# Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

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OPEN ACCESS Asian Journal of Plant Sciences

ISSN 1682-3974
DOI: 10.3923/ajps.2020.508.514

# Research Article
# Effect of Potassium Fertilizers Sources on the Production, Quality and Chemical Composition of Early Sweet Grapes Cv. Under Salinity Stress

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## Abstract

**Background and Objective:** Potassium plays a very important role in plant physiology and plays a significant role in plant resistance to biotic and abiotic stresses. The objective of this study was to compare the effect of using different sources of potassium fertilizers as foliar spray on the production and quality of early sweet grapes cv. under salinity stress. **Materials and Methods:** This study was carried out during two successive seasons (2019 and 2020) in a private vineyard orchard at west Samalout, Minia Governorate by choosing of 21 vines seven treatments each treatment replicated 3 replicates The chosen vines were 7 years old, grown in a sandy soil, planted 2×3 m, irrigated with drip irrigation system, all of the vines took the same fertilization treatment except the foliar application of potassium fertilizers. **Results:** Using of (K-MCT) was very effective in enhancing the vegetative growth characters like main shoot length, no of leaves per shoot, cane thickness, leaf area, total chlorophylls, the nutritional statute of leaves (N, P, K, Mg) and all of examined fruiting characters compare to control (untreated vines) and better than using of both of potassium sulphate and potassium Thio-sulphate at its two concentrates. The spraying of (K-MCT) at 500 ppm was significant to use it at 200 ppm. The using of (KTS) at 500 then at 200 ppm respectively gave results better than ($K_2SO_4$) but lower than (K-MCT) at their two concentrates. When using of two concentrates of ($K_2SO_4$) wasn't significant. **Conclusion:** Using of (K-MCT) at 500 ppm was the superior treatment in all of the parameters which has been examined like vegetative growth characteristics (pigments and nutrient contents of leaves), fruit characterizes and yield.

Key words: Salinity, potassium micro-carbon, potassium thio-sulphate, potassium sulphate, chemical composition

Citation: Fekry, W.M.E. and M.A. Aboel-Anin, 2020. Effect of potassium fertilizers sources on the production, quality and chemical composition of early sweet grapes cv. under salinity stress. Asian J. Plant Sci., 19: 508-514.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Grapes are the most important fruit crop in all over the world and the second one in Egypt after citrus. It is a popular and delicious fruit crop and its cultivation is promised because it is suitable for the local market and exporting to European markets with ideal weather conditions in Egypt with the season is off there.

Early sweet grapevine cultivar is new variety in Egypt considered a prime and outstanding grapevine cv. grown under Egypt conditions. The extension in vineyards is mostly located in the new reclaimed lands which have some problems, including soil salinity, saline water irrigation and higher calcium carbonate content.

Grapevine is considered as moderate sensitive to salinity. However, grapevine response to salinity depends on several factors such as rootstock, scion, fertilization, irrigation system, soil type and climate or combination between them. Moreover, changing some of these factors with the same irrigation water could produce entirely different results[1,2].

Application of heavy soluble fertilizers is another cause for an increase in soil solution concentrations. It was evident in the last four decades that the reclamation and improvement of new lands in Egypt is an absolute must to face the ever-increasing demands of the growing populations. The majority of the new lands in Egypt were sandy salty. Saline soils are characterized by having high amounts of soluble salts. The development of salinity in soils is due to salt accumulation. The most important cations and anions present in such soils are, $Na^+$, $Ca^{++}$, $SO_{4-}$, $Cl^-$ and $HCO_{3-}$[3]

Soil salinity may become from the accumulation of soluble salts which may be harmful to plants[4].

Potassium (K) is an essential element for plant nutrition and its ability to influence meristem growth, water status, photosynthesis and long distance transport of assimilates is well established. It is considered to play a major role in grape fertilization and Vines uptake large amounts of potassium from the soil.

