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Effect of organic and chemical fertilizers on the morphological and chemical properties of grapevines cultivation in the city of Zawiya

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***Abstract*—This study aimed to evaluate the effects of different fertilization treatments (organic, mineral, and mixed) on certain physiological and quality traits of grapevines, particularly focusing on vegetative growth and fruit components. The results showed that fertilization—especially 100% mineral fertilizer—led to significant improvements in vegetative traits such as berry number, size, and number of branches compared to the control. Furthermore, organic and mixed fertilization treatments positively influenced the increase of total soluble solids (TSS) in grape juice, indicating an enhancement in fruit quality. Significant differences were also observed in vitamin C content and total acidity between market and farm grapes, with farm grapes showing higher vitamin C content, while market grapes had higher levels of carbohydrates, TSS, and acidity.**

Phytochemical analysis revealed that ethyl acetate extract contained the highest concentrations of active compounds (flavonoids, alkaloids, phenols, and tannins), followed by methanol extract. These findings highlight the importance of selecting appropriate fertilization strategies to improve grapevine growth, productivity, and nutritional quality, emphasizing the synergistic role of nutrients in enhancing plant physiological functions.

Keywords—fertilization, mineral fertilizer, Phytochemical analysis,

Introduction

Grapes (Vitis vinifera L.) belong to the grape family (Vitaceae), which includes 14 genera, genus Vitis is the most important, and it is one of the important food plants in Libya and the world, and one of the most widespread. Grapes are grown in Libya in the warm and cold temperate subtropical regions, where its cultivation is widespread between latitudes (20, 50) north and (20, 40) south (Al-Saeedi, 2016).

The commercial grape belongs to the genus Vitis, and it is one of the 14 genera of the Vitaceae family, which is a family that includes more than 1000 species widely distributed in the tropics and temperate regions (Jules and Moore, 1996) and (Al-Saeedi, 2000).

Grapes occupy the top position among fruit trees in terms of production and cultivated area, and constitute a third of the world's fruit production according to statistics from the Food and Agriculture Organization of the United Nations, as the area cultivated with grapes in the world amounts to about 7,586,600 km2 and its production quantity estimated at about 77,518,398 tons annually, its production is concentrated in the top five countries in the world, respectively: China, followed by the United States, Italy, France, and Spain (FAO, 2018). Grape cultivation is also widespread in Libya along the coastal strip, with cultivated area estimated at approximately 8,270 hectares and production estimated at approximately 32,686 tons (FAO, 2018).

Grapes need a suitable degree of humidity, the ideal degree being between (60-70%). Increase humidity and temperature raises the risk of fungal infection which is difficult to resist, also, lack of light leads to a decrease in the fertility quality of the grapes produced and the falling of the bunches. As for strong winds, they affect the growth of the fruits and grape trees, so Casuarina trees are used as windbreaks (Chelliah et al., 2016).

Organic fertilizers are of organic origin, such as animal and plant waste, and their importance is due to the fact that they contain varying amounts of the basic elements for plant nutrition, such as nitrogen, phosphorus, and potassium, and some minor elements. In addition to containing organic materials, which when they decompose and merge with the soil in the form of humus, have many advantages, including the cohesion of sandy soil, and moisture retention, as it is considered a storehouse of nutrients and a breeding ground for beneficial microbes, which play an important role in soil fertility, thus increasing the yield of various plants (Ayad, 2018). Meanwhile, chemical fertilizers are the most common fertilizers, as they are added to the soil or sprayed directly onto the plant, which increases the plant's ability to directly absorb nutrients, thus having a rapid impact on growth and fruiting (Garcia et al., 1999).

Due to the aforementioned importance, the demand for grapes has increased, prompting producers to seek to increase its production. This has led to an increased use of fertilizers, as they are an essential element in increasing production. This is due to their significant role in meeting the essential needs of plants that are involved in all vital processes. Therefore, the main objective of fertilization is to improve the physical, chemical and biological properties of the soil in order to provide suitable conditions for vegetative growth and thus obtain the highest productivity and best quality, as fertilizers of all types affect the growth of plants. Fertilization is an important factor, as it has a clear impact on the vital processes and interactions that occur within the cellular system, and its reflection on improving plant growth and production (Al-Tayeb, 2012). (Creste and Lima1995) showed that field experiments with fertilization have a significant

impact on productivity, while the quantity and quality of production vary from one fertilizer to another, and from one region to another, depending on the type of soil. As previously explained that there are two types of field experiments, the first is a long-term experiment, with the aim of studying the effect of fertilizer on the plant and on production, in addition to other effects on the soil physical and chemical properties. the second is the short-term field experiment accompanied by fruit analysis.

