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Effect of Summer Pruning and Some Bio-Stimulants on Bud Fertility, Vegetative Growth, Yield and Fruit Quality of *Vitis vinifera* cv. "Superior" Grapevines

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ABSTRACT

This investigation was carried out during 2013 and 2014 seasons on ten-years-old Superior seedless grapevines grown in a sandy loam soil at El-Khatatba, Menoufiya governorate. The objective of this investigation was to study the effect of summer pruning and some bio-stimulants on bud fertility, vegetative growth, yield and fruit quality. The vines were cultivated at 2 X 3 meters apart and irrigated by the drip irrigation system, according to cane-pruning under the Spanish Baron trills system. The treatments were applied as follows: inoculation with arbuscular mycorrhiza (AM), inoculation with yeast (Y), summer pruning (Sp), (AM) + yeast (Y), (AM) + summer pruning (Sp), yeast (Y) + summer pruning (Sp), (AM) + yeast (Y) + summer pruning (Sp) and control (Uninoculated vines). The results showed that all treatment significantly increased bud fertility percentage and Fruitful coefficient in the second season than the control. Moreover, the combination of Arbuscular mycorrhiza + Yeast + Summer pruning recorded the highest significant values of yield per vine, cluster weight as well as the physical and chemical characteristics of berries. Dynamics of wood ripening, total chlorophyll and percentages of total nitrogen, phosphorus and potassium of the leaves and total carbohydrates of the canes were also improved. Concerning, microbiological activity in the rhizosphere, it was noticed that percentage of infection of AM-mycorrhizae, spore numbers of AM-mycorrhizae, the populations of total microorganism and yeast populations increased in the rhizosphere as a result of inoculation of AM-mycorrhizae and yeast.

INTRODUCTION

Agricultural bio-stimulants contain various formations of compounds, substances and micro-organisms which are able to mobilizing great nutritional mineral in the soil from non-usable to usable form by the yield plants through their biological operations. During recent days, bio-fertilizers have been extensively used as an eco-friendly approach to minimize the use of chemical fertilizers, enhance soil fertility status and for the improvement of yield production by their biological activity in the rhizosphere (Ram Rao *et al*., 2007).

Some agricultural soils, especially those deficient in profitable soil organisms, due in part to side effects of practices such as fumigation, require repair to turn them favorable for optimum crop production. Recently, artificial inoculation with selected arbuscular mycorrhizal (AM) fungi is used to rework these fungi to these soils (Abbott & Robson 1982 and Menge *et al.*, 1983). consequently, Arbuscular mycorrhyza fungal hyphae exclusively settle the root rind and form highly branched building into the cells, i.e., Arbuscules, which are considered the functional place of nutrient exchange (Balestrini *et al.*, 2015). AM fungi usage influence on hastening of flowering, fruit set and ripening of grape cultivar Perlette (Usha *et al*., 2005). Arbuscular mycorrhyzal fungi such as *Acaulospora spp, Gigaspora spp, Glomus spp, Sclerocystis spp* enhance plant growth by improvement the uptake of nutrients, especially phpsphorus in nutrient-poor soils (Gebbing *et al.*, 1977; Bolan, 1991 and Kothari *et al.*, 1991) Recently, Yeast (*Saccharomy cesccrvicisae*) is considered as a new promising biofertilitzer for many crops. The beneficial effects of using yeast could be due to one or more reasons. Yeast active photosynthesis procedure through improving the release of carbon dioxide (Larson *et al.*, 1962). Yeast contains some natural growth regulators, i.e. auxin (IAA) (Moor, 1979) and cytokinins (Cks) (Ferguson *et al.*, 1987). Also the yeast may be encouraged the uptake of different nutrients (Vilsmeier and Amberger 1988). In addition, it contains some important nutrients as N, P and K and some common amino acids (approximately 18 amino acids) (Abou-Zaid 1984).

Summer pruning is considered one of an important horticultural practices which already carried out in most of grapevine orchards. The importance of summer pruning came from the fact that it is a complementary process for the preceding winter pruning and a preliminary practice for the subsequent one. Neglecting or carrying out summer pruning incorrectly has been accompanied with undesirable influence on the yield and fruit quality of the current year besides the following one. Many farmers reviewed the effect of summer pruning on growth parameters and yield of different grape cultivars. (Alia *et al.* 2001). Therefore, the main objective of this study was a try to increase yield per vine and its components and enhance berry quality and vegetative growth of “Superior" grapevines through the inoculation with arbuscular mycorrhiza (AM), yeast and summer pruning treatments.

MATERIALS AND METHODS

This investigation was under taken during two successive seasons of 2013 and 2014 on fourteen years old Superior seedless grapevines grown in a sandy loam soil at private vineyard located in El-Khatatba, Menoufiya governorate to study the effect of inoculation with arbuscular mycorrhiza (AM), yeast and using summer pruning on bud behavior, yield and cluster quality. Some physical, chemical and microbiological characteristics of the experimental soil were measured before the applications to the method summarized by Black *et al.* (1965). Soil samples were taken from two layers at 0-30 and 30-60 cm depth and analysis data are presented in Table (1).

Table 1. Physical, chemical and microbiological analysis of the experimental soil before starting the experiment.

