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# STATUS OF NITROGEN UNDER SALINITY STRESS CONDITIONS

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**ABSTRACT : A pot experiment was carried out under greenhouse conditions at the Faculty of Agriculture in Zagazig, Egypt to study the status of nitrogen under salinity stress conditions. To achieve the aims and objectives of this study, polythene pots were filled with 10 kg soil /pot, received P (6 mg P/kg soil) and K (20 mg K/kg soil) durig seed-bed preparation, planted with 25 seeds /pot of wheat "Sakha 69", 10 days after seeding 20 plants were left in each pot which received N fertilizer in the rate of 100 kg N/fad. 21 days after seeding. Four irrigation water salinity levels were used : 0.5 dSm$^{-1}$, 2.0 dSm$^{-1}$, 4.0 dSm$^{-1}$ and 8.0 dSm$^{-1}$. Samples of plants were taken on 4 occasions : 30, 80, 125 days after seeding and at harvest. Soil samples were taken on 3 occasions : 45, 90 and 180 days after seeding. All plant and soil samples were analysed. The obtained results could be summarized as follows :**

1. **Increasing the salinity of irrigation water up to 8.0 dSm$^{-1}$ decreased both fresh and dry weight of wheat during the three growth stages.**
2. **Increasing irrigation water salinity significantly decreased N content and N uptake in wheat dry matter through the three growth stages.**
3. **Increasing irrigation water salinity from 0.5 dSm$^{-1}$ to 8.0 dSm$^{-1}$ significantly decreased straw yield of wheat.**
4. **The greater the irrigation water salinity the lower the grains yield of wheat.**
5. **Increasing the irrigation water salinity significantly decreased the nitrogen content and nitrogen uptake in both straw and grains yield of wheat.**

6. **The biological yield was decreased by increasing irrigation water salinity.**
7. **Soil nitrogen content was decreased by increasing the salinity of irrigation water.**
8. **Increasing the salinity of irrigation water significantly increased the soil salinity.**

## INTRODUCTION

One of the most important agronomic practices which determines to a great extent the yield of wheat crop is soil nitrogen content. Irrigation water salinity affects biological and chemical processes in soil, thus affecting status of nitrogen. Conversion of organic nitrogen to mineral nitrogen occurs through biochemical transformations and is influenced by factors that affect microbial activity (such as salinity, moisture, pH and temperature). The equilibrium between mineralization and immobilization is affected by soil factors such as irrigation water and soil salinity, soil moisture, the number of microorganisms, the nature and amount of the available energy-producing materials, temperature, pH and the type and amount of inorganic nitrogen in soil.

The present study was conducted to investigate status of nitrogen under irrigation water salinity and its effect on wheat yield components and wheat production.

## MATERIALS AND METHODS

### Materials :

A pot experiment was carried out under greenhouse conditions at the Faculty of Agriculture in Zagazig, Egypt to study the status of nitrogen under salinity stress conditions.

To achieve the aims and objectives of this study, soil used in this investigation was collected from the surface layer (0-30 cm) from Al-Ibrahimia in Sharkia Governorate. Physical and chemical properties of the soil are presented in Table (1).

Polythene pots were filled with 10 kg soil/pot. All pots received P (6 mg P/kg soil) as ordinary calcium super phosphate "6.5% P" and K (20 mg K/kg soil) as potassium sulphate "42% K" during seed-bed preparation.

Twenty five seeds/pot of wheat "Sakha 69" were planted on 1999 season, and when the seedlings were 10 days old, only twenty plants were left in each pot. Four irrigation water salinity levels were used : 0.5, 2.0, 4.0 and 8.0 $dSm^{-1}$.

Nitrogen fertilizer was added at in the rate of 100 mg N/kg. in one dose 21 days after seeding, beside the control.