Potassium is a highly mobile macronutrient that is integral to a number of physiological and biochemical processes within plants. The $K^+$ has a strong role in regulating the membrane potential of the cell and therefore is critical to the uptake of other ions and sugars and this is very important to salinity control in cells. It is necessary for plant signaling, osmoregulation, maintaining cation-anion balance, cytoplasmic pH regulation, enzyme activation and protein and starch synthesis[5-7].

Potassium plays very important role in plant physiology where Adequate K also increased phenol concentrations, which could also play a significant role in plant resistance to biotic and abiotic stresses[8].

Abiotic stresses can cause major damage to the crops as compared to yield losses from biotic stress[9] Major abiotic factors are drought stress (low moisture, aquaporin and water uptake, osmotic and stomatal regulation, detoxification of reactive oxygen species, etc.), salt stress, cold stress and waterlogging stress. The use of potassium triggers many plant activities, whereas depletion of potassium uptake can cause problem for plant growth. Potassium to a great extent contributes to the survival of the plants exposed to various abiotic stresses. It was documented[5] that abiotic stress factors such as heat, cold, drought and salinity had a huge impact on world agriculture, and they might decrease average yields by ~50 % for most major crop plants.

Increased application of $K^+$ has been shown to enhance photosynthetic rate, plant growth and yield and drought resistance in different crops under water stress conditions[10]. This cation also implicated in numerous functions related to plant water relations including growth processes, turgor maintenance and phloem transport[11, 12]. It plays very important role in programmed cell death and senescence[13,14.] This in the grape berry is variety dependent and linked to ripening disorders late in ripening[15,16].

Potassium is important in the development of fruit such as the apple[17], tomato [18], melon[19], peach[20], pepper[21] and working on increased fruit size, soluble solids and color[22]. The $K^+$ is the most abundant cation within the grape berry at all stages of its development[23-26.] In concert with sugar accumulation, it accumulates rapidly during ripening. From an applied perspective, this cation has a strong influence on juice pH and therefore is also important for berry, juice and wine acidity and color[27-29].

The objective of this study was to compare the effect of potassium in different formulas to alleviate the adverse effect of salinity on grapes early sweet cultivar.

## MATERIALS AND METHODS

**Study area:** This study was carried out during 2019 and 2020 seasons on 21 vines in vigor 7- years old Early Sweet grapevines grown in a private vineyard located at West Samalout, Samalout district, Minia Governorate, Egypt.

**Research procedure:** To compare the effect of using different sources of potassium fertilizers as foliar spray on the production and quality of early sweet grapes cv. under salinity stress. Water salinity was 1200 ppm and soil salinity was 1600

Table 1: The soil analysis

| Content | Value |
|---|---|
| Sand (%) | 87 |
| Silt (%) | 9.5 |
| Clay (%) | 3.5 |
| Texture grade | Sandy |
| pH ( 1: 2.5 extract) | 8.5 |
| EC (1: 2.5 extract) (dsm-1) | 2.5 |
| $CaCO_3$ (%) | 4 |
| Total N (%) | 2.3 |
| Available P ( Olsen, ppm) | 0.87 |
| Available K (ammonium acetate , ppm) | 1.5 |
| Available micronutrient (ppm) | - |
| Zn | 0.9 |
| Fe | 0.7 |
| Mn | 1.2 |
| Cu | 0.2 |

ppm according to soil analysis (Table 1). All selected vines were free of pathogen and physiological disorders and received same horticultural practice.

This experiment included the following seven treatments:

- Spraying tap water (control)
- Spraying potassium sulphate ($K_2SO_4$) at 200 ppm
- Spraying potassium sulphate ($K_2SO_4$) at 500 ppm
- Spraying potassium Thio-sulphate (KTS) at 200 ppm
- Spraying potassium Thio-sulphate (KTS) at 500 ppm
- Spraying potassium with micro carbon technology (K-MCT) at 200 ppm
- Spraying potassium with micro carbon technology (K-MCT) at 500 ppm

Each treatment was replicated three times, three vines per each. All of compounds ($K_2SO_4$, KTS and K-MCT) were sprayed three times at growth start (last week of February), just after berry setting (end of March) and one month later (end of April). Triton B as a wetting agent was added at 0.05%. Spraying was done till runoff. Randomized complete block design was followed.