Research problem

The use of chemical fertilizers in large quantities has led to the production of crops with a high level of harmful chemical compounds, for that it has become necessary to limit the use of these fertilizers and provide suitable alternatives. The concept of organic agriculture has emerged, which relies primarily on organic fertilizers as clean sources of the nutrients necessary for plants, as a result of lack of research in this field has called for further research and expansion of these fertilizers, given their great importance to agricultural production in general and fruit production in particular.

Aim of research

Study of different levels of organic fertilizers (cow and sheep manure) and chemical NPK (18-46) with an increase of 20% potassium on some vegetative traits and quality of grape fruits.

Materials and Methods

Study Site

This study was conducted on private farms in the Zawiya (Abu Sirah) region, located on the western coast of Libya. It is approximately 50 kilometers west of Tripoli. It is bordered to the west by the village of Abu Issa, to the south by the Bir Tarfas region, and to the east by the village of Al-Maya, The corner is located at latitude 32.75 degrees north of the equator and at longitude 12.72 degrees east of the Greenwich meridian. During the summer season 2018/2019, the grape plantation was planted with an area of 2 hectares. The farm was divided into two sections, each with 29 columns and 29 rows. Some 4-year-old, homogeneous trees of the Black Magic variety were selected. The trees were prepared and fertilizers were added according to the study parameters. Irrigation was done by drip irrigation using well water.

The study was on Black Magic variety, where samples were collected during the period 06/25/2018, where 3 clusters of ten bushes were collected randomly, thus the total number of clusters studied was 30. The bushes selected for the study were 4 years old, as similar as possible in terms of growth, height, and size, planted in lines at equal distances of 3*2 meters.

Fertilizers used

Chemical and organic fertilizers were used according to the parameters shown in Table.(1.3)

Table (1.3) shows the transactions included in the study.

Comparison	Transactions
100% Cow Manure	9 kg/plant in one batch in November
100% Sheep Manure	9 kg/plant in one batch in November
100% Mineral Fertilizer	600 g NPK in two batches
Sheep Manure and Mineral Fertilizer 66% 33%	6 kg/plant in one batch in November 200 g NPK
Cow Manure and Mineral Fertilizer 50% 50%	4.5 kg/plant in one batch in November 300 g NPK
Sheep Manure and Mineral Fertilizer 50% 50%	4.5 kg/plant in one batch in November 300 g NPK
Cow Manure and Mineral Fertilizer 33% 66%	3 kg/plant in one batch in November 400 g NPK
Sheep Manure and Mineral Fertilizer 33% 66%	3 kg/plant in one batch in November 400 g NPK

Traits studied

Five grapevines were randomly selected for each experimental unit.Number of branches, Number of clusters, Grain size (ml),Number of Grains

Percentage of Total Soluble Solids (TSS)

The percentage of total dissolved solids was calculated by taking several drops of fruit juice and placing them on a hand refractometer for reading. The reading was repeated three times for each sample (A.O.A.C. 1990).

Total Acids (TA%) Determination

The titration was carried out using known standard sodium hydroxide (N1) by estimating the total acids with respect to citric acid (AOAC, 2000).

Estimation of Vitamin C Concentration

It was estimated for each experimental unit, and ascorbic acid was measured by titration with 2,6-Dichlorophenol indophenols (Ammar et al., 2003) and Mazumdar et al., 2013.

Percentage of Carbohydrates in Grape Seeds

The total carbohydrate content of the fruit was estimated by taking 1 ml of the sample, adding 3 ml of concentrated

sulfuric acid solution, shaking it well, and placing the sample in a cold water bath for two minutes. It was then placed at room temperature. 0.2 ml of the sample was then taken and 5 ml of distilled water was added, The sample was placed in a spectrophotometer to read the absorbance at a wavelength of 380 nanometers (Albalasmeh et al., 2013). It was calibrated with a standard sucrose solution at different concentrations.

Oxidizing Agents

1 ml of vitamin C was mixed with 2.8 ml of potassium phosphate, 6 ml of sulfuric acid, 0.4 ml of ammonium molybdate, and 0.8 ml of distilled water. The mixture was shaken well and placed in a water bath to heat at 90°C for 2 hours. The tubes were then cooled, and 1 ml of the sample was taken. This sample was placed in a spectrophotometer to read the absorbance at a wavelength of 700 nm (Albalasmeh et al., 2013).

