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THE EFFECT OF CALCIUM ON THE GROWTH OF THE MUNG BEAN PLANT (*VIGNA RADIATA* L) GROWING IN SALINE MEDIA USING HYDROPONIC CULTURE TECHNIQUE

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Abstract

The study included conducting three types of experiments, the first was to study the effect of both sodium sulfate and calcium sulfate and their interactions on the percentage and speed of germination of mung beans and their growth represented by seedling lengths and their fresh and dry weights and at the level of Petri dishes. The second experiment included studying the effect of sodium sulfate on Plant growth, some physiological indicators and hydroponic culture technology. The third experiment included the interaction of calcium sulphate with a fixed concentration of sodium sulfate in the amount of 100 mM and with the hydroponic culture technique, in order to identify the role of calcium in improving plant growth. It was found that sodium-reduced the percentage of germination and its speed by (21.2% and 21.0%), respectively, in addition to reducing the growth of plants represented by plant heights and fresh and dry weights at (51%, 34%, 32%), respectively, While, in the third experiment, calcium showed an improvement in the percentage and speed of germination, at an average of (14% and 50%), respectively, with the improvement of plant growth and its physiological indicators in the leaf content of chlorophyll and carbohydrates and by (13% 25%), compared to sodium in The results of the second experiment, which indicates the importance of calcium in reducing the damage caused by sodium in these conditions.

Key words: calcium, Mung bean plant, *Vigna radiata* L., hydroponic culture technique.

Introduction

Agriculture plays an important and essential role in economic and social development in a large number of countries, especially developing countries, and that the decline in agricultural production is due to several biotic and abiotic factors, the most prominent of which are the abiotic factors, including the problem of salinity, as the problem of salinity is one of the widespread global problems, especially in arid and semi-arid regions, Feng *et al.,* 2002 indicated that more than 7% of the earth's crust is affected by salt, which is the most determining factor in crop production. Flagella *et al.*, 2002 also indicated that nearly half of the irrigated fields are affected by salinity, and this effect is represented in the reduction of the average and speed of germination and the emergence of seedlings above the soil surface with a clear reduction of growth indicators such as the length of the vegetative and root growth, the fresh and dry weights, etc., due to the disruption of biochemical processes such as building proteins, carbohydrates, chlorophyll pigment, etc. (Ashraf, 2004 and Patia, 2010). Many researchers have tried to understand the mechanism of salt tolerance, by conducting many studies for plants of different tolerance to salinity, to find plants more tolerant to salt in order to coexist with salinity, It has been shown that plants possess a number of mechanisms that enable them to withstand high levels of salinity (Munns and Tester, 2008). Many research has indicated the important role of calcium in diluting and improving the growth and productivity of plants growing in Salt media . Based on the foregoing, this research was conducted to include a study the effect of the sodium element in Na_2SO_4 on some phenotypic and biochemical indicators, and then identify the role of the calcium element in $CaSO_4$ in how to reduce the effects of the sodium element in those indicators of mung beans as an economically important legume crop with the help of the hydroponic culture. Due to the urgent need for healthy roots, on the one hand and on the other hand, control and accuracy in dealing with the nutrients of Hoagland solution as a growing media , fewer problems

from the soil media , to identify the mechanism of action of calcium in a high sodium media.

Materials and Methods

Nutrient solution

The Nutrient solution was prepared based on Arnon and Hoagland 1944 with a strength of 1/10 (one-tenth) because the full-strength Hoagland solution inhibits the growth of roots and table 1 shows the components of the nutrient solution with a strength of 1/5 which was diluted with non-ionic distilled water. Deionized water, with a ratio of 1: 1 to obtain the nutrient solution, with a strength of 1/10 (one-tenth). The acidity function was modified so that it was between 6.8 - 7.0.

