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Effect of *Atriplex Halimus* with Mineral and Organic Fertilization on the Proportion of Proteins and Soluble Sugars of Potato Tuber in the Salt Stress

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Abstract

Context: In agricultural areas that suffer from an increase in salinity in the soil or irrigation water, the farmer complains of a lack of yield despite the use of improvement techniques such as fertilization. Therefore, we suggest using a biological method to reduce these forms in the cultivation of halophytic plants. **Objective:** This work aims to study the effect of *Atriplex halimus* on proteins and soluble sugars in potato tubers (*Solanum tuberosum* L.) under salt stress. **Methods**: After water and soil analysis, we planted the *A. halimus* In each hole three to four plants of the age of two months in rows between the potatoes, after harvesting the tubers, we dried them, Four samples were taken from all untreated potato tubers Atriplex halimus (a witness Organic fertilizers and mineral fertilizers (urea and phosphorus)) and treatment with Atriplex halimus (a witness Organic fertilizers and mineral fertilizers (urea and phosphorus)), then measured the percentage of soluble sugars, based on the phenol method to read the spectrophotometer at the wavelength of 490 nm, also for proteins, first we prepared the reagents and then we measured the absorbance at 750 nm using a spectrophotometer. Resultants and **conclusions:** The results recorded showing a decrease in soluble sugars in the phosphorus and *A. halimus* interaction, compared to the other interactions: With regard to proteins, an increase was recorded in the interactions *A. halimus* urea, *A. halimus* phosphorus fertilizer, and *A. halimus* organic fertilizer compared to the other interactions, and this is due to the effect of the culture of *A. halimus* on the stres saline. **Significance:** The Atriplex halimus has a major role in reducing the salinity rate in the soil. Experience has proven that the cultured of Halophyte plante with potatoes and the addition of fertilizers, especially phosphorous and urée fertiliser, lead to improving the production observed from the lack of salt stress represented by the increase in proteins and the decrease in sugars in the potato tuber.

Keywords: *Atriplex Halimus, Solanum Tuberosum, Proline, Soluble Sugars, Salt Stress*

INTRODUCTION

The detrimental effect of high salinity can be observed at the whole plant level such as plant death and/or reduced productivity. Many plants develop mechanisms either to exclude salt from their cells or to tolerate its presence in the cells. (PARIDA and DAS, 2005). As such, in the saharienne regions, potato cultivation encounters various obstacles mainly in terms of mastering cultivation techniques, in particular that of mineral fertilization, which remains poorly controlled and not compatible with the physical and physico-chemical properties of the potato. Soil material of this region (low water retention capacity, high permeability, etc.) (OUSTANI, 2006).

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The introduction of plant species tolerant to abiotic stresses and of high socio-economic value is one of the approaches for the rehabilitation of saline soils. Choosing the right vegetation for these conditions is the first step in solving the salinity problem. Thus the introduction of halophiles species which complete their life cycles at high salinity levels and which have the ability to accumulate high concentrations of micronutrients, above normal levels (IPTRID., 2006) are promising for soil desalination in arid and semi-arid areas (Messedi and Abdelly, 2004).

The advantage of using these species, in particular the A. halimus, lies in the ecophysiological adaptation strategies, their great resistance to aridity and salinity (Belkhodja and Bidai, 2004). The highly branched root systems of A. halimus play an important role in the rehabilitation of degraded soils and the fight against soil erosion and desertification (Abbad et al. 2004). The main scientific objective of this work is to contribute to the reduction of salt stress represented by the ratio of both proteins and soluble sugars to the potato plant by cultivating the A. halimus plant with organic and mineral fertilization, with the aim of improving production as the percentage of proteins is low in the case of salt stress and vice versa, as for the soluble sugars they are high in the case of salt stress and vice versa Therefore, we wanted to prove the decrease in salt stress of potato tubers by using Atriplex halimus.

MATERIAL AND METHOD

Plant Material

In order to attain the objectives set by our study, which mainly focused on the effect of *Atriplex* on the proteins and soluble sugars of potatoes grown in the saline conditions of desert regions, we chose the potato *(Solanum tuberosum L.*) of the variety "Spunta"(Fig. 1*B*), and for the *Atriplex* we have chosen *A. halimus* (Fig. 1*A*).

