المطعومة على أصلى الريختر والفريدوم.

ويمكن إيجاز أهم النتائج المتحصل عليها فيما يلي:

أولا: قياسات النمو الخضري:

التأثير النوعي:

أوضحت النتائج المتحصل عليها أن النمو الخضري لشتلات العنب الكريمسون المطعومة على أصل الفريدوم أفضل من الشتلات المطعومة على أصل الريختر خلال موسمي الدراسة. كما أن تسميد شتلات العنب الكريمسون بالمعاملة رقم (4) (تسميد الشتلات (إضافة أرضية) تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و3 و2 جرام لكل شتلة + الكمبوست بمعدل 75 جرام لكل شتلة على التوالي وأيضا المعاملة رقم (5) و (7) كان لهم السبق في قياسات النمو الخضري مقارنة بباقي المعاملات خلال موسمي الدراسة.

تأثير التفاعل:

أوضحت النتائج المتحصل عليها أن تسميد شتلات العنب الكريمسون المطعومة على أصل الفريدوم بسلفات الامومونيوم والسوبر فوسفات و سلفات البوتاسيوم بمعدل 4 و 3 و2 جرام لكل شتلة على التوالي (المقارنة) + الكمبوست بتركيزات 75 منفردا، أو 25 + 10 سم من السماد الحيوي (BC). + و الكمبوست بمعدل 50 جرام لكل شتلة + 10 سم من السماد الحيوي (AZ) لكل شتلة تعطى أفضل قياسات النمو الخضري بينما اقل القياسات كانت مع شتلات العنب الكريمسون المطعومة على أصل ريختر والمسمدة بسلفات الامومونيوم والسوبر فوسفات و سلفات البوتاسيوم بمعدل 4 و 3 و2 جرام لكل شتلة على التوالي (المقارنة) بينما كانت باقي المعاملات وسطا بينهما.

ثانيا: الحالة الغذائية (نتروجين، فوسفور بوتاسيوم) و(حديد، زنك ومنجنيز) بالورقة لشتلات العنب الكريمسون المطعومة على أصلى الريختر والفريدوم.

التأثير النوعي:

أشارت النتائج بالنسبة للعناصر الكبرى الثلاثة (NPK) لشتلات العنب الكريمسون المطعومة على أصل الريختر أفضل من الشتلات المطعومة على أصل الفريدوم خلال موسمي الدراسة. حيث وجد زيادة معنوية لعنصري البنتروجين والبوتاسيوم لشتلات العنب المطعومة على أصل الريختر مقارنة بالفريدوم، أما بالنسبة لعنصر الفوسفور فلا يوجد زيادة معنوية بين الأصلين المختبرين تحت الدراسة خلال الموسمين على التوالي، كما تباينات النتائج الخاصة بتسميد شتلات العنب الكريمسون بالمعاملة رقم (4) (تسميد الشتلات (إضافة أرضية) تسميد الشتلات (إضافة أرضية) بنصف الكمية (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و 3 و 2 جرام لكل شتلة + الكمبوست بمعدل 75 جرام لكل شتلة على التوالي وأيضا المعاملة رقم (5) و (7) كان لهم السبق في قياسات النمو الخضري مقارنة بباقي المعاملات خلال موسمي الدراسة. أما بالنسبة لتأثير الأصناف مع العناصر الصغري (حديد، زنك ومنجنيز)، أضارت النتائج إلى أن أصل الفريدوم كان له السبق مع عنصر الحديد، وعلى العكس من ذلك كان الأفضلية معنوياً لعنصري الزنك والمنجنيز لأصل الريختر وذلك خلال موسمي الدراسة، أما بالنسبة لتأثير المعاملات المختبرة تحت الدراسة كانت المعاملة رقم (7) تسميد الشتلات (إضافة أرضية) بنصف الكميٍة (50 %) من سلفات الامومونيوم والسوبر فوسفات وسلفات البوتاسيوم بمعدل 4 و 3 و 2 جرام لكل شتلة + الكمبوست بمعدل 50 جرام لكل شتلة + 10 سم من السماد الحيوي الأزوتوباكتركروكوكم (AZ) هي الأعلى للثلاث عناصر خلال موسمي الدراسة

تأثير التفاعل:

أوضحت النتائج المتحصل عليها أن تسميد شتلات العنب الكريمسون المطعومة على أصل الفريدوم بسلفات الامومونيوم والسوبر فوسفات و سلفات البوتاسيوم بمعدل 4 و 3 و 2 جرام لكل شتلة على التوالي (المقارنة) + الكمبوست بتركيزات 75 منفردا، أو 25 + 10 سم من السماد الحيوي (BC). + و الكمبوست بمعدل 50 جرام لكل شتلة + 10 سم من السماد الحيوي (AZ) لكل شتلة تعطى أفضل قياسات النمو الخضري بينما اقل القياسات كانت مع شتلات العنب الكريمسون المطعومة على أصل ريختر والمسمدة بسلفات الامومونيوم والسوبر فوسفات و سلفات البوتاسيوم بمعدل 4 و 3 و 2 جرام لكل شتلة على التوالي (المقارنة) بينما كانت باقي المعاملات وسطا بينهما. أم بالنسبة للعناصر الصغري فكانت المعاملة رقم 7 مع الأصل فريدوم هي الأعلي لعنصر الحديد، أم بالنسبة لعنصري الزنك والمنجنيز فكانت المعاملة رقم (7) مع الأصل الريختر عي الأعلى معنوياً وأيضا المعاملة السادسة بدون وجود زيادة معنوية بينهما وذلك لعنصر المنجنيز خلال موسمي الدراسة.