Preparation of salt solutions used in the experiment

A. Na2SO4 sodium sulfate solution

Increasing concentrations of Na_2SO_4 sodium sulfate were prepared in the nutrient solution. After preparing the aforementioned nutrient transformer, certain weights of Na_2SO_4 were dissolved to obtain (0, 10. 20, 40, 100) mM Na_2SO_4. Then the acidity function (pH) and the electrical conductivity (EC) electrical conductivity of these solutions were measured and table 2 shows that.

B. $CaSO_4$ solution

Increased concentrations of $CaSO_4$ were prepared in the nutrient solution containing 100 mM Na_2SO_4, where the Hoagland solution was first prepared with a strength of 1/10 without calcium nitrate salt. Then, certain weights of $CaSO_4$ salt were dissolved to obtain 0, 1.5, 3.0, 6.0 mM $CaSO_4$ dissolved in the nutrient solution containing 100 mM sodium sulfate as a kind of interaction in which the calcium concentration rose in the form of calcium sulfate against a fixed concentration of sodium in the form of 100 mL Muller Sodium Sulfate and the acidic function and electrical conductivity were also measured, table 3.

Table 1: Components of the nutrient solution (Hoagland solution) with a strength of 1/10 used in the current research.

Concentration (nM)	Chemical formula	Salts of nutrients
		a . The macroelements salts
0.2	KNO_3	1. Potassium nitrate
0.4	$MgSO_4 . 7H_2O$	2. Hydrated magnesium sulfate
0.4	$NH_4H_2PO_4$	3. Dihydrogen ammonium phosphate
0.6	$Ca(NO_3)_2$	4. Calcium nitrate
Ppm		B. microelements salts
2.5	$C_6H_5FeO_7 .H_2O$	1. Iron hydrated citrate
0.004	$(NH_4)_6MoO_{24}. 4H_2O$	2. Aqueous ammonium molybdates
0.004	$CuSO_4 .5H_2O$	3. Aqueous copper sulfate
0.01	$ZnSO_4 .7H_2O$	4. Aqueous zinc sulfate
0.01	H_3BO_4	5. Boric acid
0.01	$MnSO_4$	6. Manganese sulfate

Table 2: The electrical conductivity and acidity function of sodium sulfate used in the present research.

pH	EC	Concentration Na_2SO_4 (mM)
6.9	0.5	*C
6.4	1.3	10
6.7	3.8	20
6.7	6.7	40
6.6	15.1	100

*The control treatment means the nutrient solution.

Table 3: The electrical conductivity and acidity function of calcium sulfate used in the present research.

EC	Ph	Concentration Ca_2SO_4 (mM)
6.5	15.1	*C
6.4	15.0	0.5
6.5	15.3	1.5
6.4	15.3	3.0
6.5	15.4	6.0

*Control treatment means the nutrient solution containing 100m MNa_2SO_4.

Results and Discussion

Experiments conducted

A. The Petri dishes experiment

A number of preliminary experiments were conducted using Petri dishes that dealt with the study of seed viability by measuring the percentage and speed of germination at ten days old, followed by studying the effect of treatments for the purpose of identifying the sodium concentration affecting and primarily on the growth of the seedlings of the Mung bean by adopting some phenotypic traits (length of the vegetative and root groups and their dry and fresh weight) and the growth conditions inside the growth chamber are commensurate with the type of plant and the nature of the experiment, where the temperature was 2 : 20 and the relative humidity ranged between 70-85%.

B. Hydroponic culture

Plastic containers (pots) with no bottom holes, a capacity of 2 liters and a diameter of 20 cm, have been used. They have been provided with synthetic cork covers that have been tightly configured commensurate with the diameter of the container mouth and have four pits made.

As two pads were placed in each pit in the

cork cover after wrapping the area between the roots and the stem with a little sterile medical cotton to support the seedlings with a small pit to pass an air tube for the purpose of ventilating the roots and placed on a wooden table inside the greenhouse and distributed randomly so each container represents an experimental unit.

The experiment conducted according to Completely Randomized Design (C.R.D)by three replicates and five treatments. The results of the experiment were analyzed statistically to find the least significant difference L.S.D at a probability of 0.05 and each experimental unit contained 8 seedling and the volume of the nutrient solution was adjusted with distilled water whenever needed and replaced once a week.