Figure 1: Plant material. *A- Atriplex halumus. B-* Potato *(Solanum tuberosum L.*) variety "Spunta"

Description of the Study Area

Our experiment was performed in a farm specializing in potato cultivation located 10 km north of the Commune of TRIFAOUI, Wilaya of El-Oued, Algeria, with an area of 20 hectares (Fig. 2)

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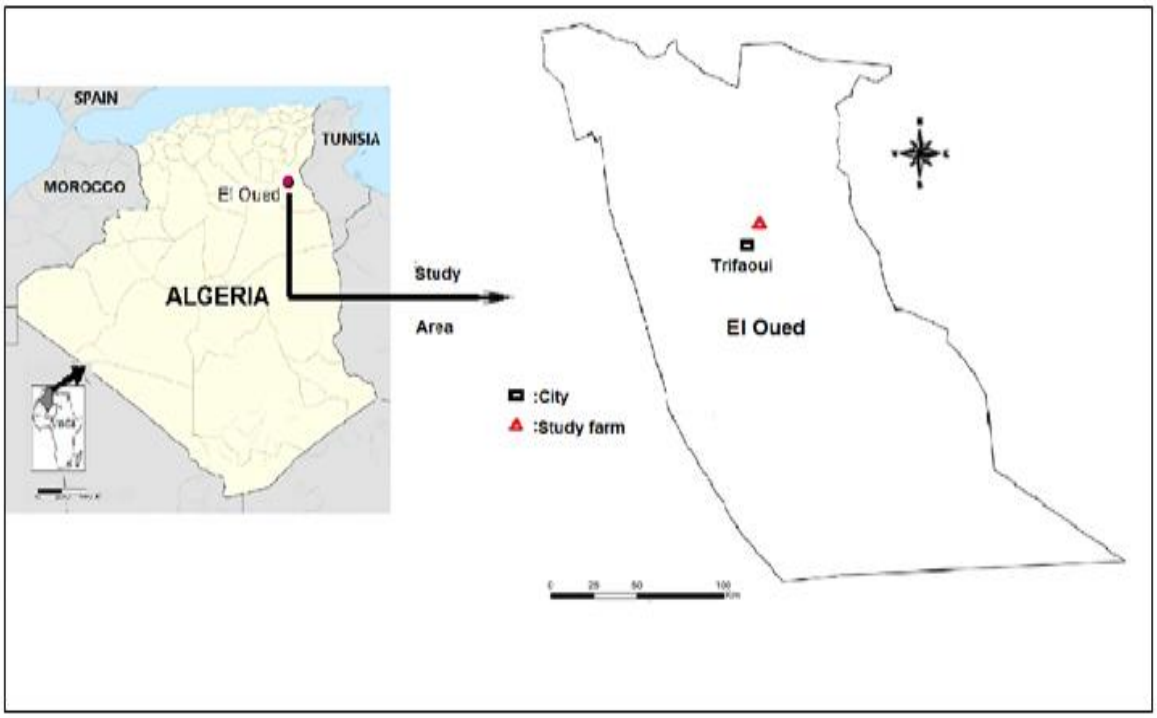

Figure 2: Map Of the Study Area, Tarifawi Oued Souf, Algeria (red triangle)

Experimental conditions

1. Soils of the Experimental Site

The analysis results (Table 1) show that our soil is characterized by sandy texture, low organic matter content and neutral pH. On the other hand, the rate of salts such as chloride, calcium and sodium is high, which leads to a high electrical conductivity.

Table 1: Soil Physical and Chemical Properties of the Cultivation Area

Parameter	Unit	Result
Ph	/	7.92
Conductiviy 1/5	mS/cm	0.50
TDS	g/kg	1.92
Phosphate p_2O_5	mg/Kg	112.81
Potassium k_2O_5	mg/Kg	47.12
Calcium Ca	mg/Kg	581.16
Chloride Cl	mg/Kg	868.60
Soduim Na	mg/Kg	71.00
Organic Matter	%	0.86
Total Limostone	%	11.76

According to the results the soil of Oued souf is a Saharan soil poor in mineral elements, in particular in potassium, without forgetting its lack of nutrients.