Characters		Depth 0-30cm	Depth 30 - 60 cm
Physical	Sand (%)	70.28	73.48
	Silt (%)	2.43	2.84
	Clay (%)	27.29	23.68
	Texture	Sandy loam	
Chemical	Organic carbon (%)	0.06	0.05
	Ph	7.73	7.77
	EC (mmhos/cm)	1.45	1.65
	Water holding capacity (%)	27.00	27.9
	Ca Co3 (%)	0.62	0.67
	N (%)	0.90	0.88
	P (%)	0.12	0.12
	K (%)	0.54	0.51
Microbiological	Number of AM (spore/g soil)	3.8	3.6
	AM infection (%)	6.2	5.9
	Total microbial count (cfu/g soil)	11.4×10^5	10.2×10^5
	Total yeast count (cfu/g soil)	0.07×10^5	0.06×10^5

The chosen vines were spaced at 2 x 3 meters apart under the drip irrigation system and pruned according to cane-pruning under the Spanish Baron trills system. During the second week of January the vines were pruned with to 6 canes with 12 eyes each along with 6 renewal spurs. In this study, ninety-six uniform vines were chosen in a randomized complete-block design, each four vines symbolized as a replicate and each three replicates were treated by one of the following: -

1- Inoculation with arbuscular mycorrhiza (AM).
2- Inoculation with yeast (Y).
3- Summer pruning (Sp)
4- Inoculation with arbuscular mycorrhiza (AM) + yeast (Y).
5-Inoculation with arbuscular mycorrhiza (AM) + Summer pruning (Sp)
6- Inoculation with yeast (Y) + Summer pruning (Sp).
7-Inoculation with arbuscular mycorrhiza (AM) + yeast (Y) + Summer pruning (Sp)
8- Control.

At the second week of January, the soil drench was made beside the roots of the grapevine. Mycorrhizal spores that included the mixture of the following genera *Glomus, Gigaspora* and *Acaulospora* were extracted from the soils of Egypt Extraction and counting of specific mycorrhizal spores were undertaken with reference to the method characterized by Massoud (1999), where the soil mass was gently removed from root system of each vine (250g), hanging and then sieved using the wet ridding and decanting technique. Five ridding (400, 250, 150, 75 and 65 mesh size) were used. The remained fractions were transferred into a glass bottle and palliated with water. The number of spores was estimated by spreading certain volume of mycorrhizal spore suspension onto a squared Petri–dish, which was divided into squares from the base. The number was scored using a binocular microscope (30-50X) Daft and Hogarth (1983).

Mixed spores of mycorrhizal species via *Glomus spp.*, *Gigaspora spp.* and *Acaulospora spp.*, was prepared after extraction and mixed with sand as a carrier (40- 50 spore/gram inoculum) and then added to the soil at the rate of long inculum/line (1 m long) so each vine 2.5 m around needs 250 g inculum.

Yeast (*Saccharomyces cerevisiae*) inoculation (15 g/vine) were prepared as cell suspension (g/L) dry weight. The density was evaluated to standardize the inoculation to 105 cells/ml, then soil drench was added through two times: the 1st time (after bud burst) and the 2nd time (after shattering). Yeast was grown on Hertz and Levine's medium Difco (1984).

Yeast (*Saccharomyces cerevisiae*) was active dry with gassing power 150 cm3/91 hour and its concentration was 95% of fungus cells. The chemical analysis of active dry yeast according to Gaser *et al.* (2006) is shown in Table (2).

Table 2. Chemical analysis of the active dry yeast

N (%)	Polysaccharides (%)	Fats (%)	Protein (%)	Fiber (%)	Ash (%)	Thiamin (B1) (mg)	Riboflavin (B2) (mg)	Niacin (B4) (mg)	Vitamin (B6) (mg)	Vitamin (B12) (mg)
7.3	32.3	3.5	35	1.1	6.7	2.33	5.41	36.7	4.41	0.02

Summer pruning was included shoot thinning to 15 shoots per meter before the start of bloom, laterals topped to 4-5 leaves and leaf removal through the fruiting zone. Shoot thinning was applied before the inflorescences underwent capfall. All secondary and tertiary shoots were hand removed and remaining shoots were thinned evenly, as necessary, to 15 shoots/m. Basal leaf removal (BLR) was applied, while berries were pea sized (6 to 8mm). In simulating grower applied hand leaf removal, leaves and laterals in about the first 5 nodes were hand removed from both sides of the trellis for approximately 75% visual cluster exposure.

The following parameters were adopted to evaluate the tested treatments:-

1. Bud fertility:

During the spring of each season, number of bursted buds/vine and number of clusters/vine were counted, then the percentage of bud fertility and coefficient of fruitful were calculated according to the methods described by Bessis (1960) as follows:

- Bud fertility % = (Number of fruiting buds /total number of buds) × 100
- Fruitful coefficient = Number of clusters /total number of bursted buds.

2. Vegetative growth:

Vegetative growth parameters were measured at the beginning of verasion stage as follows:

- Average shoots diameter (cm)

It was determined by measuring the rate diameter of 4 shoots / vine (shoot from each side)

- Average leaf area (cm^2/leaf)

Average leaf area (cm^2) of the apical 5^{th} and 6^{th} leaves using a CI-203 Laser Area-meter made by CID, Inc., Vancouver, USA.