Preliminary Screening for Active Compounds

To initially screen for active compounds in grapes, a grape extract must be prepared as follows:

Preparation of the Grape Extract

After harvesting the grapes, cleaning them, and washing them thoroughly, they are then dried and placed in an oven for three consecutive days at 60°C. They are then ground using an electric grinder to obtain a fine powder. The powder is stored in special plastic bags in the refrigerator until ready to use. The extract is then prepared. 5 grams of grape fruit powder was weighed and placed in a beaker, 20 ml of methanol was added to it, and it was left for 24 hours at room temperature. Then, the mixture was filtered using Whatman filter paper (No. 1), and then the alcohol was evaporated from the extract using a rotary vaporator at a temperature of 35°C. Then, the material was stored at a temperature of 4°C in the refrigerator until use (Rois and Viler, 1987).

Detection of Active Compounds

Flavonoids

To detect flavonoids, 10 mL of **ethanol (50%)** was mixed with 10 mL of **sodium hydroxide solution (50%)**. An equal volume of the grape extract was then added to this mixture. The appearance of a **yellow color** indicated the presence of flavonoids (Patel et al., 2014).

Tannins

A volume of **2 mL of grape extract** was placed in a test tube and gently heated for **two minutes**. After cooling, **three drops of ferric chloride solution (1%)** were added. The formation of an **orange color** confirmed the presence of tannins (Patel et al., 2014).

Alkaloids

A **1% hydrochloric acid solution** was prepared and added to **2 mL of grape extract** in a test tube. The mixture was heated for **20 minutes** with gentle shaking, then allowed to cool and filtered through **filter paper (No. 1)**. Subsequently, **1 mL of the extract** was mixed with **two drops of Wagner's reagent**, leading to the formation of a **cream-to-brown precipitate**, indicating the presence of alkaloids (Patel et al., 2014).

Phenols

Approximately **3 mL of grape extract** was dissolved in **5 mL of distilled water**, followed by the addition of a few drops of **1% ferric chloride solution**. The development of a **dark green color** confirmed the presence of phenols (Patel et al., 2014).

Statistical Analysis

The results were statistically analyzed using **SPSS software (Version 26)**. A **one-way analysis of variance (One-way ANOVA)** was applied to determine differences between treatments at a **significance level of 0.05**.

Results

Number of Branches

The results presented in Figure (1) indicate that the number of branches varies depending on the type of fertilizer used. The significance level was (P = 0.64), indicating no statistically significant differences between the fertilizers in terms of the number of branches.

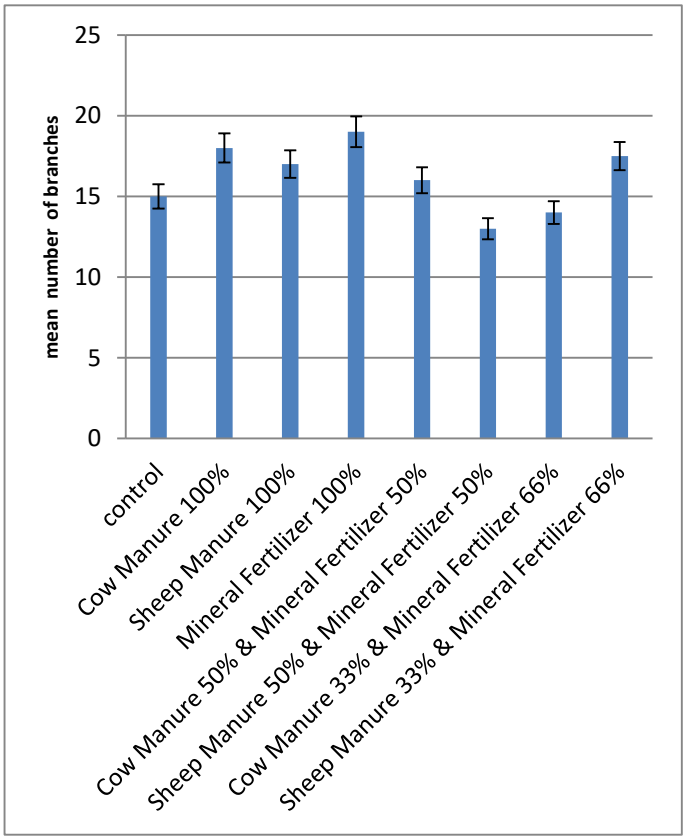


Fig (1): **Effect of treatments on the** number **of grapevine branches**

2 Number of Clusters

According to Figure (2), fertilization treatments had a non-significant effect on the number of clusters (P = 0.23).