**Vegetative criteria and chemical composition determinations:** At middle of May, during season's growth characteristics, main shoot length, number of leaves and leaf area ($cm^2$)[30] were measured in ten labeled main shoot/vine. At winter pruning, weight of one -year old wood (kg) and cane thickness (cm) were recorded. Plant pigments, chlorophyll a & b and total chlorophylls (mg/100 g F.W.) in the leaves[31] and N, P, K, Mg % (one dry weight basis) were determined at this time.

After harvest (last week of May) setting %, Yield (kg/vine), weight (g) of cluster and number of clusters/ vine were recorded. Berry longitude and width were measured in cm. TSS %, reducing sugars % and total acidity (as g tartaric acid 100 mL juice)[32] were determined.

**Statistical analysis:** Statistical analysis was performed[33]. Treatment means were compared using new L.S.D 5%.

## RESULTS AND DISCUSSION

**Vegetative growth characteristics:** It is clear from the data in Table 2 spraying of potassium with micro-carbon technology at 500 ppm was significant compare to control and other treatments where is superior in all examined parameters where the results were (main shoot length in cm (119.5 and 119.5) in both seasons compare to control (90.3 and 90.3), no of leaves (30 and 30) compare to control (11 and 12) , cane thickness (1.50 and 1.53) while (1 and 1.01) in control and leaf area was 161 and 162 $cm^2$ where control was (130.3 and 132) in both seasons that explained by role of potassium where it was at this formula act as organic fertilizer which has The beneficial effects of organic fertilization Enhancing cell division and the biosynthesis of carbohydrates could give another explanation.

This enhancement came from potassium increase the leaves content of carbohydrates and the enzymes which

Table 2: The effect of using different sources of potassium fertilizers as foliar spray on some of vegetative growth parameters of early sweet grapes cv under salinity stress

| | Main shoot length(cm) | | No. of leaves | | Cane thickness(cm) | | Leaf area ($cm^2$) | |
|---|---|---|---|---|---|---|---|---|
| Treatment | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| K MCT 500 ppm | $119.5^a$ | $119.5^a$ | $30^a$ | $30^a$ | $1.50^a$ | $1.53^a$ | $161^a$ | $162^a$ |
| K MCT 200 ppm | $117^b$ | $117^b$ | $28.3^b$ | $29.3^a$ | $1.46^b$ | $1.48^b$ | $156^b$ | $159^b$ |
| KTS 500 ppm | $109.4^c$ | $109.4^c$ | $25^c$ | $25^b$ | $1.36^c$ | $1.37^c$ | $152^c$ | $153^c$ |
| KTS 200 ppm | $105.2^d$ | $105.2^d$ | $24^c$ | $25^b$ | $1.32^d$ | $1.32^d$ | $145.3^d$ | $146^d$ |
| $K_2SO_4$ 500 ppm | $101.4^e$ | $101.4^e$ | $21^d$ | $22.6^c$ | $1.23^e$ | $1.23^e$ | $141^e$ | $144^d$ |
| $K_2SO_4$ 200 ppm | $97.1^f$ | $97.1^f$ | $18^e$ | $19^d$ | $1.17^f$ | $1.22^e$ | $135^f$ | $136^e$ |
| Control | $90.3^g$ | $90.3^g$ | $11^f$ | $12^e$ | $1^g$ | $1.01^f$ | $130.3^g$ | $132^f$ |
| New L.S.D at 5% | 0.87 | 0.67 | 1.52 | 1.57 | 0.017 | 0.021 | 2.16 | 2.29 |