Samples of plants were taken (5 plants from each pot) on 4 occasions : 30, 80, 125 days after seeding and at harvest (straw and grains). The plant samples through the three growth stages were washed with distilled water, then oven dried (at 70 °C) weighed and ground to pass through 40 mesh screen for N determination. At the day of harvest (180 days after seeding) shoots and grains were weighed, ground and prepared for analysis.

Samples of soil were taken (50 gm from each pot) on 3 occasions : 45, 90 days after seeding and at harvest (180 days after seeding) for analysis.

**Methods of Analysis :**

Particle size distribution of the soil was carried out adapting the international pipette method *(Piper, 1950)*.

The chemical analysis of soluble cations and anions of the saturation extract of soil was done according to the method described by *Black (1965)*.

Calcium carbonate content of the soil was determined volumetrically using the calcimeter *(Piper, 1950)*.

Soil pH was measured using glass-electrode pH meter using soil water ratio of 1 : 2.5 (w : v) *(Jackson, 1965)*. The walkely and Black method was adapted to determine the organic matter as discribed by *Black (1965)*. Electrical conductivity of saturated extract was determined by using the salt bridge. Total nitrogen was determined using the microkjeldahl procedure described by *Black (1965)*.

Statistical analysis for the results was carried out according to *Snedecor and Cochran (1972)*.

## RESULTS AND DISCUSSION

1. Fresh and dry weight, straw and grains yield

Data in Table (2) indicate that increasing the irrigation water salinity from 0.5 up to 8.0 $dSm^{-1}$ decreased the fresh and dry weight of wheat during the three stages of growth. The high relative decrease was noticed during the heading stage followed by elongation and tillering stage, respectively.

The relative decrease values of fresh weight under the 0.5 $dSm^{-1}$ treatment were 1.8%, 6.7% and 11.7% for 2.0, 4.0 and 8.0 $dSm^{-1}$ for the tillering, while for the elongation and heading stages the corresponding relative values were 13.1%, 16.9% and 22.8%, and 13.7%, 50.1% and 62.9%, respectively.

The dry weight of wheat increased progressively up to the heading stage.

Increasing the salinity of irrigation water up to 8.0 $dSm^{-1}$ decreased the dry weight of wheat during the three stages of growth. The relative decrease values under the 0.5 $dSm^{-1}$ treatment were 3.5%, 6.4% and 11.5% for irrigation water of 2.0, 4.0 and 8.0 $dSm^{-1}$ for the tillering stage, while for the elongation and heading stages, the corresponding relative values were 5.9%, 9.5% and 26.2%, and 5.9%, 47.2% and 61.0%, respectively. These results fully confirm the results of *Verma and Bains (1974)*.

Taking in consideration the effect of irrigation water salinity on straw yield of wheat, the data revealed that increasing irrigation water salinity from 0.5 to 8.0 $dSm^{-1}$ significantly decreased straw yield. The relative decrease values of wheat straw yield under 0.5 $dSm^{-1}$ treatment were 6.3%, 56.2% and 65.4% for 2.0, 4.0 and 8.0 $dSm^{-1}$ treatments, respectively. This findings fully confirm the results of *Kumar (1979)*.

With regard to the grain yield of wheat under the effect of irrigation water salinity, the data show that the greater the irrigation water salinity the lower the grain yield of wheat. The relative decrease values of the yield of wheat grain under 0.5 $dSm^{-1}$ treatment were 6.0%, 19.3% and 31.9% for 2.0, 4.0 and 8.0 $dSm^{-1}$ treatments, respectively.

## 2. Nitrogen

### 2.1. Nitrogen content in wheat plants :

Stress conditions would adversely affect biological and chemical processes in soil, thus affecting status of nitrogen.

Regarding the effect of irrigation water salinity on N content in dry matter of wheat, the data in Table (3) indicate that increasing the irrigation water salinity from 0.5 to 8.0 $dSm^{-1}$ showed a significant decrease in N percentage in the dry matter of the three growth stages and the lowest nitrogen percentage was obtained at heading stage. The relative decrease values under the irrigation water salinity of 0.5 $dSm^{-1}$ at tillering stage were 4.0%, 7.0% and 18.3% for irrigation water salinity of 2.0, 4.0 and 8.0 $dSm^{-1}$, respectively, while at elongation and heading stages, the corresponding relative decrease values were 3.0%, 7.9% and 18.2%; 2.5%, 8.0% and 18.6%, respectively.