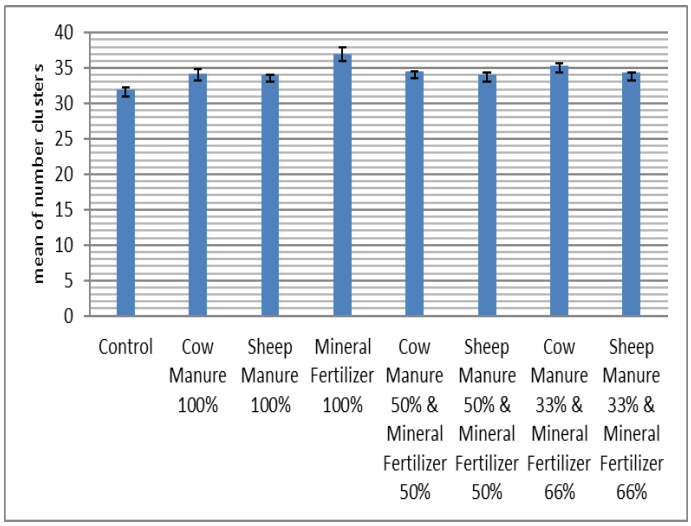


fig (2): Effect of treatments on the number of grape clusters

Number of Grapes per Cluster

Figure (3) **show** highly significant differences (*P* = 0.00) among treatments.

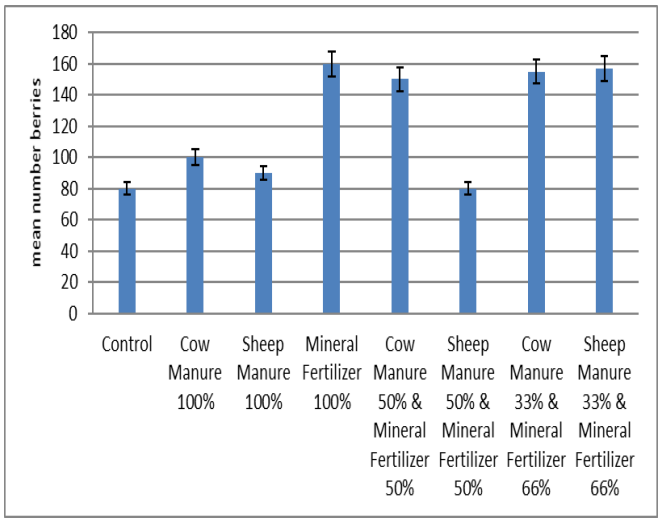
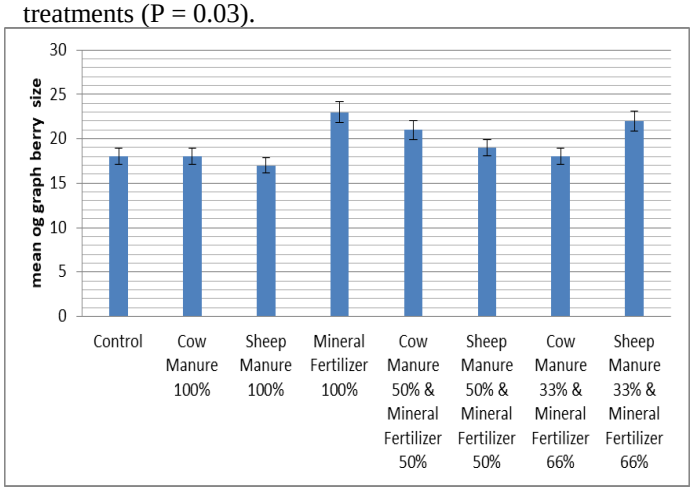


Fig (3): Effect of treatments on the number of berries per cluster

Berry Size

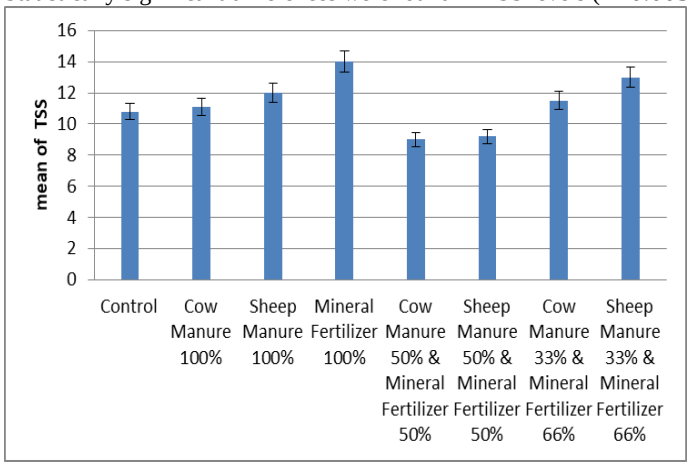
Significant differences were found in berry size between treatments (P = 0.03).