2. Experimental Site Irrigation Water

The study site is irrigated by a single borehole with a depth of 35 m and a flow rate of 34 l/s. the irrigation system adopted is localized drip. The results of the analysis show a very high salinity level (Table. 2).

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Table 2: Physico-Chemical Characteristics of Irrigation Water

Parameter	Unit	Result	Norm
Ph	/	7.46	6.5-9
Conductivité	µS/cm	4500	2800
TDS	mg/l	3413.45	2110
Calcium Ca	mg/l	545.09	200
Soduim Na	mg/l	298.960	200
Chloride Cl	mg/l	315.53	500
Potassium K	mg/l	39.56	12

From the irrigation point of view, this water belongs to class C_4-S_1 of the "*Reverdis*" classification. It has a very high salinity rate and very high sodium content according to the results

3. Experimental Protocol

The experimental design is the split-plot type, and the planted area is divided into four plots. A witness plot and three plots that were treated with different fertilizers, each of these plots divided into two parts to distinguish them from those planted with *A. halimus* (Fig. 3).

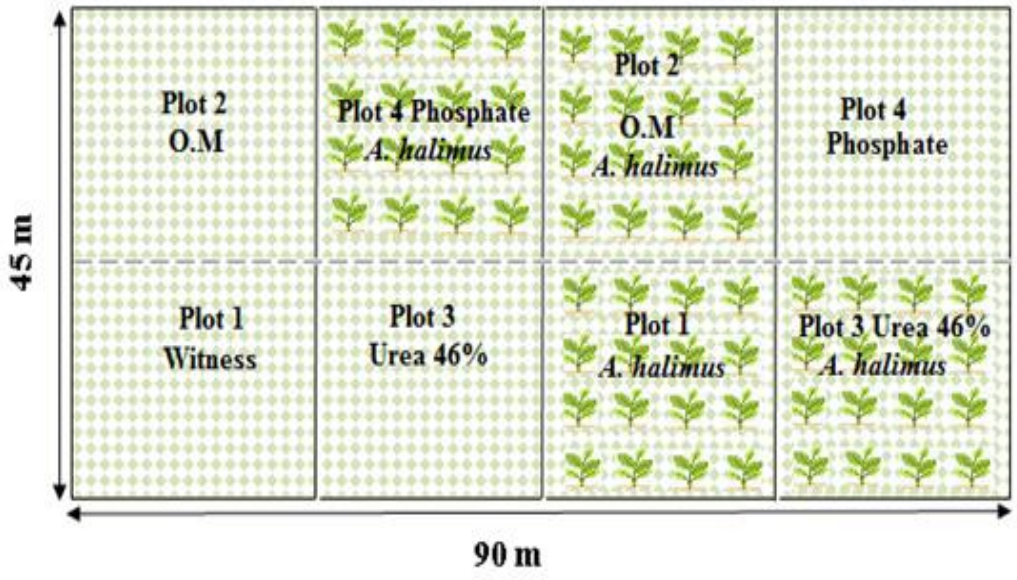

Figure 3: Diagram of the Experimental Design, Planting Potatoes (Green Points)

90 meters long and 45 meters wide, planting *A. halimus* (green plant), Plot 1: Without fertilizer, Plot 2: Organic fertilizer of plant origin in the form of a gel with a dosage of 03 kg per day after the lifted stage until harvest, Plot 3: Nitrogen fertilizer Urea 46% (solid, simple fertilizer), The dose used is 2 kg per day after the lifted stage until harvest, Plot 4: phosphate fertilizer P_2O_5 50% with a dosage of 2kg day by day after the emergence stage until the harvest.

Been cultivated Atriplex halimus about three to four plants in each hole as the distance between each plant and another is two meters, and the distance between each line and the other is five meters ,the number of lines is four between the potato lines.

Statistical study of the data the averages of the variable measured on the different sampling areas were subjected to a varience analysis, between the different variables measured, using the XLSTAT software.

