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Article

The Impact Of Asphalt Material And Soil Salinity On Crop Growth Of Sunflower

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Abstract: The sunflower represents a significant economic annual plant (oil-producing and edible). Even though the sunflower is categorized as one of the most salt-tolerant plant types and is treated as a significant plant in saline soil reclamation, the rate of its photosynthetic and growth are adversely influenced by high levels of salt in the soil, significantly when the groundwater level rises on the soil surface, which in turn causes the raising of soil salinity. Therefore, there is a critical need to control salt accumulation to increase sunflower crop yields. An evaluation of the impact of asphalt material, soil salinity, groundwater table depth, and soluble ions on the growth of sunflower crops is presented in this paper. Several treatments were used in this study: asphalt material, bitumen material, and controlling treatment. The experiments were conducted, calibrated, and validated during the season of spring 2019. The results show a considerable reduction in soil salinity and groundwater table depth regarding the asphalt material control aspect, thus increasing the growth properties of the sunflower crops.

Keywords*:* Growth of Sunflower, Asphalt and Bitumen Materials, Soil Salinity, Soluble Ions, Groundwater Table Depth.

Introduction

One of the leading agricultural and environmental threats is the rise in soil salinity, which adversely influences the productivity of global agriculture [1]. Furthermore, The water quality utilized for irrigation impacts the physicochemical situations of soil and, thus, crop production, resulting in fertility scarcity adversely impacting plant growth. Additionally, the immoderate irrigation using inappropriate drainage systems causes a rise in the water table depth. Consequently, this can result in rising salinity in the root zone, adversely influencing plants' productivity [2].

Generally, the widely utilized and most produced crops for the nutrition of animals/humans, like horticultural, forages, or cereals crops, are vulnerable to high salt concentrations either existing in the rhizosphere or dissolving in irrigation [water 5]. Sunflowers hold considerable importance in food production and biofuels and biomass, representing the most promising renewable energy options. The sunflower crop represents one of the most significant salt-tolerant plants. However, this crop's early growth, emergence, and even germination are pretty sensitive to saline soil [6]. So, there is a need to develop new techniques for addressing these challenges.

Many studies have concentrated on salt accumulation management and its impacts on the growth of sunflower crops. Using N fertilizer could decrease the negative impacts of soil salinity. However, the application of N should be suitable for the growth of sunflowers, and the dynamic transport of salt in the soil profile during the period of sunflower growth should also be considered. [8] evaluated the impacts of water, soil salinity, and N on sunflowers at different stages of growth and suggested increasing the amount of irrigation after the initiation of buds to prevent the negative impact of nitrogen and salt stress. However, applying the N rate should be reasonable to alleviate the impacts of the interaction of N and salt on the growth of sunflowers. [9] investigated the effects of plastic film mulch and straw layer on soil salinity, moisture, and sunflower yields in saline soil. Using plastic mulch with a straw layer resulted in lower salt content in the soil and higher sunflower yields. Furthermore, using a straw layer could increase the holding capacity of soil water.

This study is intended to present the impacts of asphalt and Bitumen materials, soil salinity, groundwater table depth, and soluble ions on the growth of sunflower crops.

Materials and Methods

The field experiment is conducted to evaluate the impact of some materials of asphalt on salinity and soluble ions of soil, electrical conductivity, and groundwater table depth to increase the growth of the sunflower crops in sandy loam soil during the season of spring (from 20/2/2019 to 25/6/2019) at Baghdad, Iraq. Several treatments were used in this study: cold mineral asphalt and bitumen emulsion materials and controlling treatment. Additionally, A randomized complete block design is utilized with three replications. Table 1 demonstrates the main characteristics and proportion of the utilized components of asphalt material.

Material	Specific weight (15.6 C)	Percentage	Light grade (5m)
Asphalt (40 to 50)	104	25%	240
Bentonite clay	Density equal to 2.75 gm/cm^3	6%	-
Kerosene	0.801	5%	38
Water	1	64%	-

Table 1: The main characteristics and proportion of the utilized components of asphalt material.

In each hole (plot) of 100×100×120 cm, the soil was first removed and substituted with sandy loam soil; then, the asphalt material was spread below and on the sides of each hole. After that, the soil was compressed to obtain the original bulk density. Table (2) demonstrates the chemical and physical properties of the soil used in this study.

Particles of Soil			Texture of Soil	Bulk Density	Penetration Resistance of Soil	PH	EC
Loam	Sand	Clay					
10.2%	82.4%	7.4%	Sandy loam	1.3 gm/cm^3	1.2 kg/cm^3	7.6	2.1 dS/m

Table 2: The chemical and physical properties of the soil.

In this study, sunflower seeds of local species were used and planted on lines during the growing season of spring. The distance between seeds was thirty centimeters, and the distance between each line and the other was seventy centimeters. Before planting, eighty Kg/ha of Nitrogen and eighty Kg/ha of P205 were added. The water irrigation process was initiated when the soil moisture content attained fifty percent from the obtainable water. This process was controlled by installing tensiometers in the soil at fifteen centimeters depth.