KMCT : Spraying potassium with micro carbon technology, KTS : Potassium Thio-sulphate, $K_2SO_4$ : Potassium sulphate

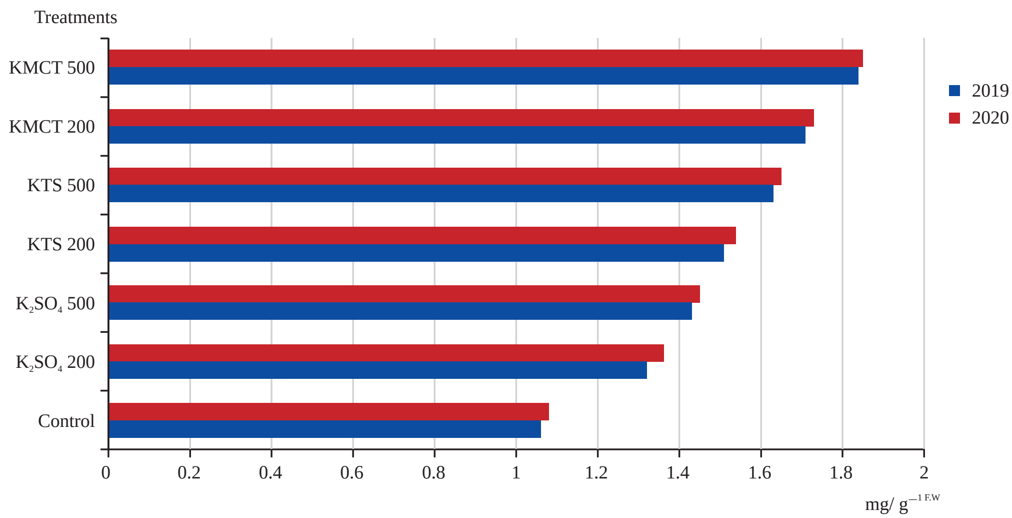


Fig. 1: The effect of using different sources of potassium fertilizers as foliar spray on chlorophyll (a) of early sweet grapes cv Under salinity stress

x-axis: Chlorophyll measurement, KMCT: Spraying potassium with micro carbon technology, KTS: Potassium thio-sulphate, $K_2SO_4$: Potassium sulphate

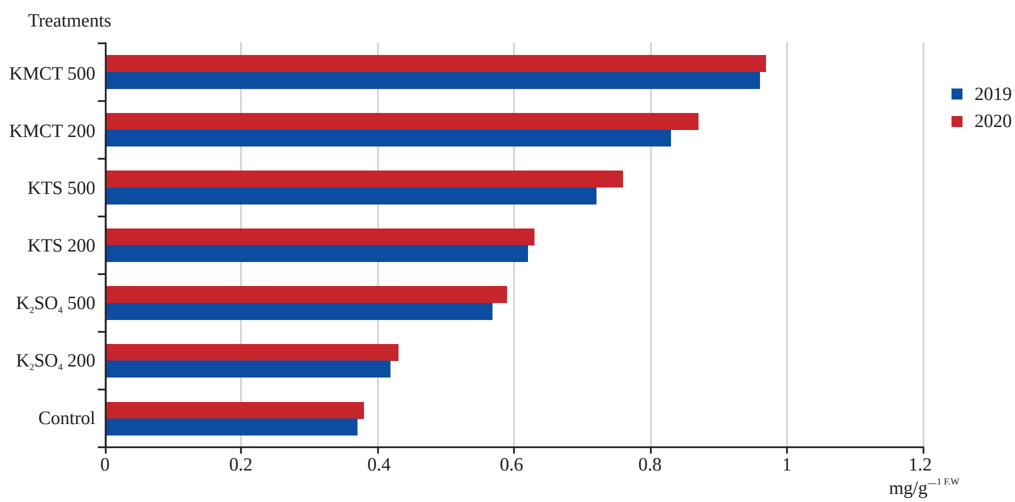


Fig. 2: The effect of using different sources of potassium fertilizers as foliar spray on chlorophyll (b) of early sweet grapes cv under salinity stress