Fig(4): Effect of treatments on grape berry size

Total Soluble Solids (TSS)

Statistically significant differences were found in TSS levels (P=0.003).



Fg (5): Effect of treatments on TSS in grape juice

Vitamin C, Total Acidity, Carbohydrates & Oxidative Compounds

Vitamin C: Significantly higher in farm grapes (7.5%) than market grapes (4.86%) (P = 0.000).

Total Acidity: Higher in market grapes (37.2%) vs farm grapes (21.0%) (P = 0.01).

Carbohydrates: No significant difference (P = 0.27). Market grapes had slightly more (121.0%) than farm grapes (108.5%).

Oxidative Compounds: No significant difference. Market grapes slightly higher (50.33%) than farm grapes (40.25%).

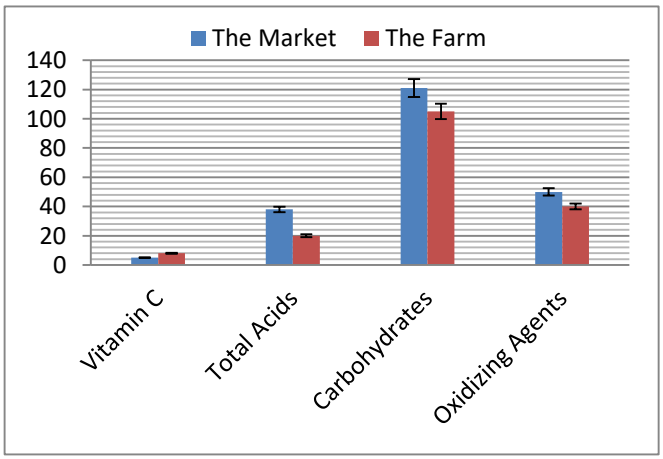


fig (6): Comparison of Vitamin C, Acidity, Carbohydrates & Oxidative compounds between farm and market grapes

Discussion

The results presented in figures (1, 2, 3,4, and 5) indicated that the different fertilization treatments had a significant effect on vegetative growth traits, specifically the number of berries, berry size, and number of branches, with statistically significant differences exceeding (0.05), except for the number of clusters. The treatment with 100% mineral fertilizer recorded the highest mean values for the number of berries, berry size, number of branches, and number of clusters, compared to the control. These findings are consistent with those reported by Qatna et al. (1989) and Jarad (2003). This effect may be attributed to the role of potassium and nitrogen in chemical fertilizers, which enhance vegetative growth (Patrick et al., 2001). Furthermore, the synergistic interaction between fertilizers likely contributed

to increased biological activity, enhancing the plant's ability to absorb nutrients, which played a key role in improving vegetative growth and increasing yield (Mahmoud et al., 2015; Merghany et al., 2019; Hataf Hammoud, 2012).

figure (5) shows that the treatments of (100% mineral fertilizer), (33% sheep manure + 66% mineral fertilizer), and (100% sheep manure) had the greatest effect on the total soluble solids (TSS) content in grape juice, with highly significant differences compared to the other treatments. This result aligns with findings by Song et al. (2004) and Ferrini et al. (1996). The increased TSS may be due to enhanced photosynthetic activity in the leaves and improved translocation of assimilates to the fruits, as a result of fertilization (Patrick et al., 2001). The sugar content in fruits increases with larger leaf area (Qatna et al., 1989), and the boron released from organic fertilizers also plays a role in sugar translocation (Devlin, 2001).

As for figure (6), the results revealed significant differences in the levels of vitamin C and total acidity, while no significant differences were recorded in oxidants and carbohydrates. Market grapes surpassed farm grapes in carbohydrate content, total soluble solids, and total acidity, except for vitamin C, which was notably higher in farm grapes. This may be explained by the effect of nitrogen released from fertilizers in the soil, which increases the vitamin C content in juice. These findings are also consistent with the vital role potassium plays in vitamin synthesis in grapes, as potassium is released from decomposed fertilizers in the soil (Gibson, 1993).

In this study showed, ethyl acetate extract had the highest content of active compounds (flavonoids, alkaloids, phenols, and tannins), followed by methanol extract compared to other extracts. This finding is in agreement with Karadeniz (2000), who reported a high phenolic content in black raisins.

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