

Effect of Some Modified Hochland Solutions and NaCl on the Growth of Phaseolus Aureus L

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Annotation: The effect of complete and modified Hochland solutions (nitrogen deficient solution, phosphorus deficient solution, iron deficient solution, micronutrient deficient solution) in addition to sodium chloride solution at a concentration of 200 mmol/L on the growth of mung bean plant for 30 days in the advanced plant laboratory was studied. After the experiment was completed, mung bean plant was harvested and the plant physiological indicators were estimated, represented by plant height, fresh and dry weights, and chlorophyll a and b content and total. We note that the plants grown in the Hochland solution deficient in nitrogen as well as the sodium chloride solution recorded the highest plant height and fresh and dry weights in the plants treated with complete Hochland solution compared to the control (distilled water) and tap water, while the rest of the treatments recorded the lowest rate of physiological indicators when treated with sodium chloride solution, and the other treatments had an effect between them.

Introduction:

Mung bean is a legume grain crop that tolerates drought and heat and has a short growing season. It is a summer crop that needs a moderately hot climate and tolerates all temperatures except the flowering period. It is suitable for mixed soil and is not good for cultivation in saline and flooded lands. Mung bean is considered a legume crop that is beneficial to the soil as it fixes nitrogen from the air in the soil through bacterial nodules formed on the roots of the plant. Mung bean is planted on two dates: the first is in mid-March until early April. The second date is in early June until late August.

Soil salinity indicates the presence of excessive salts in the soil, which can negatively affect plant growth and productivity. This occurs when the salt concentration in the soil exceeds the tolerance level of plants. Water salinity refers to the concentration of dissolved salts in the water. The effects of salt on plants vary depending on the type of crop being grown, the amount of salt, and the type of salts in the soil. The presence of salts in the shallow layers of the soil will have a greater negative effect than those in the lower layers, due to their proximity to the roots of the plants. Salt tolerance varies greatly from one crop to another.

Mung bean *Phaseolus aureus* L.:

Mung bean is a legume crop that tolerates drought and heat and has a short growing season (90-120) day. Mung bean is usually grown for its seeds, which have a high nutritional value for humans. It is also used as green fodder in animal feed. The seedlings have a high protein content of 21-28%, calcium, phosphorus, and essential vitamins. Mung bean seeds that are not suitable for use are used in livestock feed, as every 1.5 tons of them are equivalent to one ton of soybean meal. It is from the legume family that fixes nitrogen in the soil through root nodules, in addition to being used as a green fertilizer, thus improving the physical and chemical properties of the soil.

Mung bean is considered one of the legume crops that are beneficial to the soil, as it fixes nitrogen from the air in the soil through bacterial nodules formed on the roots of the plant. To encourage seedlings to grow, it is recommended to add 50 kg/acre of ammonium sulphate fertilizer with a concentration of 21% nitrogen or 22 kg/acre of urea fertilizer with a concentration of 46% nitrogen with 32 kg/acre of triple superphosphate fertilizer with 46% phosphorus pentoxide. These fertilizers are added in one batch after plowing and before smoothing in the case of hand planting or with seeds when using fertilized seed in planting. Harvesting begins when the pods dry and their color changes from green to dark brown tending to black. This occurs at the end of June or the first half of July in the case of spring planting and during October for autumn planting. It is preferable to begin harvesting when the dryness of the pods in the field reaches 70% to avoid the seeds falling apart when completely dry. Harvesting is done either by hand or by mowing the crop using mechanical mowing machines (mowers). The crop is left in the field in piles until it dries completely, then it is threshed with a combine or trampled by animals (threshed) or by pounding the crop with sticks for small areas or when threshing is not available. After threshing, the crop is cleaned by winnowing and sieves and packed in bags. The average production per acre is about (250-200) kg.

Effects of salinity on plants:

- ✓ Saline soil reduces the plant's ability to absorb water.
- ✓ Symptoms of osmotic stress appear, which are very similar to those of drought stress.
- ✓ Growth cessation.
- ✓ Poor germination.
- ✓ Leaf burn and wilting.
- ✓ Excess salinity affects the availability and absorption of nutrients in the plant.
- ✓ Causes toxicity problems from sodium and chlorine.