**2.2. Nitrogen uptake by wheat plants :**

With regard to the effect of irrigation water salinity, the obtained data (Table 3) revealed that irrigation water salinity significantly decrease N uptake by wheat dry matter through the three growth stages. The relative decrease values under the irrigation water salinity of 0.5 $dSm^{-1}$ were 6.5%, 12.1% and 27.8%; 14.2%, 15.7% and 30.4%; and 8.0%, 50.6% and 67.6% for irrigation water salinity of 2.0, 4.0 and 8.0 $dSm^{-1}$ at tillering, elongation and heading stages, respectively.

**2.3. Nitrogen content in wheat straw :**

Regarding the effect of irrigation water salinity on nitrogen content in wheat straw, the data in Table (3) indicate that N content in wheat straw was decreased with increasing irrigation water salinity. The relative decrease values under the 0.5 $dSm^{-1}$ treatment were 2.9%, 7.4% and 17.6% for the 2.0, 4.0 and 8.0 $dSm^{-1}$, respectively.

**2.4. Nitrogen uptake by wheat straw :**

With respe4ct to the effect of irrigation water salinity on nitrogen uptake by wheat straw, the data in Table (3) showed that increasing irrigation water salinity significantly decreased nitrogen uptake by wheat straw. The relative decrease values of nitrogen uptake due to increasing irrigation water salinity from 0.5 $dSm^{-1}$ to 2.0, 4.0 and 8.0 $dSm^{-1}$ were 8.6%, 58.7% and 71.0%, respectively.

**2.5. Nitrogen content in wheat grains :**

The data in Table (3) revealed that increasing irrigation water salinity significantly decreased nitrogen content in wheat grains. The relative decrease values due to increasing irrigation water salinity from 0.5 $dSm^{-1}$ to 2.0, 4.0 and 8.0 $dSm^{-1}$ were 2.8%, 6.8% and 17.6%, respectively.

**2.6. Nitrogen uptake by wheat grains :**

The data in Table (3) reveal that increasing irrigation water salinity significantly decreased

Table (1) : Some physical and chemical properties of soil under study.

**a. Mechanical analysis**

| | Coarse sand % | Fine sand % | Silt % | Clay % | Texture | $CaCO_3$ % | C % | Organic matter % | Total N % | C/N ratio | S.P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7.8 | 36.6 | 16.1 | 39.5 | Sand Clay Loam | 2.01 | 0.21 | 0.36 | 0.020 | 10.5 | 56 |

S.P : saturation percent

**b. Chemical analysis**

| | | Soluble anions (mmol$_c$) | | | | Soluble cations (mmol$_c$) | | | | | Available*** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EC* $dSm^{-1}$ | pH** | $CO_3^{=}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{=}$ | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | SAR | N | P | K |
| | | | | | | | | | | | mg/kg | | |
| 2.48 | 8.1 | - | 1.4 | 14.0 | 9.1 | 6.6 | 3.9 | 13.6 | 0.4 | 5.5 | 13.0 | 3.2 | 26.6 |

* EC of soil water extract (saturation extract).