Studies traits

The percentage and speed of germination

The percentage and speed of germination were calculated seven days after cultivation.

Plant growth

After one month of cultivation, the effect of treatments on plant growth was studied through the following treatments:

A. Lengths of the vegetative and root growth:

After a month of cultivated the plants, the lengths of the vegetative and root growth were measured using a ruler included for each plant within the same level. The average length of each repetition was calculated by dividing the average of the lengths by the number of plants.

B. Weights of the vegetative and root growth (fresh and dry).

The fresh weight of the vegetative and root growth of each plant was calculated within the same level using a Bosch/S2000 type sensor scale.

As for the dry weight, it was calculated after drying the vegetative and root growth in a heated oven of the type (Heraeus) at a temperature of 70°C. for 48 hours or until the weight was stable.

Physiological measurements

A. Plant content of chlorophyll pigment (chlorophyll)

The content of fresh leaves of chlorophyll was determined using a chlorophyll meter type SPAD-502 and a SPAD unit.

B. The plant's carbohydrate content

The study plants' content of soluble carbohydrates was estimated based on Herbert *et al.,* 1971 and as shown in the following:

To determine the standard glucose curve, dissolve 100 mg of glucose sugar in 1 liter of distilled water where a base solution for glucose sugar and from which five specific concentrations were prepared, 1 ml of each concentration was taken and 1 ml of 5% phenol reagent was added to it and mixed well and then 5 ml of acid were added Concentrated sulfuric and mixed well as well, Then the tubes were incubated in a water bath at a temperature of 25-300°C to reduce the reaction temperature while ensuring homogeneity for a period of 20 minutes. After that, the absorbance of the color resulting from these reactions was measured using a Spectrophotometer of Optima at the wavelength of 488 nm.

Results and Discussion

The first experiment (Petri dishes):

Study the effect of Na_2SO_4 Sodium Sulfate Salt

A. The percentage and speed of germination

Table 4 showed that the two concentrations 20 and 40 ml Na_2SO_4 caused an insignificant decrease in the percentage of germination compared to the control, but at a concentration of 100 ml of Na_2SO_4, it led to a significant reduction in the percentage of germination at a probability 0.05 compared to the control and by 21.2% As the percentage of germination reached 78% and with regard to the germination speed, it is also noted from the same table that levels 40 and 100 ml Na_2SO_4 significantly reduced the germination speed by 2.1% and 21.0%, respectively, which indicates the extent of the effect of sodium salts in that experiment on the percentage and the speed of germination on the one hand and the extent of the susceptibility of the Mung bean plant to salinity in those conditions.

B. Seedling growth

Table 5 indicates that the two concentrations 20 and 40 mM Na_2SO_4 caused an insignificant decrease in the

Table 4: The effect of Na_2SO_4 concentrations on percentage and germination speed of mung beans.

germination speedseed/day	The percentage of germination (%)	Concentration Na_2SO_4(mM)
3.33	99	C
3.30	90	20
3.23	88	40
2.60	78	100
0.07	12.21	L.S.D 5%

Table 5: Effect of Na_2SO_4 on mean length of vegetative and root growth of mung beans seedlings.

root system (cm)	vegetative growth (cm)	Concentration Na_2SO_4 (mM)
7.1	8.4	0
6.2	7.9	20
5.0	6.6	40
4.7	4.1	100
2.30	3.00	L.S.D 5%

lengths of the vegetative and root growth compared to the control. While the concentration of 100 mM Na_2SO_4 caused a significant decrease in this traits compared to the control, by 51.2% and 33.8% for each of the vegetative and root growth, respectively, indicating the effect of sodium on the growth of Mung bean seedlings, as a result of increased sodium concentrations in the growth media.

As for the dry and fresh weights, it is noticed from table 6 that the concentration of 100 mM Na_2SO_4 led to a significant decrease in the mean dry and fresh weights of the vegetative total, with a percentage decrease of 34.3% and 32%, respectively.