x-axis: Chlorophyll measurement, KMCT: Spraying potassium with micro carbon technology, KTS: Potassium thio-sulphate, $K_2SO_4$ : Potassium sulphate

responsible for the conversion of carbohydrates to Ribose sugar, which is a component of RNA these results agreed with another previous study[34].

**Pigments and nutrient contents of leaves:** It is clear from Fig. 1-4, that the chlorophyll a,b and total chlorophylls also the nutrients content of leaves (N, P, K, Mg) were the highest value to (K-MCT) at 500 ppm and significant compare to control (untreated vines) and treated by (KTS) and ($K_2SO_4$) both of them at the low and high concentrate and were higher than using it at 200 ppm concentrate, this enhancement cause of potassium activity which help to increase ions transfer to leaves[7-9].

**Setting and yield:** Data in Table 3 reveal those setting percent in plants which treated by (K-MCT) at 500 ppm was very high 10.66 and 10.38% compared to 6.52 and 7.01% at untreated plants in both of seasons treatment was significant with all other treatments and higher than using of (KTS) ($K_2SO_4$) at the two concentrates and with control in weight of cluster and yield per vine where the yield was 14 and 14.1 kg per vine while 10.8 and 11.06 kg per vine. The cluster weight in vines

Table 3: The effect of using different sources of potassium fertilizers as foliar spray on setting percentage, no of clusters per vine, weight of cluster and yield per vine of early sweet grapes cv under salinity stress

| | Setting % | | No. of clusters/Vine | | Weight of cluster (g) | | Yield/Vine (kg) | |
|---|---|---|---|---|---|---|---|---|
| Treatment | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| K MCT 500 ppm | 10.66a | 10.83a | 24a | 24a | 582a | 586a | 14a | 14.1a |
| K MCT 200 ppm | 10.2b | 10.5b | 24a | 24a | 571.3b | 574a | 13.8b | 13.8ab |
| KTS 500 ppm | 9.3c | 9.8c | 23b | 24a | 553c | 559b | 12.8c | 13.4b |
| KTS 200 ppm | 9.04c | 9.43d | 23b | 23b | 544.3d | 549b | 12.5d | 12.9c |
| $K_2SO_4$ 500 ppm | 8.33d | 8.4e | 23b | 23b | 533e | 548b | 12.3e | 12.7c |
| $K_2SO_4$ 200 ppm | 7.5e | 7.8f | 23b | 23b | 525f | 526.3c | 12.1f | 12.1d |
| Control | 6.52f | 7.01g | 22.3c | 22.3c | 488.6g | 493.6d | 10.8g | 11.06e |
| New L.S.D at 5% | 0.39 | 0.26 | 0.38 | 0.38 | 7.03 | 14.61 | 0.12 | 0.38 |

KMCT : Spraying potassium with micro carbon technology, KTS : Potassium Thio-sulphate, $K_2SO_4$ : Potassium sulphate

Table 4: The effect of using different sources of potassium fertilizers as foliar spray on some physical and chemical parameters of berries of early sweet grapes cv under salinity stress