** pH of soil : water suspension 1 : 2.5 w/w.

*** available N extracted by KCl; available P extracted by $NaHCO_3$; available K extracted by $NH_4$ acetate.

Table (2) : Effect of irrigation water salinity on fresh and dry weight, straw and grains yield of wheat at different growth stages and at harvest, gm/pot$^{-1}$.

| Irrigation water salinity dSm$^{-1}$ | Tillering stage | | Elongation stage | | Heading stage | | At harvest | |
|---|---|---|---|---|---|---|---|---|
| | Fresh | Dry | Fresh | Dry | Fresh | Dry | straw | Grains |
| | weight | | weight | | weight | | yield | |
| 0.5 | 13.38 | 3.73 | 23.06 | 5.91 | 57.48 | 14.76 | 20.95 | 7.68 |
| 2.0 | 13.14 | 3.60 | 20.03 | 5.56 | 49.62 | 13.89 | 19.62 | 7.22 |
| 4.0 | 12.48 | 3.49 | 19.16 | 5.35 | 28.70 | 7.79 | 9.17 | 6.20 |
| 8.0 | 11.81 | 3.30 | 17.81 | 4.96 | 21.34 | 5.75 | 7.24 | 5.23 |

Table (3) : Effect of irrigation water salinity on nitrogen of wheat plants at different growth stages and at harvest.

| Irrigation water salinity, $dSm^{-1}$ | Preharvesting stages | | | At harvest | |
|---|---|---|---|---|---|
| | Tillering | Elongation | Heading | Straw | grains |
| **Nitrogen content (%)** | | | | | |
| 0.5 | 3.27 | 3.03 | 1.99 | 1.36 | 1.76 |
| 2.0 | 3.14 | 2.94 | 1.94 | 1.32 | 1.71 |
| 4.0 | 3.04 | 2.79 | 1.83 | 1.26 | 1.64 |
| 8.0 | 2.67 | 2.48 | 1.62 | 1.12 | 1.45 |
| **Nitrogen uptake (mg / pot)$^{10^{-1}}$** | | | | | |
| 0.5 | 12.96 | 19.04 | 31.43 | 30.32 | 14.36 |
| 2.0 | 12.12 | 16.34 | 28.92 | 27.70 | 13.18 |
| 4.0 | 11.39 | 16.06 | 15.52 | 12.53 | 10.96 |
| 8.0 | 9.36 | 13.26 | 10.17 | 8.78 | 8.25 |

**Table (4) : Effect of irrigation water salinity on biological yield, soil nitrogen content, % and soil salinity.**

| Irrigation water salinity $dSm^{-1}$ | Biological yield (grains + straw) | Soil N content % | Soil salinity, $dSm^{-1}$ | | |
|---|---|---|---|---|---|
| | | | Days after seeding | | |
| | | | 45 | 90 | 180 |
| 0.5 | 28.62 | 0.191 | 2.34 | 2.52 | 2.68 |
| 2.0 | 26.84 | 0.180 | 2.62 | 3.00 | 3.15 |
| 4.0 | 15.37 | 0.162 | 3.14 | 3.54 | 3.70 |
| 8.0 | 12.48 | 0.145 | 3.98 | 4.37 | 4.53 |