The decrease in the percentage of germination and the growth average of plants with the increase in the concentration of sodium sulfate in the growth media can be due to the following reasons

1- Reducing the average of water uptake by the roots as a result of increasing the osmotic pressure of the growth media , and consequently the metabolic processes of the embryo and the seedling are disturbed (Abdelbasset *et al.,* 2010).

2- Toxic effect of salinity-causing ions, as an increase in the sodium concentration in the seeds or seedlings, affects the vital actions of the embryo and seedlings, such as inhibition of the enzyme amylase and invertase, which are necessary for converting starch into soluble sugars (Al-Saady *et al.,* 2013).

Inhibition of protein synthesis (Gloria and Lilia, 2010), RNA and DNA synthesis (Udovenko, *et al.,* 1971; Nieman, 1965) and mitosis (Gaidamakina, 1967). And that the general decline could come from the impact of many physiological processes of seedlings with high concentrations of sodium sulfate salt, such as photosynthesis, protein building, respiration, and others.

Table 6: The effect of Na_2SO_4 on the average fresh and dry weights of the Mung bean.

dry weight (g)	fresh weight (g)	Concentration Na_2SO_4 (mM)
0.025	0.064	0
0.022	0.061	20
0.021	0.058	40
0.017	0.042	100
0.005	0.008	L.S.D 5%

Study the effect of calcium sulfate

A. The percentage and speed of germination

Many studies have indicated the important role of calcium in mitigating the effect of sodium in the growth of plants, and with regard to the effect of that interaction on the percentage of germination and germination speed of mung beans, table 7 shows that the high concentration of calcium sulfate with a constant concentration of sodium sulfate (100mM) led to An increase in the germination percentage at concentrations (1.5, 3.0 and 6.0) and by a percentage (6%, 13% and 14%) and germination speed (11%, 30% and 50%), respectively, compared to the control, indicating to the importance of calcium in these conditions.

Table 7: The effect of Na_2SO_4 and CaSO4 interaction on The percentage and speed of germination of mung bean.

germination speed seed/day	The percentage of germination (%)	Concentration Na_2SO_4 (mM)
2.6	78	0
2.9	83	1.5
3.4	88	3.0
3.9	89	6.0
0.23	4.21	L.S.D 5%

Table 8 shows the effect of the interaction between calcium sulfate and sodium sulfate on the average length of the vegetative and the root growth of mung beans seedlings It is noticed that the increase in the concentration of calcium sulfate in the growth media led to an increase in the average length of the vegetative and root growth at concentrations (1.5, 3.0 and 6.0) ml of calcium sulfate and a percentage increase was (26%, 36% and 50%) and (72%, 82% and 124%) for each of the vegetative and root growth, respectively, in comparison with the control, indicating the importance of escalated calcium in plant growth.

Table 8: The effect of interaction between Na2SO4 with $CaSO_4$ on The lengths of vegetative and root growth of Mung bean plant.

root system (cm)	vegetative growth (cm)	Concentration Na_2SO_4 (mM)
2.01	3.0	0
3.46	3.8	1.5
3.66	4.1	3.0
4.50	4.5	6.0
1.11	0.788	L.S.D 5%

With regard to the effect of that the interaction on the average dry and fresh weight of the seedlings of the mushroom plant, it is noticed from table 9, that there were significant increases in the rate of dry and fresh weights of the vegetative total of Mung bean plant, starting from the concentration of 1.5 mM calcium sulfate with percentages reaching (40% and 104%). %, 140%), (100%, 133% and 233%) for each of the fresh weight and the dry weight, respectively. Thus, the importance of calcium in the significant increases in plant growth, represented by the fresh and dry weights, is evident with the control treatment. The reason for this is due to the role that calcium ions play in protecting plants from the harmful effects of sodium by their effect on cell membranes affected by sodium ions (Munns and Tester, 2008, Epstein, 1972). Sodium ions weaken the structure of cellular membranes and increase their permeability. As a result, the ion content of plants is disturbed and the various physiological processes are disturbed, and this is reflected in the reduction of the plant growth average (AL-Rahmani *et al.,* 1988). As for calcium ions, they return the cell membranes to their normal state and reduce their permeability through the displacement of sodium ions from the surfaces of cells and as a result, the ion content and physiological processes of plants are regulated and this is reflected in improving the rate of plant growth (Mansor, 2013).