| | Berry length (mm) | | Berry width (mm) | | Total soluble solids % | | Reducing sugars % | | Total acidity % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| K MCT 500 ppm | 23.2a | 23.8a | 21.2a | 21.4a | 19.8a | 19.8a | 17.3a | 17.4a | 0.523f | 0.521f |
| K MCT 200 ppm | 22.2b | 22.4b | 19.5b | 19.9b | 19.2b | 19.3b | 17.1a | 17.3a | 0.566e | 0.580e |
| KTS 500 ppm | 21.3c | 21.7c | 18.8c | 18.5c | 18.7c | 18.8c | 16.1b | 16.4b | 0.653d | 0.646d |
| KTS 200 ppm | 20.3d | 20.9d | 17.6d | 17.3d | 18.1d | 18.3d | 15.2c | 15.5c | 0.672c | 0.671c |
| $K_2SO_4$ 500 ppm | 19.2e | 19.8e | 16.8e | 17.1e | 17.6e | 17.8e | 14.3d | 14.5d | 0.697b | 0.693b |
| $K_2SO_4$ 200 ppm | 18.3f | 18.7f | 16.3f | 16.6f | 17.1f | 17.3f | 14.2d | 14.5d | 0.710ab | 0.716a |
| Control | 17.3g | 17.6g | 15.8g | 16g | 16.3g | 16.8g | 13.9e | 13.8e | 0.729a | 0.723a |
| New L.S.D at 5 % | 0.33 | 0.26 | 0.35 | 0.22 | 0.24 | 0.13 | 0.15 | 0.25 | 0.019 | 0.01 |

KMCT: Spraying potassium with micro carbon technology, KTS: Potassium Thio-sulphate, $K_2SO_4$: Potassium sulphate

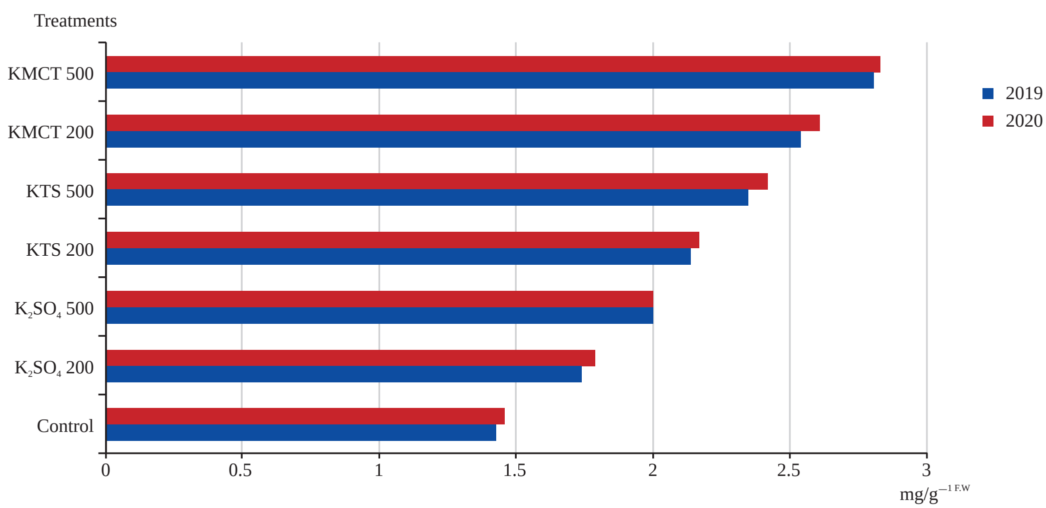


Fig. 3: The effect of using different sources of potassium fertilizers as foliar spray on total chlorophylls of early sweet grapes cv under salinity stress

x-axis: Chlorophyll measurement, KMCT: Spraying potassium with micro carbon technology, KTS: Potassium thio-sulphate, $K_2SO_4$ : Potassium sulphate

which sprayed by (K-MCT) at 500 ppm was 582 and 586 g in 2019 and 2020 respectively, while Untreated vines produced lower weight clusters 488.6 and 493.6 that means this treatment increase the cluster weight 93.4 and 92.4 g. using of (KTS) ($K_2SO_4$) at 200, 500 ppm didn't give results higher than(K-MCT). This obtained results agreed with previous studies [35,36].