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4. Dosage Of Parameters Study

- **Soluble Sugars**

For the determination of soluble sugars, the phenol method was used (Dubois et al, 1956). Meter 100 mg of fresh material in test tubes then add 3 ml of 80% ethanol. The whole is left for 48 hours, and then evaporate the total alcohol by putting the test tubes in a water bath at 80C° for 48 hours, after cooling, we put in each test tube 20 ml of distilled water, then take 1 ml of the solution obtained and add 1 ml of 5% phenol, taking care to shake well, at the end, place the test tubes in an ice bath, add 5ml of concentrated sulfuric acid using a burette. And let them rest for 25 minutes in the ice bath, then proceed to the spectrophotometer reading at the wavelength of 490nm.

The calibration of the device is done by mixing 3ml of ethanol, 5ml of sulfuric acid and 1ml of 5% phenol. The calibration curve was expressed in glucose

- **Proteins**

For the protein dosage, we used the method (LAWRY et al, 1951). According to the following steps:

✓ **Reagent preparation**

Alkaline solution **(A):** 50ml de soud 0.1NaoH (02g /500ml) +50ml sodium carbonate Na_2CO_3**,** Cupric solution **(B):** 10ml copper sulphate $CuSo_4$ (0.5%) + sodium nitrate $KNaC_4H_4.O_64H_2O$. (0.1%), Solution **(C):** Prepare the folin-Ciocalteu (1V1V) solution. Solution **(D):** 50ml de la solution (A) avec solution (B).

After maceration for 24 hours in distilled water, we filtered the solution. This is the solution to be dosed. Take 1ml of the sample and add 5 ml of solution (C). Let them rest for 10 minutes at room temperature, add 0.5 ml of folin-Ciocalteu reagent and leave for 30 min in the dark.

This reagent allows the reduction of amino acids leading to the formation of a colored complex. The absorbance will be measured at 750 nm using a spectrophotometer.

RESULTS

Effect of Atiplex Halimus on Protein Level in Potatoes

The analysis of the variance of the values obtained on the protein content of the tubers of potatoes grown in a soil of mineral and organic fertilizers planted with Atriplex halimus indicates that the results are highly significant for the phosphorus and Atriplex effect and very significant for the effect of the urea Atriplex and organic matter interaction, and not significant for the Atriplex organic matter and urea interaction and the phosphorus Atriplex interaction (Table 3).

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Table 3: Analysis Of Variance of the Interaction Effect of Atriplex and Mineral And Organic Fertilizer on the Protein Content of Potato Tubers

Contrast	Difference	Standardized Difference	Critical Value	Différence Critique	Pr > Diff	Significant
WITNESS vs UREA Atriplex	-0,157	-4,215	2,924	0,109	**0,004**	Yes
WITNESS vs. Atriplex O M	-0,044	-1,175	2,924	0,109	0,746	No
WITNESS vs UREA	-0,042	-1,121	2,924	0,109	0,781	No
WITNESS vs phosphorus Atriplex	-0,038	-1,013	2,924	0,109	0,844	No
WITNESS vs phosphorus	0,234	6,305	2,924	0,109	**< 0,0001**	Yes
WITNESS vs. WITNESS Atriplex	0,227	6,108	2,924	0,109	**0,000**	Yes
WITNESS vs O M	0,184	4,942	2,924	0,109	**0,001**	Yes

In salt stress, the percentage of protein decreases, and this is noticeable in every potato whose soil has been improved with phosphorous, organic matter, and Atriplex halimus . Figure 4