Table 9: The effect of interaction between Na_2SO_4 with CaSO4 on both fresh and dry weights of Mung bean plant.

dry weight (g)	fresh weight (g)	Concentration Na_2SO_4 (mM)
0.009	0.083	0
0.018	0.116	1.5
0.021	0.170	3.0
0.030	0.200	6.0
0.007	0.231	L.S.D 5%

The second experiment (Hydroponics culture experiments)

Plants growth at one month age

A. The lengths of the vegetative and root growth

Table 10 showed that the increase in sodium levels in the growth media led to a decrease in the average length of the vegetative and root growth of the Mung bean . The decrease was significant compared with the control treatment with respect to the concentration of 100 mmMol $4Na_2SO$ and the decrease was 37% and 48% for the vegetative and root growth, respectively, This indicates the clear effect of sodium in reducing the growth of these plants in the Hydroponics represented by these indicators.

Table 10: The effect of Na_2SO_4 on average The lengths of the vegetative and root growth of Mung bean plants at one month of age and growing in the hydroponic culture.

root system (cm)	vegetative growth (cm)	Concentration Na_2SO_4 (mM)
20.0	20.4	C
19.1	16.1	20
15.1	14.5	40
10.3	12.8	100
7.1	6.3	L.S.D 0.05

B. Fresh and dry weight (vegetative and root growth).

Table 11 shows a decrease in the fresh and dry weights of both the vegetative and root growth, with a significant increase in sodium concentrations compared to the control treatment, and that at a concentration of 100 mM Na_2SO_4 and the decreases were (82%, 85%) for the vegetative total, fresh and dry respectively and (71% and 83%) of the root system were fresh and dry, respectively, indicating that the sodium also caused a reduction in the growth of Mung bean with these indicators in the hydroponic culture.

Table 11: The effect of Na_2SO_4 on average the fresh and dry weights of the vegetative and root growth of Mung bean plants at one month of age and growing in the hydroponic culture.

root growth (g)		Vegetative growth(g)		Concentration Na_2SO_4 (mM)
fresh weight	dry weight	fresh weight	dry weight	
0.06	0.7	0.07	1.7	C
0.06	0.7	0.06	1.2	20
0.03	0.5	0.05	0.9	40
0.01	0.2	0.01	0.3	100
0.04	0.3	0.04	1.0	LSD 0.05

The reasons for the reduced growth of Mung bean plants, expressed in fresh and dry weights, can be due to the decrease in the structure of carbohydrates, proteins, and amino acids (Tzortzakis, 2010 and Siddique *et al.,* 2000), the relative water content and imbalance of the microstructure of the plant cell, such as damage to the plasma membrane and the low content of plants from the ratio of K/Na, which leads to the disruption of many important metabolic pathways in plant growth where a result of the influence of many physiological phenomena such as photosynthesis and respiration due to high levels of salinity. Hasegawa, 2000 and Al-Rahmani *et al.,* 1997; 2001a; AL- Epstein. 1972).

Physiological (functional) indicators

A. Leaf content of chlorophyll pigment

Table 12 indicates that the high sodium concentrations caused a significant decrease in the chlorophyll content of the leaves of Mung bean plants necessary for photosynthesis. The decrease was significant and at concentrations (40 and 100) mM Na_2SO_4 compared to the control treatment with percentages of (30% and 41%), respectively.

Table 12: The effect of Na_2SO_4 on the leaves content of Chlorophyll (SPAD) in Mung bean plants at a month age growing in the hydroponic culture.