In each plot, several measurements were accomplished as follows:

Firstly, measuring the electrical conductivity of soil via utilizing the device of electrical conductivity (EC) meter;

Secondly, measuring the rise of the groundwater table via utilizing the device of electrical sound;

Thirdly, measuring the soluble ions (Na, Cl, Mg, K, S, and Ca) via utilizing the USDA methods (1954);

Finally, the number of seeds in each plant head, the height of the plant, and plant yields were measured on 25/6/2019.

Results

The substantial impact of asphalt and Bitumen materials on groundwater table depth is demonstrated in Figure 1. From the obtained experimental results, it is noticeable that materials of asphalt and bitumen worked on decreasing the groundwater table depth and, hence, inhibited the salty groundwater table from arising on the surface of the soil. Figure 2 demonstrates the impact of the three treatments on the soil electrical conductivity)EC(and the soil soluble ions (Na, Cl, Mg, K, S, and Ca).

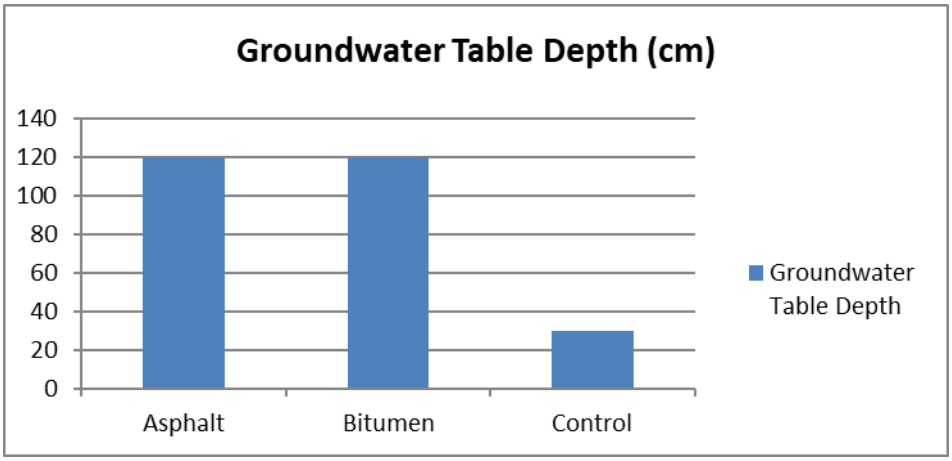
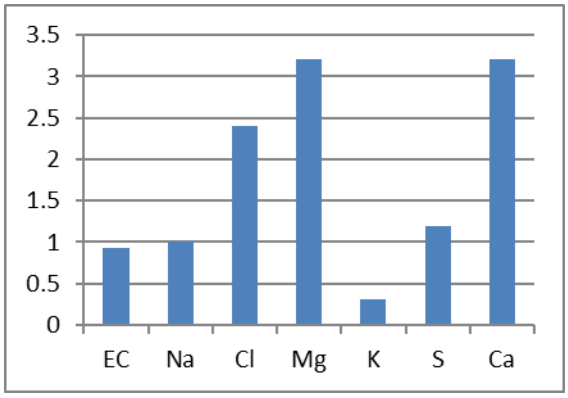
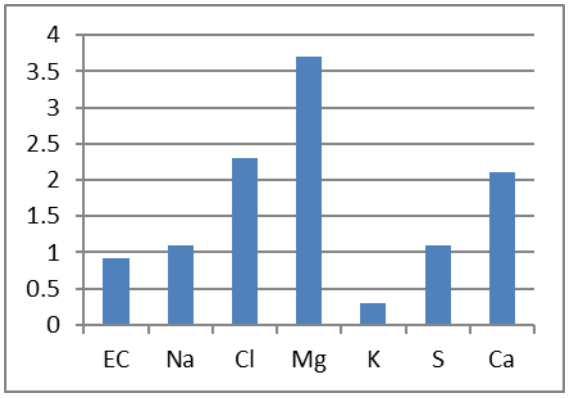


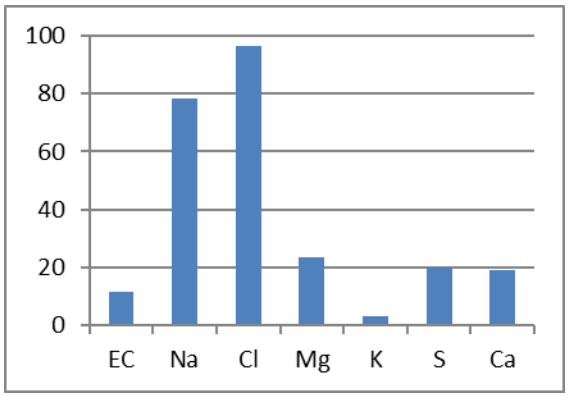
Figure 1: The impact of asphalt and Bitumen materials on groundwater table depth.