Hochland nutrient solution:

The availability of major and minor nutrients is very important for plant growth in terms of their participation or entry into some vital activities within the plant, and the deficiency of any of them leads to a major defect in growth, which is reflected in the yield and the available ones in the soil do not provide the minimum for plant growth naturally. These nutrients in some soils are exposed to many factors that limit their movement and readiness for the plant to benefit from them, and sometimes the plant does not respond in such soils to added fertilizers, and the reason may be attributed to their low readiness in the soil (Abdul, 1988).

The plant needs nutrients in the environment in which it grows in order to be able to build tissues and complete its life cycle (from seed to seed) naturally.

These nutrients are called essential nutrients, and not every element inside the plant is a nutrient, but rather the nutrient is the element that enters into the vital process and its deficiency affects the growth of the plant. It has been found that the number of elements inside the plant has exceeded 60 elements, but in fact the nutrients do not exceed 20 elements. 16 of them are called essential nutrients, which are: C, H, O, N, P, K, S, Ca, Mg, Fe, Zn, Cu, B, Mn, Mo, Cl. The plant obtains the first three from water and air, and the rest of the elements are obtained from the soil through the roots. The rest of the elements are obtained from the soil or added to the plant in the form of fertilizers or a nutrient solution.

The importance of the major and minor nutrients in the growth, pollination, fertilization and seed setting process in the clover crop when added directly to the soil or sprayed on the plant is not hidden. Therefore, using fertilizers at the right time and in ideal quantities contributes greatly to increasing production when the weather conditions are suitable for growth (Joly, 1993). The scientist Hoagland and Arnon (1940) developed a nutrient solution named after him that contains all the major and minor nutrients that the plant needs for growth and crop production.

Materials and Methods

Source of mung bean seeds:

Mung bean seeds were obtained from local markets.



Figure (1): Phaseolus aureus L.

Materials and tools:

- ✓ Modified Hochland solutions
- ✓ Sodium chloride salt NaCl
- ✓ Distilled water
- ✓ Plastic dishes for cultivation
- ✓ Plastic spoons

- ✓ Sawdust
- ✓ Hochland seeds

Preparation of Hochland solution:

The Hochland solution was prepared according to the following table:

cm ³ per liter of nutrient solution	Nutrient solution M	salt (compound)
1	KH ₂ PO ₄	Potassium dihydrogen phosphate
5	KNO ₃	Potassium nitrate
5	Ca (NO ₃) ₂	Calcium nitrate
2	MgSO ₄	Magnesium sulfate

Composition of solutions containing micronutrients

Number of grams dissolved in one liter of distilled water	Nutrient solution	compound
2.86	H ₃ BO ₃	Boric acid
1.81	MnCl ₂ .4H ₂ O	manganese chloride
0.22	ZnSO ₄ .7H ₂ O	Zinc sulphate
0.08	CuSO ₄ .5H ₂ O	Copper sulphate
0.01	H ₂ MoO ₄ .H ₂ O	Molybdic acid

In addition to chelated iron.

Preparation of sodium chloride solution with a concentration of 200 mg/L:

Sodium chloride solution with a concentration of 200 mg/L was prepared by taking 200 mg (0.2 g) of sodium chloride and dissolving it and completing the volume to 1 liter with distilled water.

Method of work:

The seeds to be used were soaked for a whole night before planting, the seeds were distributed in plastic dishes containing sterilized sawdust with boiling water, then tap water was added for the purpose of germinating the mung beans, and after the seeds germinated within 10 days. The plants were treated with the prepared solutions for one month at a rate of adding every 15 days and between adding the solutions the plants were watered with tap water to prevent the plants from drying out.

Plant height (cm):

The plant height was measured at the end of the season starting from the site of the plant's contact with the soil surface to the growing tip for three plants for each concentration and variety and according to the rate.

Protein content assay:

Proteins were estimated according to the method of (Bishop et al., 1985), where the protein reacts with the copper ion from copper sulfate CuSO₄ in the biuret solution to give a violet color that absorbs light with a wavelength of 555 nm, which is the color resulting from the formation of a complex compound between the copper atom and the peptide bond.