Chlorophyll (SPAD)	Concentration Na_2SO_4 (mM)
39.1	C
30.0	20
27.4	40
23.0	100
10.2	0.05 LSD

B. Carbohydrate content

Table 13 indicates that the level of sodium 100 mM Na_2SO_4 led to a significant increase in the content of the vegetative and root growth of plants compared to the control treatment in relation to the level and with percentages of 50% and 81% for the vegetative and root growth, respectively.

Table 13: The effect of Na_2SO_4 on the plant content of carbohydrate (mg/g fresh weight) at the age of one month and growing in the hydroponic culture.

root system (g)	vegetative growth (g)	Concentration Na_2SO_4 (mM)
4.4	7.7	C
4.6	8.1	20
5.7	8.6	40
8.0	11.6	100
2.10	1.92	L.S.D 0.05

Dhingra and Varghese 1985 indicated that a higher level of salinity in the growing media leads to an increase in the content of plants of dissolved carbohydrates with a decrease in their content of starch. This is due to the fact that the high salinity disrupts the metabolic processes, which led to an increase in the concentration of carbohydrates in plants. As the high salinity impedes the conversion of simple sugars (glucose and fructose) into complex sugars (starch) and as a result, the concentration of starch will decrease at the expense of the high concentration of simple soluble sugars in plants (this is what happened to the Mung bean in question) in the media of growth, especially when concentrated. 100 mM Na_2SO_4 In addition, Delune *et al.,* 1982 and Munn, 1982 indicated that a higher salinity of the growth media leads to a higher concentration of dissolved carbohydrates in plants.

The third experiment (Hydroponic culture experiments)

Studies have indicated that the role of calcium in increasing plant tolerance to salinity may be due to its importance in regulating cellular membrane integrity and in regulating the selectivity of ions across the plasma membrane, especially sodium and potassium ions (Al-Rahmani *et al.,* 2001), The addition of calcium in the form of calcium sulfate $CaSO_4$ in rising concentrations in the middle of the saline growth of the hydroponic culture .They increased the growth of plants (Lahye and Epstein, 1971). Based on this, the third experiment was conducted (the experiment of overlapping escalating concentration of calcium sulfate with a constant concentration of sodium sulfate 100 mM Na_2SO_4).

This was to study the effect of calcium in reducing the effect of sodium by measuring the phenotypic and functional indicators, the results were as follows:

Plant growth

A. The lengths of the vegetative and root growth

Table 14 showed that the high levels of calcium sulfate in the constant salinity growth media (100 mM Na_2SO_4) led to an increase in plant lengths and the increases were significant and with a probability of 0.05 compared to the control treatment with respect to the two levels (3.0 and 6.0 mM $CaSO_4$), with a ratio ranging between (43 and 69)%, respectively with regard to the vegetative total and by a ratio between (40 and 52)%, respectively for the root group, which indicates the importance of calcium in limiting the effect of sodium in the growth of those plants in these conditions, represented by these indicators.

B. Dry and fresh weights (vegetative and

Table 14: The effect of CaSO4 interaction with a constant concentration of Na_2SO_4 on the length of the vegetative and root growth of Mung bean plants at the age of one month and growing in the hydroponic culture.

root system (g)	vegetative growth (g)	Concentration Na_2SO_4 (mM)
20.0	20.4	C
24.0	23.1	1.5
28.1	29.3	3.0
30.4	34.5	6.0
4.71	6.88	L.S.D 0.05

root growth)

Table 15 showed that the high levels of calcium sulfate in the constant salinity growth media (100 mM Na_2SO_4), led to an increase in the average fresh and dry weights of the plants and the increases were significant compared to the control treatment in relation to the two concentrations (3.0 and 6.0 mM $CaSO_4$). Its maximum limit is (109 and 200)%, For the fresh and dry weights, respectively, of the vegetative growth, and by (308 and 200)% for the fresh and dry weights, respectively, of the root system, which confirms the importance of calcium in increasing the plant's growth represented by these indicators in the media affected by salinity in those conditions.