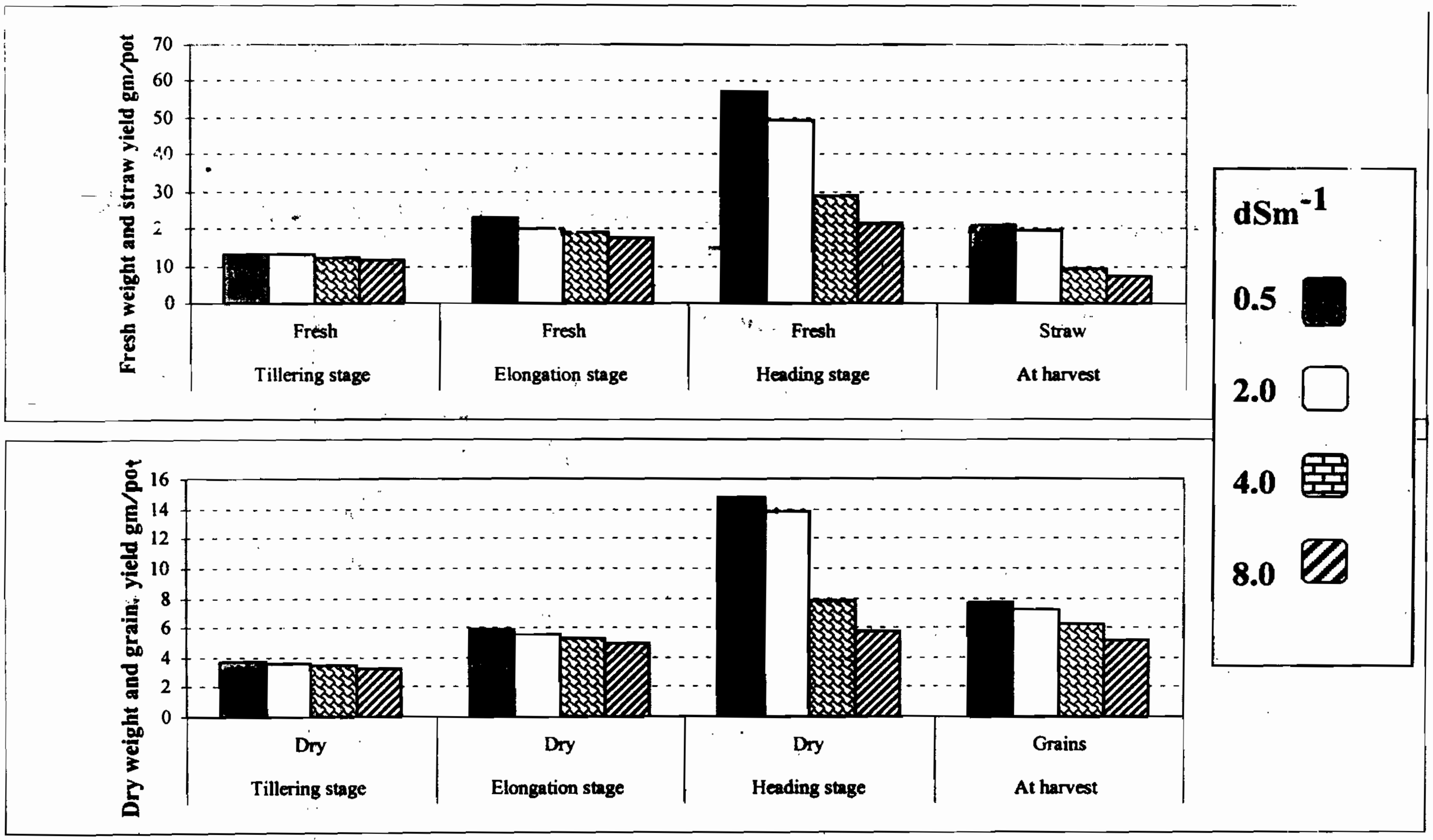
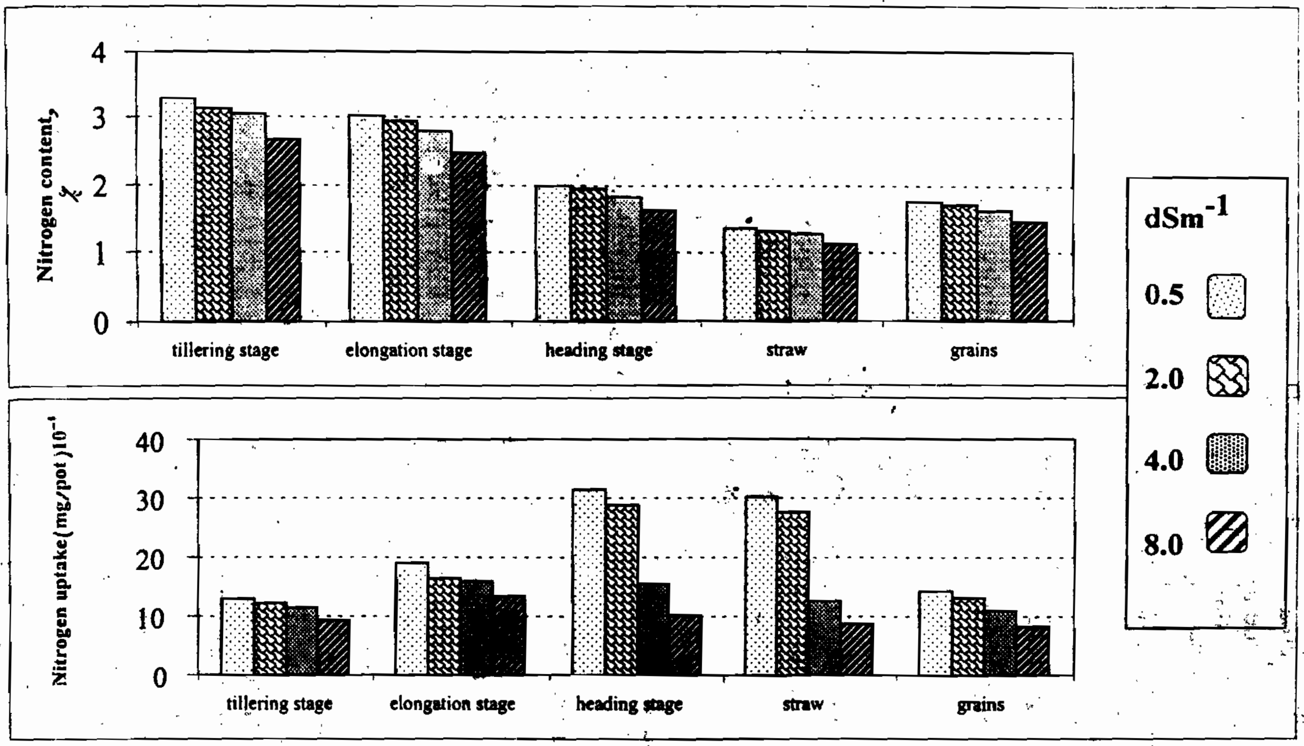