Preparation of solutions used

1-Biuret solution:

Prepared by dissolving (3 g) of copper sulfate CuSO_4 in (500 ml) of distilled water. Add (9 g) of potassium sodium tartrate, and 5 g of potassium iodide KI. After completely and well dissolving them, add (100 ml) of sodium hydroxide NaOH at a concentration of (1M). Dilute the mixture to one liter with distilled water. Store in a dark bottle at room temperature.

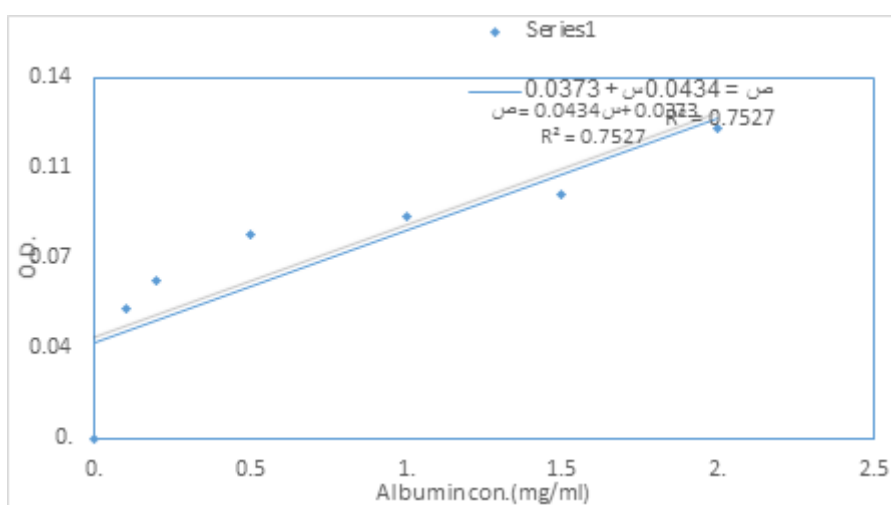
2-Phosphate buffer solution (0.1M), prepared from the following solutions:

First: - Potassium dihydrogen phosphate KH_2PO_4 (1 M), prepared by dissolving 136.09 g of KH_2PO_4 in distilled water and adding to a volume of one liter.

Second: - Sodium hydrogen phosphate Na_2HPO_4 , prepared by dissolving 142.07 g of Na_2HPO_4 in distilled water and adding to a volume of one liter. To obtain pH = 5.6, 9.41 ml of the first solution is mixed with 0.59 ml of the second solution.

Procedure:

Take (1 g) of the plant part and crush it with (6) ml of Phosphate buffer solution (pH = 5.6) in a clay mortar. Place the mortar on ice during crushing for (5-10) minutes to obtain a low temperature. The mixture was filtered through two layers of gauze, then the filtrate was collected and centrifuged at (1500) rpm for (15) minutes. The precipitate was discarded and the filtrate was taken and completed to (15 ml) using the phosphite buffer solution mentioned above. (2 ml) of the protein extract was taken and (8 ml) of Biuret reagent was added to it, shaken and left for half an hour, after which the optical density was read using a Spectrophotometer-21 at a wavelength of (555 nm). The blank was prepared from (2 ml) phosphite buffer, 8 ml of Biuret solution and used to calibrate the device. Albumin was used as a standard solution.



Standard curve of albumin (mg/ml) at wavelength 555 nm

Estimation of chlorophyll content:

The chlorophyll content in the leaves was estimated by crushing (1) g of fresh leaves in a ceramic mortar with the addition of 10 ml of acetone (80%), then filtering the extract using filter paper, then measuring the absorbance at wavelengths 663 and 645 nm, then applying the following equations to extract the amount of chlorophyll:

$$\text{Chlorophyll a (mg/g)} = [12.7 (A663) - 2.69 (A645)] \times V / 1000 \times W$$

$$\text{Chlorophyll b (mg/g)} = [22.9 (A645) - 4.68 (A663)] \times V / 1000 \times W$$

$$\text{Total chlorophyll (mg/g)} = [20.2 (A645) + 8.02 (A663)] \times V / 1000 \times W$$