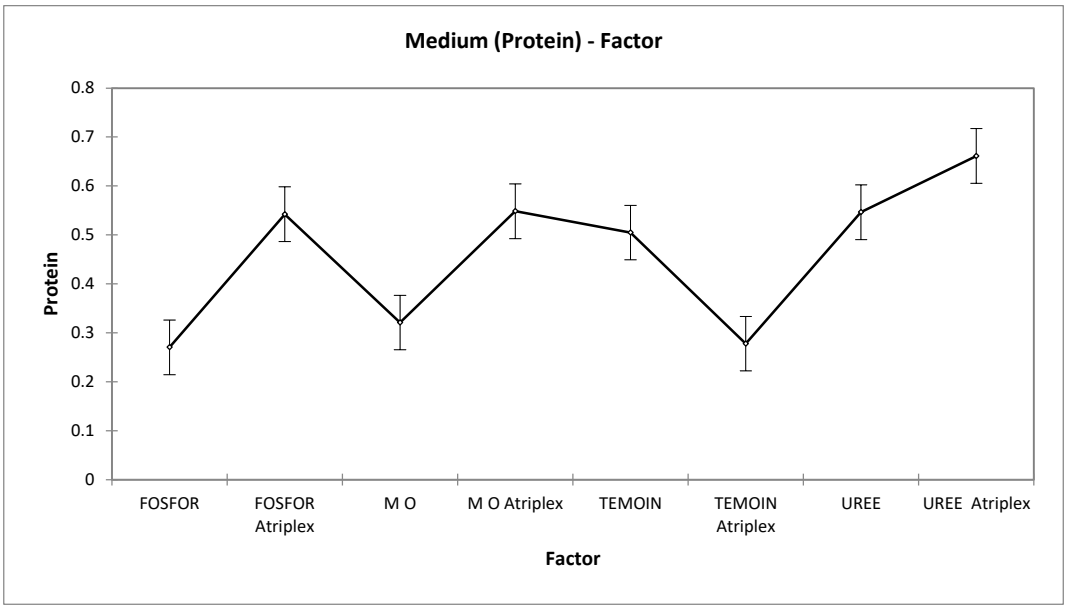

Figure 4: Average Potato Protein Rates Planted in Fertile Soil and Planted by Atriplex

The potato protein rate values for the Atriplex-Urea 46% (0.7 ug/l) interaction increase the interaction between Atriplex and fertilizers (phosphor, organic matter) (0.5ug/l) compared to the other ones.

Effect of Atiplex Halimus on Soluble Sugars in Potatoes

The analysis of the variance of the results obtained on the rate of soluble sugars of the tubers of potatoes rown in a soil of mineral and organic vas planted with Atriplex halimus indicates that the results are very significant for Urea-Atriplex and not significant for the others. Interaction (Table 4).

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Table 4 : Analysis Of The Variance Of The Interaction Effect Of Atriplex And Mineral And Organic Fertilizer On The Soluble Sugar Content Of Potato Tubers

Contrast	Difference	Standardized difference	Critical value	Différence critique	Pr > Diff	Significant
WITNESS vs UREA Atriplex	-0,393	-4,054	2,924	0,283	0,005	Yes
WITNESS vs. Atriplex O M	-0,088	-0,909	2,924	0,283	0,897	No
WITNESS vs UREA	-0,048	-0,499	2,924	0,283	0,995	No
WITNESS vs phosphorusAtriplex	-0,034	-0,348	2,924	0,283	0,999	No
WITNESS vs phosphorus	-0,027	0,282-	2,924	0,283	1.000	No
WITNESS vs. WITNESS Atriplex	0,159	1,642	2,924	0,283	0,442	No
WITNESS vs O M	0,147	1,518	2,924	0,283	0,519	No

Salt stress increases the dissolved sugars to raise the osmosis and this is observed in the potato tuber Except for the interaction between Atriplex halimus and phosphorus, a minimum value (0.4 ug/l) was recorded due to the role of Atriplex halimus in reducing salinity (Figure 5).