3. Leaf content of total chlorophyll, N, P and K:

- Total Chlorophyll content in the leaves:

Samples of five mature and fresh of the apical (6^{th} and 7^{th}) leaves on the main shoot/vine and were determined for the following studied:

Leaf content of total chlorophyll was measured by using nondestructive Minolta chlorophyll meter SPAD 502 of the (6^{th} and 7^{th}) leaves (Wood *et al*., 1992).

- N, P and K content in the leaves:

At the beginning of verasion stage, samples of 20 leaf petioles per replicate were taken from leaves opposite to cluster and cleaned with tap water, dried at 70°C to constant weight and finally grind to determine N, P and K content.

- **Total nitrogen percentage:** It was estimated by using micro-Kgeldahl according to the method described by Jones (2001).
- **Phosphorus:** It was measured calorimetrically using the stannous-reduce molybdophoric blue color method in sulphuric system as described by Jones (2001).
- **Potassium percentage:** It was estimated in the digested blanc substance using flame photometer according to Jones (2001).

4. Yield and physical characteristics of bunches:

Actress random samples of 6 bunches per vine were harvested when SSC reached about 16-17% according to Muhtaseb and Ghnaim (2007). The following characteristics were determined:

- **Yield/vine (kg)** was estimated as number of bunches /vine multiplied by average bunch weight /vine and average estimated yield /vine was calculated.
- **Average bunch weight (g):** It was determined in grams using an electrical sensitive balance.
- Bunch length and width (cm) were estimated.

5. Physical characteristics of berries:

Sixty berries from each cluster were taken randomlyto measure the average of following parameters:

- **Berry weight (g):** It estimated in gram by using an electrical sensitive balance.
- **Berry size (cm^3):** This parameter was determined by immersing the same berry sample in water in a graduated glass cylinder containing water to a certain level, and then the bumped water was measured.
- Berry dimensions (length and diameter) (cm).
- Berry firmness and adherence strength (g/ cm^2) (using Shatilons's instrument) were determined.

6. Chemical characteristics of berries:

- Soluble solids content in berry juice (SSC %): It was estimated by Carlziss hand refractometer.
- Total titratable acidity as tartaric acid (%): It was estimated according to the method of A.O.A.C. (1985) by the following equation:

$$\textbf{Total acidity in g/ml. juice} = \frac{\text{ml.NOH X N.NaOHX 0.075}}{\text{ml. juice}} \quad \textbf{X100}$$

Where, 0.075 =milliequivalent weight of tartaric acid.
N = Normality of NaOH

6. 3- SSC /acid ratio were calculated as a percentage.

7. Microbiological studies:-

Samples of soil were taken from the rhizospheric zone of grapes plants roots after harvest and determined as follows:

- **Arbiscular mycorrhizal infection (%):** determined according to the methods described by Massoud (2005).
- **Number of AM (spore/g soil):** estimated according to the methods described by Massoud (2005).
- Total microbial count (-x105 colony forming unit (cfu)/g soil): estimated according to the methods described by Esher and Jensen (1972).
- Total yeast count (-x105 colony forming unit (cfu)/g soil): estimated according to the methods described by Difco (1984).

8- Determination after harvesting:

- Total carbohydrate in the canes:

Samples of canes were taken at winter pruning during the fourth week of December and were determined according to the method described by Smith *et al.* (1956).

- Coefficient of wood ripening

At the first week of November; Samples of five mature canes were taken to determine the length of the ripened part of the shoot (changing from greenish to brownish color) dividing by the total length of the same shoot to determine coefficient of wood ripening according to the methods described by Bouard (1966).

9 - Statistical analysis:

The obtained data were statistically analyzed as complete randomized block design according to the method described by Snedecor & Cochran (1994).

RESULTS AND DISCUSSION

1- Bud fertility and fruitful coefficient

Data in Table (3) clearly show that bud fertility percentage and Fruitful coefficient were not affected by any of the treatments in the first season of the study. This can be explained by the fact that the clusters have already been formed in the preceding season. In the second season all treatment significantly increased bud fertility percentage and Fruitful coefficient than the control. Moreover the combined application of inoculation with arbuscular mycorrhiza (AM), yeast and Summer pruning gave the highest values of increased bud fertility % and Fruitful coefficient (32.8 % & 0.64) compared with the other treatments or the control.

Table 3. Influence of Arbuscular Mycorrhiza, yeast and summer pruning treatments on bud fertility and fruitful coefficient of Superior Seedless grapevines during 2013 and 2014 seasons.

Treatments	Characteristics	Bud fertility (%)		Fruitful coefficient	
		Season		Season	
		2013	2014	2013	2014
1	Arbuscular mycorrhiza	26.4	29.4	0.48	0.53
2	Yeast	26.8	30.5	0.51	0.58
3	Summer pruning	26.5	29.9	0.49	0.55
4	Arbuscular mycorrhiza + Yeast	26.9	31.5	0.52	0.61
5	Arbuscular mycorrhiza + Summer pruning	26.9	30.9	0.51	0.59
6	Yeast + Summer pruning	27.1	32.2	0.53	0.63
7	Arbuscular mycorrhiza+ Yeast + Summer pruning	27.2	32.8	0.55	0.64
8	Control	26.3	28.9	0.46	0.52
	New LSD at 5%	N.S	0.4	N.S	0.01

The positive effect of AM and yeast inoculations on and bud fruitfulness could be attributed to that yeast include some natural growth regulators, i.e. auxin (IAA) (Moor, 1979) and cytokinins (Cks) (Ferguson *et al*., 1987). Moreover, the interaction between soil commercial yeast and AM fungi is essential for growth and development of plants (Sampedro *et al*., 2004). In addition, The positive effect of shoot thinning and topping on fruit set and fertility can be explained by the leaves in the mid- and upper- branch part export carbohydrates to the branch tip during bloom stage (Carmo vasconcelos and Castagnoli (2000). After hedging, the translocation direction is reversed instead of moving to the branch tip assimilates are diverted basipetally (Quinlan, and Weaver, 1970) and made useful to the promoting inflorescences. This is thought to enhance berry set.