(a) Asphalt



(b) Bitumen

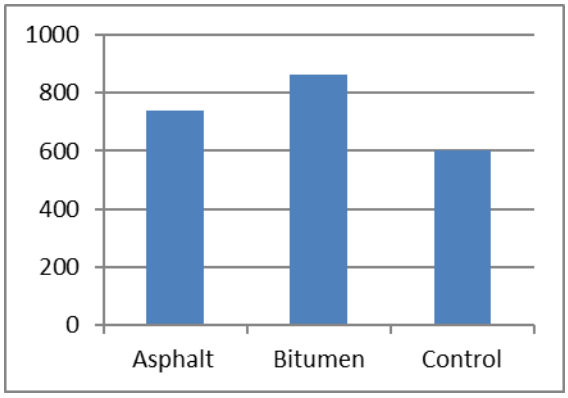


(d) Control

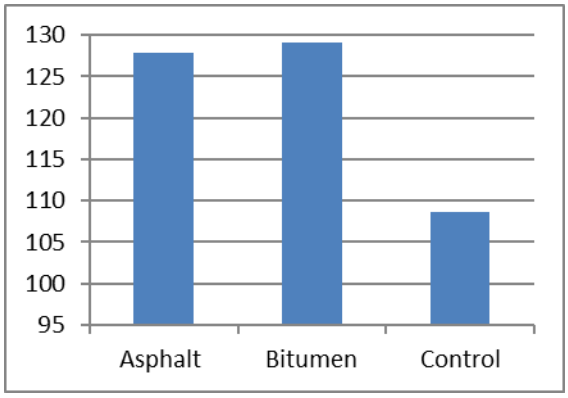
Figure 2: The impact of (a) Asphalt, (b) Bitumen, and (c) control treatments on the electrical conductivity and the soluble ions of soil.

The obtained results of the soil electrical conductivity shown in Figure 2 were 0.93 ds/m for asphalt treatment, 0.92 ds/m for bitumen treatment, and 11.6 ds/m for the control treatment. These results show the impact of asphalt materials on reducing the attribute of soil electrical conductivity, and this could be due to the decrease in the depth of the groundwater table. Furthermore, the obtained results of concentrations of soluble ions of soil were also decreased when the asphalt and bitumen materials were used compared with the control treatment, and this could be due to the decrease in the groundwater level on the soil surface and the decrease in electrical conductivity of the soil.

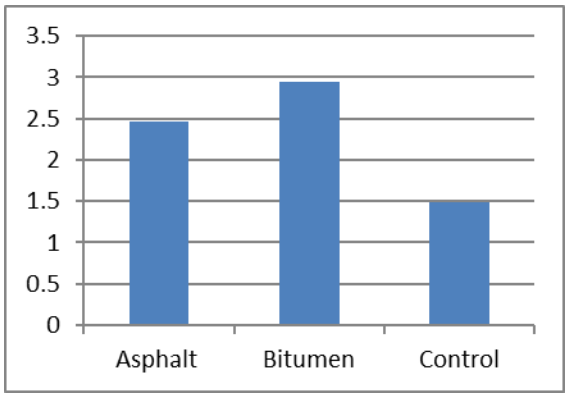
The impact of asphalt materials on the growth and yield characteristics of the sunflower plant is demonstrated in Figure 3.



(a) Number of seeds in plant head.



(b) Plant Height.



(d) Plant Yield.

Figure 3: The impact of Asphalt, Bitumen, and control treatments on (a) Number of seeds in plant head (seeds/head), (b) Plant height (cm), and (d) Plant yield (kg/ha).

Regarding the obtained results in Figure 3, it is noticeable that the characteristics of the sunflower plant (number of seeds in plant head, plant height, and plant yield) were significantly influenced by asphalt and bitumen materials compared with control treatments. These characteristics were increased when the asphalt and bitumen materials were used, and this could be due to the decrease in salt accumulation on the soil subsurface and surface.

Discussion

The presence of high salt levels in the irrigation water and the soil causes osmotic stress by reducing the ability of root systems to absorb water; furthermore, it induces ionic stress owing to the high salt ions cumulation in the plant cells [3]. The entrance of Cl and Na into the plant cells induces a severe imbalance of ions, and excess uptake may damage many vital life-supporting processes incorporating energy, lipid metabolism, protein synthesis, and photosynthesis. Moreover, the high Na concentration prevents Ca and K uptake, making the plants further susceptible to nutritional deficiencies and ionic disturbance, reducing their growth and survival yields [4] . [7] evaluated the impacts of interacting nitrogen (N) rate and soil salinity on sunflower growth. [10] presented a helpful model to evaluate the possible development of crop roots and to evaluate the sunflower crop production by investigating the impact of various rates of N and the electrical conductivity of soil on root depth, root distribution, and the yield production of sunflower.

Conclusion

In this study, the utilization of asphalt and bitumen materials resulted in a considerable decrease in the soluble ions accumulation of the soil because the salt groundwater table depth decreased and the soil electrical conductivity decreased. Consequently, the growth and yield characteristics of the sunflower plant were increased. In future works, we will investigate the impact of asphalt and bitumen materials on various soils and crops.

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