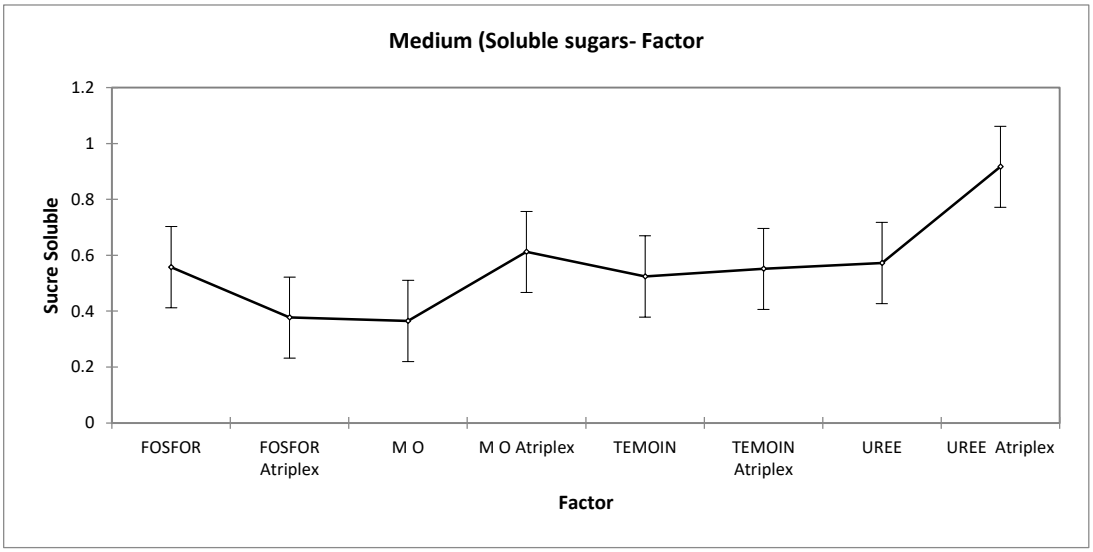

Figure 5: Average Soluble Sugar Levels of Potato Planted In Fertile Soil and Planted By Atriplex

DISCUSSIONS

Effect of Atiplex Halimus on Protein Level in Potatoes

Because there is a relationship between the electrical conductivity in the very high and salt-laden irrigation water and the protein level with the fertilizer, Atriplex ,in this case the Atriplex played a very important role in reducing the rate of salt in the soil and the irrigation water and releasing the nutrient, the effect of the salt manifests itself in a reduction in the content of soluble proteins (HAOUALA et al., 2007) due to a slowing down of protein synthesis and inhibition of enzymatic activity (MUNNS et al., 2006) The importance of

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Atriplex halimus cultivation in reducing salt stress, and from it, the percentage of protein is high compared to other results.

Effect of Atiplex Halimus on Soluble Sugars in Potatoes

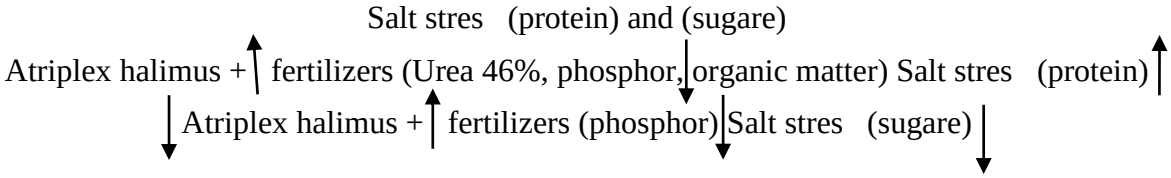
Salt stress induces changes in the relative levels of carbohydrates in several plant species with a more or less significant accumulation of total soluble sugars (sucrose, glucose and fructose). These sugars appear to play an important role in osmotic adjustment. They participate in maintaining VV balance of osmotic force to keep turgidity and cytosolic volume as high as possible and also allow preservation of membrane integrity as well as protein protection (Guignard et Dupont., 2004).

Meaning that there is a proportionality between the soluble sugar content and the increase in salinity. Soluble sugars are part of the organic solutes involved in salinity tolerance (ALLAOUI, 2006).

Sugars are carbonaceous compounds that require the presence of a carbonaceous source to develop, this justifies the positive correlation recorded with the planting of Atriplex halumus the average value of soluble sugar (urea-Atriplex) increase compared to the other interaction, the content of Na+ cl- in the cultivated soil and the very high water which influences the movement and the absorption of the mineral element on the plant, and the very saline soil site presented maximum values of Sugars compared to the site low salty

CONCLUSION

In this context, it can be concluded that the production of potato (Spunta variety) under saline conditions can be improved by mineral and organic inputs according to the analysis of soil and water with the interaction of Atriplex mineral fertilizer phosphoru, s-Atriplex is a good choice for good potato yield in a saline environment compared to the other interaction This is to reduce the percentage of salt stress associated with an increase in soluble sugars and a decrease in proline, and this is shown in the following chart



The Atriplex in this case play a very important role in absorbing and degrading the relationship of salt in the water to release the nutrient in the soil for absorption by the plant, which gives a good chemical composition (protein, sugar)

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