2- Shoot diameter, leaf surface area and total chlorophyll in the leaves:

The concerned data in Table (4) that all treatments enhanced shoot diameter, leaf surface area, and total chlorophyll in leaves as compared to the control during both seasons of study. The data also used Yeast (T2) individually increased shoot diameter, leaf surface area, and total chlorophyll in leaves as compared with Arbuscular mycorrhiza (T1) and summer pruning (T3) respectively, in both seasons of study. Moreover, the combination of Arbuscular mycorrhiza + Yeast + Summer pruning (T7) recorded the highest significant values of shoot diameter(1.21 cm & 1.25 cm), leaf area (190.7 & 196.5 cm^2) and total chlorophyll in leaves (38.7 & 39.9 mg/g) in leaves as compared with untreated during both seasons .While, the control treatment (T8) recorded the lowest values (1.01 & 1.03 cm) for shoot diameter, (169.5 & 177.8 cm^2) for leaf area, (31.8 & 34.5 mg/g) for total chlorophyll, in 2013 and 2014 respectively.

Table 4. Influence of Arbuscular Mycorrhiza, yeast and summer pruning treatments on growth parameters of Superior Seedless grapevines during 2013 and 2014 seasons.

Treatments	Characteristics	Shoot diameter (cm)		Leaf area (cm^2)		Total chlorophyll (mg/g FW)	
		Season		Season		Season	
		2013	2014	2013	2014	2013	2014
1	Arbuscular mycorrhiza	1.04	1.08	172.8	178.9	33.5	36.1
2	Yeast	1.09	1.13	177.9	186.6	35.1	37.9
3	Summer pruning	1.06	1.11	175.3	182.2	34.9	36.8
4	Arbuscular mycorrhiza + Yeast	1.14	1.20	185.3	190.7	36.5	38.2
5	Arbuscular mycorrhiza + Summer pruning	1.11	1.16	182.1	188.4	35.7	38.5
6	Yeast + Summer pruning	1.18	1.23	186.9	193.3	37.4	39.4
7	Arbuscular mycorrhiza + Yeast + Summer pruning	1.21	1.25	190.7	196.5	38.7	39.9
8	Control	1.01	1.03	169.5	177.8	31.8	34.5
	New LSD at 5%	0.02	0.01	3.7	3.1	0.9	0.4

The positive effect of AM and yeast inoculations on vegetative growth parameters could be explained by that AM mycorrhizae produced some enzymes which promote the respiration of the root and enhancing uptake of elements and the production of growth promoting substances (Edrees 1982). Moreover, several researchers emphasized that AM mycorrhizae increase the growth of plants by enhancing nutrient uptake. Abd El-Wahab, *et al.* (2008) illustrated that here are three possible explanations for the major uptake of elements nutrients by mycorrhizal plants compared to non-mycorrhizal ones. First, mycorrhizae improve nutrient uptake by decreasing the distance at which nutrients must diffuse to plant roots (Hattingh *et al*, 1973 and Rhodes & Gerdemann, 1975). Secondly, mycorrhizal roots may differ from non-mycorrhizal roots in the relationship between rate of nutrient absorption and nutrient focus at the absorbing surface (Cress *et al.*, 1979). The end , mycorrhizal hyphae may chemically change the availability of nutrients for uptake by tree and increase nutrient uptake from soil primarily by shortening the space that nutrients must diffuse through soil to the root (Baylis, 1975). The beneficial effect of the shoot thinning on improving of vegetative growth can be explained through the following fact: shoot thinning increased photosynthetic production and physiologically efficient leaf area of the remained shoots which improved root consistency (Hunter and Le Roux, 1992) and improve in nutrient absorption and translocation of most carbohydrates to on growth parameters (Hunter and Visser, 1990).

3- N, P and K (%) content in leaf petioles

Results presented in Table 5 showed that of N, P, and K (%) content in leaf petioles were extremely affected by the applied inoculation Arbuscular mycorrhiza, inoculation Yeast and Summer pruning as compared to untreated vines in both seasons and gave non-significant deference between inoculation Arbuscular mycorrhiza (T1) and Summer pruning (T3) in this respect.

These results are in go in line with those given by Many researchers who reported that mycorrhizal fungi improved leaf nutrient content of their host plant on citrus seedlings, El-Sharkawy (1989) on citrus seedlings, Gardiner & Christensen (1991) on pear seedling, (Helail, 1993) on avocado seedling and Mona (2001) on guava and banana plants. Moreover, the data showed that the combination of mycorrhiza + Yeast + Summer pruning (T7) scored the highest significant values of N, P, and K content in leaf petioles as compared to untreated during both seasons. The N values were (1.81 & 1.87%), the P values were (0.44 & 0.47%) and the K values were (1.64 & 1.69%) during 2013 and 2014 seasons, respectively. While, the control treatment (T8) recorded the lowest values (1.69 & 1.87%) for N, (0.24 & 0.29 %) for p and (1.49 & 1.55%) for K respectively, in both seasons of study.