Statistical analysis

The results were analyzed using SPSS program, using the Completely Randomized Design (CRD) and the Duncan test was adopted to compare the treatments at a significance level ($P \leq 0.05$)

Results and Discussion

The effect of different treatments on the height of the mung bean plant:

Table (1) shows the effect of different treatments on the physiological indicators of the mung bean plant. We note that the treatment with Hochland solution recorded a significant increase in plant height of 9.37 cm by 43.5% compared to plants grown and irrigated with tap water, while the treatment with Hochland solution deficient in nitrogen recorded the least significant decrease in plant height (5.25 cm) by 29.1%.

The results also showed that the fresh weight of mung bean plants increased significantly in plants treated with Hochland solution (0.287 g) by (267.9%) compared to the control (tap water), while the treatment with Hochland solution deficient in nitrogen was (0.031 g). The different treatments had an effect on the dry weight of mung bean seedlings, and the Hochland treatment (0.81 g) had a higher dry weight by (42%) compared to the control (tap water).

Table (1): The effect of different treatments on some physiological plant indicators of mung bean plant.

Dry weight (g)	Fresh weight (g)	Plant height (cm)	Transactions
0.057	0.078	6.78	Tap water
0.081	0.287	9.73	Haukland
0.073	0.031	5.25	Nitrogen shortage
0.073	0.101	6.68	phosphorus deficiency
0.060	0.103	6.33	Nutrient deficient
0.054	0.144	7.28	Iron deficiency
0.051	0.112	6.03	Sodium chloride

Different letters indicate significance at ($p \leq 0.05$) level

Effect of different treatments on chlorophyll content of mung bean plant:

Table (2) indicated the effect of different treatments on chlorophyll content a, b and total, as chlorophyll content a reached a significant increase and was 3.64 mg/g fresh weight with an increase rate (110%) when treated with complete Hochland solution, while the two treatments (Hochland iron deficient treatment with sodium chloride) recorded the lowest chlorophyll content b and was 1.35 and 1.57 mg compared to the control 4.65 mg with a decrease rate (70.9% and 66.2%) respectively.

Table (2): Effect of different treatments on the content of chlorophyll a, b and total chlorophyll in mung bean plants.

Chlorophyll content (mg/g fresh weight)			Transactions
Total	chlorophyll b	Chlorophyll a	
6.38	4.65 c	1.73 a	Tap water
8.27	4.63 c	3.64 c	Full Hookland
7.33	4.92 c	2.41 b	haukland nitrogen deficiency
6.92	4.24 c	2.68 b	Haukland is deficient in phosphorus.
9.30	2.63 b	2.47 b	haukland nutrient deficient
3.24	1.35 a	1.89 a	Haukland iron deficiency
2.99	1.57 a	1.42 a	Sodium chloride

These results are consistent with Zhu et al. (2014) that treatment with Hochland solutions deficient in nitrogen caused a decrease in chlorophyll content in *Stylich grass*, in addition to the effect of Hochland solutions deficient in nitrogen on photosynthesis efficiency (Bever et al., 2013). Phosphorus deficiency also causes a decrease in stem and root growth, a reduction in plant weight, and a distortion in the morphological shape of leaves (Choi & Lee, 2012). Miller and Shetty (1965) also indicated that iron deficiency causes a decrease in chlorophyll a, b content. Rychter and Rao (2005) explained that phosphorus deficiency available to plants leads to inhibition of shoot and root growth, and a decrease in leaf area and plant weight. Therefore, phosphorus deficiency in plants inhibits chlorophyll production, and it is known that prolonged P deficiency can also lead to anthocyanin accumulation, which subsequently results in purple discoloration on the leaf surface (Osborne et al., 2002).

This is consistent with (Zhu et al., 2014) that nitrogen deficiency causes a decrease in biomass, leaf area, root surface area, photosynthetic efficiency, and chlorophyll content.

Salinity caused by sodium chloride is an abiotic stress that causes morphological and physiological disturbances. Treatment with sodium chloride can cause significant reductions in shoot biomass, plant height, and leaf area (Petretto et al., 2019).

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