Table 15: The effect of $CaSO_4$ interaction with a constant concentration of Na_2SO_4 on the length of the vegetative and root growth of Mung bean plants at the age of one month.

root growth (g)		Vegetative growth(g)		Concentration Na_2SO_4 (mM)
fresh weight	dry weight	fresh weight	dry weight	
0.06	0.7	0.07	1.7	C
0.09	1.51	0.09	2.38	1.5
0.10	1.98	0.18	2.98	3.0
0.18	2.86	0.21	3.56	6.0
0.032	1.17	0.097	1.11	LSD 0.05

Physiological (functional) indicators

A. Chlorophyll content

Table 16 showed that the high levels of calcium sulfate in a high-sodium growth media (100 mM Na_2SO_4) led to a significant increase at the concentration of 6.0 mM $CaSO_4$, the chlorophyll pigment in plant leaves compared to the control treatment, and the increase reached 13%, which confirms the importance of Calcium in improving the chlorophyll in the leaves of plants, in general, by those conditions in the media affected by salt. The reasons for this improvement in the chlorophyll content of plants can be explained to an improvement in the state of plant growth due to the effect of calcium, which is indicated in the growth indicators represented by the fresh and dry weights and lengths according to the results shown in table 14 and 15, respectively.

Table 16: The effect of CaSO4 interaction with a constant concentration of Na_2SO4 in the chlorophyll SPAD at a month age for Mung bean plants growing in hydroponic culture.

Chlorophyll (SPAD)	Concentration Ca_2SO_4 (mM)
39.1	C
1.5	40.7
3.0	42.1
6.0	44.1
4.0	0.05 LSD

B. Plants content of carbohydrate

Table 17 shows that the high levels of calcium sulfate in a high-sodium growth media (100mM Na_2SO_4) led to insignificant increases in the plant carbohydrate content compared with the control treatment at concentrations 1.5 and 3.0 mM $CaSO_4$, while the increase was significant at concentration 6. 0 mM $CaSO_4$ reached (9.6 and 7.6) mg/g soft weight for each of the vegetative and root growth, respectively. As an approach to the plants content of carbohydrate was from the effect of sodium, the content of plants with the effect of 100mM Na_2SO_4 was equal to 11.6 and 8.0 for the vegetative and root growths, respectively, compared to the control treatment, which reached 7.7 and 4.4 for the vegetative and root growths, respectively. When calcium sulfate was used increasingly and interaction with sodium sulfate, the carbohydrate content of plants began to gradually increase with the increase in the content of the growing media of calcium sulfate until it approached its levels at a concentration of 6.0 mM $CaSO_4$, reaching (9.6 and 7.6) mg/g fresh weight, a ratio Increase (25% and 73%) for both vegetative and root growth, respectively. This may be due to the important role of calcium in reducing the negative effects of sodium in media affected by salinity. Studies have indicated the effective role of calcium in increasing plants' susceptibility to salt stress (Lahaye and Epstein, 1971). The importance of calcium in increasing plant tolerance to salinity is due to its role in maintaining membrane integrity and regulating the selective permeability of cellular membranes, particularly the plasma membrane (Wright *et al.,* 1994). With the increase of the important K/Na ratio in the content of plants, so the decrease in the concentration of the calcium element in the growth media will lead to higher absorption in favour of sodium, which leads to the occurrence of cell metabolism disturbance, so the plants in such a circumstance to accumulate carbohydrates as osmotic regulators to avoid the action

Table 17: The effect of $CaSO_4$ interaction with a constant concentration of Na_2SO_4 on the carbohydrate content (mg / g lean weight) of Mung bean plants at one month age.

root system (g)	vegetative growth (g)	Concentration Na_2SO_4 (mM)
4.4	7.7	C
6.0	8.0	1.5
6.5	8.7	3.0
7.6	9.6	6.0
2.71	1.81	L.S.D 0.05

of sodium in Increased osmosis followed by disturbance of plant growth (Hall, 1977).

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