Table 5. Influence of Arbuscular Mycorrhiza, yeast and summer pruning treatments on N, P and K of Superior Seedless grapevines grapevines during 2013 and 2014 seasons.

Treatments	Characteristics	N (%)		P (%)		K (%)	
		Season		Season		Season	
		2013	2014	2013	2014	2013	2014
1	Arbuscular mycorrhiza	1.71	1.74	0.27	0.31	1.51	1.56
2	Yeast	1.74	1.76	0.32	0.35	1.54	1.61
3	Summer pruning	1.72	1.76	0.31	0.34	1.52	1.56
4	Arbuscular mycorrhiza + Yeast	1.77	1.81	0.35	0.38	1.58	1.66
5	Arbuscular mycorrhiza + Summer pruning	1.75	1.78	0.34	0.37	1.57	1.65
6	Yeast + Summer pruning	1.78	1.83	0.38	0.42	1.61	1.67
7	Arbuscular mycorrhiza +Yeast+Summer pruning	1.81	1.87	0.44	0.47	1.64	1.69
8	Control	1.69	1.72	0.24	0.29	1.49	1.55
	New LSD at 5%	0.02	0.03	0.05	0.04	0.02	0.01

4- Yield and bunch Physical characteristics:

Results in Table (6) indicated that all treatments significantly increased cluster weight and yield/vine as compared to untreated in both seasons of study. Moreover, the combined application of mycorrhiza + Yeast + Summer pruning (T7) recorded the highest significant values of yield per vine (11.52 & 14.35 kg/vine) and bunch weight (587.5 & 607.6 g) followed in a descending order by the treatment of Yeast + Summer pruning (T6) which recorded the values of yield per vine (11.10 & 13.65 kg/vine), bunch weight (569.2 & 588.8 g) as compared with control during both seasons. While, the untreated treatment (T8) gave the lowest values which recorded yield per vine (8.53 & 9.67 kg/vine), cluster weight (451.2 & 464.9 g) in 2013 and 2014 seasons, respectively.

These results were in line with those by Thamsurakul *et al.* (2000) who found that AM fungi increased the yield of pineapple by 73.57% compared to the control. As for the effect of yeast, Ahmed *et al.* (2000) on "King Ruby" cv., Omran (2000) and Esmaeil *et al.* (2003) on “Roumy Red" cv. and Gaser *et al.* (2006) on "Flame Seedless" indicated that yeast treatment as foliar or soil drench gave a significant increase in bunch weight and yield/vine. The positive effect of removal of some vegetative shoots applications on increasing number of bunches/vine and yield can be explained through the following fact: shoot thinning improves canopy density, reduces shading, thereby stimulating of the reserved materials especially photosynthesis assimilates which leads to increases of carbohydrates in the remained shoots which increases in the coefficient of bud fertility, thereby increasing of number of bunches/vine and yield, Shaker (2015).

Table 6. Influence of Arbuscular Mycorrhiza, yeast and summer pruning treatments on yield and its components of Superior Seedless grapevines during 2013 and 2014 seasons

Treatments	Characteristics	No. of bunch		Bunch weight (g)		Yield/vine (Kg)	
		Season		Season		Season	
		2013	2014	2013	2014	2013	2014
1	Arbuscular mycorrhiza	19.0	21.2	467.3	481.4	8.88	10.21
2	Yeast	19.3	21.9	509.4	525.3	9.83	11.52
3	Summer pruning	19.1	21.5	493.8	508.5	9.43	10.93
4	Arbuscular mycorrhiza + Yeast	19.4	22.7	553.6	572.9	10.74	12.98
5	Arbuscular mycorrhiza + Summer pruning	19.4	22.3	532.7	551.2	10.33	12.26
6	Yeast + Summer pruning	19.5	23.2	569.2	588.8	11.10	13.65
7	Arbuscular mycorrhiza + Yeast + Summer pruning	19.6	23.6	587.5	607.6	11.52	14.35
8	Control	18.9	20.8	451.2	464.9	8.53	9.67
	New LSD at 5%	N.S	0.3	18.1	18.7	0.37	0.43

5- Physical characteristics of berries:

Berry firmness and adherence

The results presented in Table 7 indicated insignificant difference between the applications of inoculation arbuscular mycorrhiza (T1) and summer pruning (T3) treatments on berry firmness and adherence strength as compared with control during the two seasons of study. While the best individual treatments were yeast (T2) in this study.

Treatment Arbuscular mycorrhiza + yeast + summer pruning (T7) gave the highest significant values as for berry firmness (403.6 & 426.6 g/cm^3) and berry adherence (271.9 & 289.1 g/cm^3) during the two seasons of study, respectively. Whereas, control treatment (T8) gave the lowest values in this respect, which recorded 368.7 & 384.5 g/cm^3 for berry firmness and 241.6 & 253.4 g/cm^3 for berry adherence during 2013 and 2014 seasons, respectively.