**Fig. ( 1 ) : Effect of irrigation water salinity on fresh and dry weight ,straw and grain yield of wheat at different growth stages and at harvest , gm/ pot.**




**Fag. ( 2 ) : Effect of irrigation water salinity on nitrogen of wheat plants at different growth stages and at harvest.**

nitrogen uptake by wheat grains. The relative decrease values of nitrogen uptake due to increasing irrigation water salinity from 0.5 $dSm^{-1}$ to 2.0, 4.0 and 8.0 $dSm^{-1}$ were 8.2%, 23.7% and 42.5%, respectively.

### 3.Biological yield gm per pot:

Concerning the effect of irrigation water salinity on the biological yield, the data in Table (4) show that the biological yield was decreased by increasing irrigation water salinity. The average decreases were 6.2%, 46.3% and 56.4% for irrigation water of 2.0, 4.0 and 8.0 $dSm^{-1}$ compared with irrigation water of 0.5 $dSm^{-1}$.

### 4. Soil nitrogen content :

Stress conditions would adversely affect biological and chemical processes in soil, thus affecting status of nitrogen. Data presented in Table (4) show that soil nitrogen content was decreased by increasing the salinity of irrigation water. The average decrease of soil nitrogen content were 5.8%, 15.2% and 24.1% for irrigation water of 2.0, 4.0 and 8.0 $dSm^{-1}$ compared with irrigation water of 0.5 $dSm^{-1}$. This decrease may be attributed to an inhibition of nitrifying bacteria with increasing soil salinity. Also the high salinity may have increased the loss of N as ammonia. Similar results were obtained by *Laura (1977), Doddema et al., (1985) and Mc-Clung and Frankenberger (1985)*.

### 5. Soil salinity :

The increasing percentage in soil salinity resulted from using irrigation water of 2.0, 4.0 and 8.0 $dSm^{-1}$ were 12.0%, 34.2% and 70.1%, respectively 45 days after seeding, 19.0%, 40.5% and 73.4%, respectively 90 days after seeding and 17.5%, 38.1% and 69.0%, respectively at harvest as compared to the irrigation water of 0.5 $dSm^{-1}$. These findings are in harmony with those obtained by *Gupta and Abichandani (1973)*.