**Berry quality:** As shown at Table 4 spraying of (K-MCT) at 500 ppm significantly increased berry quality in terms of berry length from (17.3 and 17.6mm) in control to (23.2 and 23.8mm) in promised treatment in both seasons, berry width alleviate from (15.8 and 16 mm) in control to (21.2 and 21.4) in superior one, T.T.S% and reducing sugars % both of them at the two seasons increased

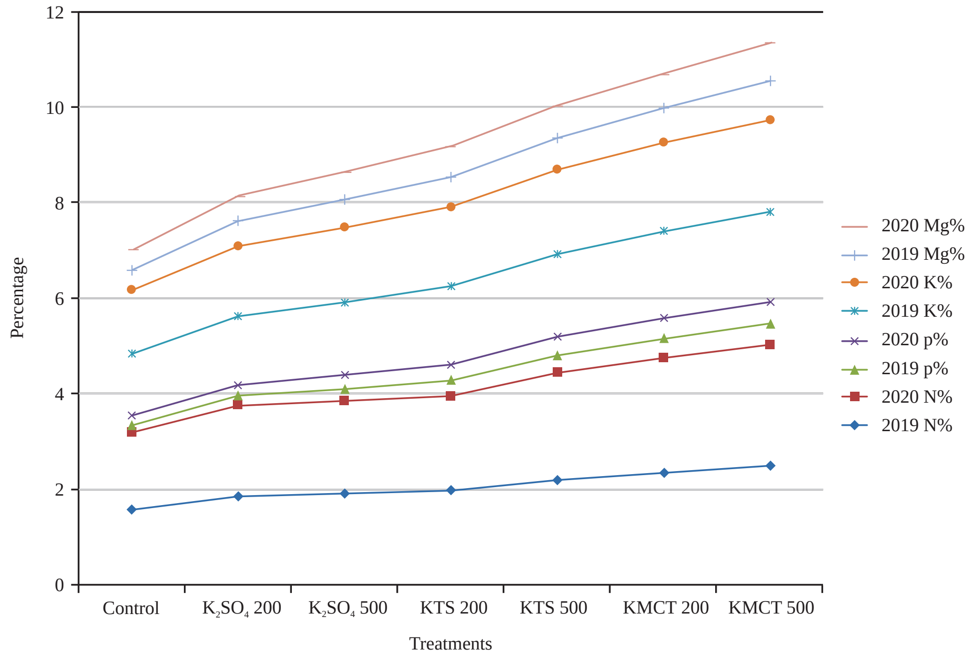


Fig. 4: The effect of using different sources of potassium fertilizers as foliar spray on leaf nutrient contents N%, P%, K% and Mg% of early sweet grapes cv Under salinity stress
KMCT : Spraying potassium with micro carbon technology, KTS : Potassium thio-sulphate, $K_2SO_4$ : Potassium sulphate

from (16.3 and 16.8) (13.9 and 13.8) to (19.8 and 19.8) (17.3 and 17.4) respectively and decreased total acidity % relative to the control from (0.729 and 0.723) to (0.523 and 0.521). Where untreated vines produced low-quality berries compare to the promised treatment which explained by potassium role in increased carbohydrates and water inside berries[34]. This enhancement in berries quality came from the pigments and nutrients increasing.

## CONCLUSION

The results conclude that the use of Using of (K-MCT) at 500 ppm was the superior treatment in all of the parameters that have been examined, which enhance the growth, yield and fruit quality. The additive should be sprayed at 500 ppm concentration three times at growth start (last week of February), just after berry setting (end of March) and one month later (end of April).

## SIGNIFICANCE STATEMENT

This study discovered the effect of using (K-MCT) at 500 ppm with the foliar application can be beneficial for alleviating adverse effects of salinity on the growth and fruiting of grapes early sweet and this study will help the researchers to uncover the critical areas of grapes early sweet cultivar grown under salinity stress that many researchers were not able to explore. Thus a new theory on alleviating salinity stresses may be arrived at.

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