Table 7. Influence of arbuscular mycorrhiza, yeast and summer pruning treatments on berry firmness and adherence strength of Superior seedless grapevines during 2013 and 2014 seasons.

Treatments	Characteristics	Berry firmness (g/ cm^3)		Berry adherence strength (g/ cm^3)	
		Season		Season	
		2013	2014	2013	2014
1	Arbuscular mycorrhiza	371.3	388.9	243.8	255.5
2	Yeast	388.2	406.5	257.7	267.8
3	Summer pruning	375.1	393.3	249.2	261.2
4	Arbuscular mycorrhiza+ Yeast	380.3	397.8	251.2	262.4
5	Arbuscular mycorrhiza + Summer pruning	393.5	413.1	262.1	272.9
8	Yeast + Summer pruning	389.8	408.5	258.7	268.8
7	Arbuscular mycorrhiza + Yeast + Summer pruning	403.6	426.6	271.9	289.1
8	Control	368.7	384.5	241.6	253.4
	New LSD at 5%	13.1	17.4	12.9	16.7

- berry weight, size, length and diameter:

The results presented in Table (8) indicated that the combination of mycorrhiza + Yeast + Summer pruning (T7) recorded the highest significant values of on berry weight, berry size, firmness and adherence strength as compared with control during the two seasons of study. Whereas, no significant difference between the applications inoculation Arbuscular mycorrhiza (T1) individual and summer pruning (T3). While the best individual treatments were yeast (T2) in this study

The increase in berry physical properties observed in AM and yeast inoculations on could be attributed to that yeast includes some natural growth regulators, i.e. auxin (IAA) (Moor, 1979) and cytokinins (Cks) (Ferguson *et al.*, 1987). Moreover, the interaction between soil commercial yeast and AM fungi is essential for growth and development of plants (Sampedro *et al.*, 2004).

The effect of shoot removal is regarding to the activation of photosynthesis into the canopy of the vine through improving light penetration and temperature, which encourage an increase in total sugars in the fruits, increasing its osmotic pressure and attraction force of water, thus enhancing physical berry characteristics. These results are in accordance with those obtained by Abdel-Rahman and Tolba (2016) who found that physical characteristics of berries i.e. berry weight, volume, firmness and adherence strength were significantly increased by all yeast application and summer pruning usage.

Table 8. Influence of Arbuscular Mycorrhiza, yeast and summer pruning treatments on berry weight, size, length and diameter of Superior Seedless grapevines during 2013 and 2014 seasons.

Treatments	Characteristics	Berry weight (g)		Berry size (cm^3)		Berry length (cm)		Berry diameter (cm)	
		seasons							
		2013	2014	2013	2014	2013	2014	2013	2014
1	Arbuscular mycorrhiza	2.91	2.98	2.67	2.74	2.19	2.25	1.72	1.74
2	Yeast	3.01	3.09	2.75	2.85	2.23	2.27	1.73	1.75
3	Summer pruning	2.97	3.05	2.72	2.81	2.21	2.26	1.72	1.75
4	Arbuscular mycorrhiza+ Yeast	3.13	3.22	2.86	2.96	2.28	2.30	1.75	1.77
5	Arbuscular mycorrhiza + Summer pruning	3.08	3.16	2.81	2.90	2.26	2.29	1.74	1.76
6	Yeast + Summer pruning	3.19	3.27	2.88	2.99	2.29	2.32	1.75	1.78
7	Arbuscular mycorrhiza+ Yeast + Summer pruning	3.24	3.33	2.92	3.02	2.31	2.35	1.77	1.79
8	Control	2.86	2.92	2.64	2.69	2.18	2.23	1.71	1.73
	New LSD at 5%	0.04	0.03	0.03	0.02	0.01	0.02	0.02	0.01

6 - Chemical characteristics of berries

It is evident from Table (9) that soluble solids content (SSC), total acidity and SSC/acid ratio of berries were significantly affected by with inoculation Arbuscular mycorrhiza (T1), inoculation Yeast (T2) and Summer pruning as compared with control in the two years of study.

The maximum values of SSC % and SSC/acid ratio in addition the minimum significant values of total acidity were obtained from vines treated with mycorrhiza + Yeast + Summer pruning (T7) followed by the treatment of Yeast + Summer pruning (T6) then other treatments during the two seasons of study. While, the untreated vines (T8) had significant decrease of SSC %, SSC/acid ratio and increased of total acidity as compared with other treatments in the two years of study.

Table 9. Influence of Arbuscular Mycorrhiza, yeast and summer pruning treatments on chemical characteristics of berries of Superior Seedless grapevines during 2013 and 2014 seasons

Treatments	Characteristics	SSC (%)		Acidity (%)		TSS/acid ratio	
		Season		Season		Season	
		2013	2014	2013	2014	2013	2014
1	Arbuscular mycorrhiza	16.6	16.8	0.88	0.86	18.9	19.53
2	Yeast	16.9	17.1	0.86	0.85	19.7	20.12
3	Summer pruning	16.8	16.9	0.87	0.86	19.3	19.65
4	Arbuscular mycorrhiza + Yeast	17.2	17.4	0.85	0.83	20.2	20.96
5	Arbuscular mycorrhiza + Summer pruning	17.1	17.3	0.85	0.84	20.1	20.6
6	Yeast + Summer pruning	17.2	17.5	0.84	0.83	20.5	21.08
7	Arbuscular mycorrhiza + Yeast + Summer pruning	17.4	17.6	0.83	0.81	21.0	21.73
8	Control	16.4	16.7	0.89	0.87	18.4	19.2
	New LSD at 5%	0.2	0.1	0.01	0.02	0.4	0.3

The positive effect of AM and yeast inoculations on berry chemical properties (SSC %, SSC/acid ratio) and decrease acidity% in the grape juice could be attributed to the absorption and translocation of minerals to host root tissues by mycorrhizal fungi (Mona 2001). The present results are in the same trend with those mentioned by Ahmed *et al.* (2000) on "King Ruby" cv., Omran (2000) and Esmaeil *et al.* (2003) on “Roumy Red" cv., Gaser *et al.*, (2006) on "Flame Seedless" Abd El-Wahab, *et al.* (2008) and Abdel-Rahman and Tolba (2016) showed that the inoculation of *Saccharomyces cerevisiae* (20L/fed) in combination with summer pruning application significantly increased SSC percentage and SSC/acid ratio of Ruby Seedless grapevines fruit skin and decreased of acidity in the berry juice followed by application the inoculation of *Candida tropicalis* (20L/fed) maxed with summer pruning application.

7- Total carbohydrates and coefficient of wood ripening

With respect to total carbohydrates in the canes and coefficient of wood ripening data in the table (10) revealed that total carbohydrates in the canes and coefficient of wood ripening were significantly influenced by the all treatments as compared to untreated except inoculation Arbuscular (T1) gave non-significant deference in total carbohydrates in the canes and coefficient of wood ripening as compared with control (T1) during the two seasons of study.

Table 10. Influence of arbuscular mycorrhiza, yeast and summer pruning treatments on Total carbohydrates and coefficient of wood ripening of Superior Seedless grapevines during 2013 and 2014 seasons.

Treatments	Characteristics	Total carbohydrates (%)		Coefficient of wood ripening	
		Season		Season	
		2013	2014	2013	2014
1	Arbuscular mycorrhiza	24.5	28.1	0.83	0.87
2	Yeast	25.2	29.1	0.86	0.90
3	Summer pruning	24.9	28.6	0.84	0.89
4	Arbuscular mycorrhiza+ Yeast	26.5	30.3	0.89	0.93
5	Arbuscular mycorrhiza + Summer pruning	26.1	29.8	0.87	0.92
6	Yeast + Summer pruning	26.7	30.4	0.90	0.95
7	Arbuscular mycorrhiza+ Yeast + Summer pruning	27.4	31.2	0.92	0.96
8	Control	24.1	27.7	0.81	0.84
	New LSD at 5%	0.6	0.5	0.02	0.01

The data also showed that the treating Superior seedless grapevines with inoculation Yeast individually (T2) increased total carbohydrates in the canes and coefficient of wood ripening as compared with inoculation Arbuscular mycorrhiza (T1) and Summer pruning (T3) respectively, in both seasons of study.

The highest significant values of total carbohydrates in the canes (27.4 & 31.2 %) and coefficient of wood ripening (0.92 & 0.96) were obtained with vines treatment of mycorrhiza + Yeast + Summer pruning (T7) during the two seasons of study. While, vines untreating (T8) recorded the lowest values total carbohydrates in the canes (24.1 & 27.7%) and coefficient of wood ripening (0.81 & 0.84) in the two seasons of this study.

The obtained results could be interpreted in view of the effect of the inoculation with arbuscular mycorrhiza (AM) which produced enzymes that enhance the respiration of root (Edrees, 1982). AM fungi are able to absorb and translocate elements to host root tissues (Mona, 2001). Also, AM fungi improved nutrition mode possible by extensive hyphae network.

The beneficial effect of yeast on total carbohydrates in the canes could be due to that some yeast like *Saccharomyces cerevisiae* have the ability to produce and freeing diverse metabolites improving the biosynthesis and motion of total carbohydrates in canes as well as their positive effect on stimulating both cell division and cell enlargement and stimulating plant growth and their potentialities for increasing vegetation growth, yield and berry quality (Massoud *et al*. 2014).

These results are nearly similar to those achieved by (El-Sharkawy 1989) on citrus seedlings Gaser *et al.* (2006) on Flame Seedless grapevines, Derbew *et al.*

(2007) and Rizk-Alla and Tolba (2010) reported that the highest values of coefficient of wood ripening of Black Monukka grapevine, were recorded in case of vines treated with (humic acid + Nile fertile + AM fungi) amounting to 0.86 & 0.89 in both seasons, respectively.

8- Microbiological characteristics:

- AM infection (%) and Number of AM (spore/g soil):

With regard to the percentage of infection of grapevines roots with Am-mycorrhizal fungi, data shown in Table 11 revealed the superiority of arbuscular mycorrhiza as for AM infection % of roots and number of spores/g soil compared to yeast and summer pruning treatments when add individually, which recorded 55.3 & 67.3% for AM infection % and 145.48 & 262.2 spore/g soil for count of AM spore/g soil during the two seasons of study, respectively. Data also showed that the treatment arbuscular mycorrhiza + yeast + summer pruning showed the best infection percentages (78.3 & 85.7%) for AM infection % and (222.5 & 425.9 spore/g soil) for number of AM spore/g soil compared to the other treatments for both seasons, respectively. Moreover, Turk *et al.* (2006), who explained that AM-mycorrhizae settle plant roots and fundamentally inside the around the roots and improved spore number of AM - mycorrhiza which considered as beneficial agents in the soil for one year.

- Total yeast count (-x10^{5}cfu/g soil) and Total microbial count (-x105cfu/g soil):

It's obvious from table 11 that comparing the treatments of arbuscular mycorrhiza, yeast and summer pruning on total microbial count and total yeast count when added individually, the treatment of yeast alone had the superiority over the other two treatments, which recorded 16.8 & 30.3 x10^{5}cfu/g soil for total yeast count and 72.4 & 130.6 x10^5 cfu/g soil for total microbial count. The results also showed that application of arbuscular mycorrhiza and yeast (*Saccharomyces ccrvicisae*) with summer pruning treatment significantly increased the populations of rhizospheric microorganisms in the roots zone. It was recorded the highest populations of rhizospheric microorganism (111.0 & 212.5 cfu/g soil) for total microbial count compared with the other treatments in two seasons, respectively.

These results go in line with Godeas *et al.* (1999) who interpret that the increment in populations of rhizospheric microorganism in roots of most plants are effected by a mixture inoculation of AM fungi and yeasts where the soluble exudates of yeasts increased AM colonization and consequently, microbial abundance in the soil will be increased.

Abd El-Wahab *et al.* (2008) reported that inoculated Black Monukka grapevines soil with 15g yeast + AM-mycorrhizae gave the best yeast populations, which emphasize the pathogenic symbiosis of the two fungi and their beneficial role if they added individually or in combination.

Table 11. Influence of arbuscular mycorrhiza, yeast and summer pruning treatments on microbiological characteristics of Superior seedless grapevines during 2013 and 2014 seasons.

Characteristics / Treatments		AM infection (%)		Number of AM (spore/g soil)		Total yeast count (x10^{5}cfu/g soil)		Total microbial count (-x10^{5}cfu/g soil)	
		Season		Season		Season		Season	
		2013	2014	2013	2014	2013	2014	2013	2014
1	Arbuscular mycorrhiza	55.3	67.3	145.4	262.2	12.5	22.2	48.5	86.3
2	Yeast	23.0	29.2	27.0	48.0	16.8	30.3	72.4	130.6
3	Summer pruning	16.0	20.5	13.6	24.8	0.2	0.4	22.4	40.8
4	Arbuscular mycorrhiza + Yeast	71.9	81.6	191.5	360.5	23.5	44.2	91.3	171.8
5	Arbuscular mycorrhiza + Summer pruning	64.2	75.6	174.2	322.3	15.1	27.0	60.4	108.2
6	Yeast + Summer pruning	31.5	39.2	30.4	54.4	21.0	38.8	74.1	137.1
7	Arbuscular mycorrhiza + Yeast + Summer pruning	78.3	85.7	222.5	425.9	31.9	51.1	111.0	212.5
8	Control	8.9	11.6	5.4	9.6	0.1	0.2	15.1	26.7
	New LSD at 5%	5.3	3.9	27.4	31.7	19.6	8.1	11.7	19.6

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تأثير بعض المنشطات الحيوية والتقليم الصيفي علي خصوبة البراعم والنمو الخضري والمحصول وجودة ثمار العنب "السوبريور"

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أجرى هذا البحث لمدة موسمين متتاليين (2013، 2014) على كرمات عنب صنف السوبريور بهدف دراسة تأثير التقليم الصيفى وبعض المنشطات الحيوية على خصوبة البراعم والنمو الخضرى والمحصول وجودة ثمار هذا الصنف ويبلغ عمر الكرمات التى خضعت للدراسة عشر سنوات منزرعة فى تربة رملية فى مزرعة بمنطقة الخطاطبة بمحافظة المنوفية وزرعت هذه الكرمات على مسافة 2×3م وتروى بنظام الرى بالتنقيط وتم تقليمها بنظام التربية القصبية تحت نظام تدعيم التكاعيب الأسبانية. وقد تم اجراء ثمانية معاملات وهى التلقيح بفطر الميكروهيزا - والتلقيح بالخميرة - والتقليم الصيفى - والتلقيح بالميكروهيزا مع الخميرة - والتلقيح بفطر الميكروهيزا مع التقليم الصيفى - واضافة الخميرة مع التقليم الصيفى - والتلقيح بفطر الميكروهيزا مع اضافة الخميرة واجراء التلقيم الصيفى - واخيرا المقارنة. وقد اشارت نتائج الدراسة الى ان تلقيح التربة حول النبات بالميكروهيزا والخميرة مع اجراء التقليم الصيفى قد اعطت أفضل النتائج مقارنة بالكرمات الغير معاملة حيث اعطت اعلى محصول ومكوناته بالإضافة الى تحسين الصفات الطبيعية والكيميائية للحبات مع الحصول على أفضل قياسات خضريا وديناميكية نضج الخشب بالإضافة لزيادة النسبة المئوية لكل من النيتروجين والفوسفور والبوتاسيوم ومحتوى القصبات من الكربوهيدرات كما أدت إلى زيادة النسبة المئوية لفطر الميكروهيزا وعدد جراثيم الفطرى والعدد الكلى لخلايا الخميرة.