## REFERENCES

Black, C.A. (1965) : Methdos of soil analysis. Part 2. American Society of Agronomy. INC. Publisher, Madison, Wisconsin, U.S.A.

Doddema, H.; Rajaa Saad Eddin; A. Mahasneh (1985) : Effect of seasonal changes of soil salinity and soil nitrogen on the N-metabolism of the halophyte *Arthrocnemum fruticosum* (L.) Moq. Plant and Soil. 92 (2) : 279-293.

Gupta, I.C. and C.T. Abichandani (1973) : Seasonal variations in the salt composition of some saline water irrigated soils of western Rajasthan II, Effect of fallowing and irrigation, Bhartiya Krishi Anusandhan Patrika (Hindi), 1 : 53-56.

Jackson, M.L. (1965) : Soil chemical analysis. Prentice – Hall of India, New Delhi.

Kumar, V. (1979) : Growth and yield of wheat as affected by saline water application at different growth stages, Proc. Natn. Physiological basis of crop productivity and harvesting solar energy in relation to agril. Develop., Aligarh.

Laura, R.D. (1977) : Salinity and nitrogen mineralization in soil. Soil Biol. Biochem. 9 : 333-336.

Manchanda, H.R. and D.K. Bhandari (1976) : Effect of pre-soaking of seeds in salt solutions on the yield of wheat and barley irrigated with highly saline waters, J. Indian Soc. Soil Sci., 24 : 432-5.

McClung, G. and W.T. Frankenberger (1985) : Soil nitrogen transformations as affected by salinity Soil Sci. 139 (5) : 75-79.

Piper, C.S. (1950) : Soil and Plant Analysis Inter-Science Publishers. Inc. New York.

Snedecor, G.W. and W.G. Cochran (1972) : Statistical Methods. 6th ed. Iowa State Univ. Press, Ames Iowa, U.S.A.

Talati, R.P. (1972) : Water quality and use of saline water in Gujarate state, Proc. Symp. Soil Water Management, Hissar, 1969, 300-1.

Verma, V.K. and S.S. Bains (1974) : A note on saline irrigation of wheat at various growth stages, Indian J. Agron., 29 : 80.

Yadav, J.S.P. (1977) : Effect of saline water irrigation on soil and crop growth, Agrokem. Talajt., 26 : 19-27.

# حالة النيتروجين تحت ظروف إجهاد الملوحة

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أجريت تجربة أصص بصوبة كلية الزراعة جامعة الزقازيق وذلك لدراسة حالة النيتروجين تحت ظروف إجهاد الملوحة. ولتحقيق الهدف من البحث فقد ملئت أصص بلاستيك كل بعشرة كيلو جرامات تربة وأضيف سمادى الفوسفور والبوتاسيوم (٦ مجم فو / ١ كجم تربة ، ٢٠ مجم بو / ١ كجم تربة على التوالي لجميع المعاملات عند تجهيز الأرض للزراعة) ، وزرعت ٢٥ حبة قمح (سخا ٦٩) فى كل أصيص وتم الخف بعد عشرة أيام من الزراعة ليتبقى ٢٠ نبات فى كل أصيص. وتم إعطاء سماد النيتروجين بمعدل ١٠٠ وحدة نيتروجين/فدان بعد الزراعة بـــ ٢١ يوم والرى بمياه تركيز الملوحة بها ٠,٥ ، ٢ ، ٤ ، ٨ ملليموز/سم وأخذت العينات النباتية بعد ٣٠ ، ٨٠ ، ١٢٥ يوم من الزراعة وكذلك عند الحصاد أما عينات التربة فقد أخذت بعد ٤٥ ، ٩٠ ، ١٨٠ يوم بعد الزراعة. وحللت عينات النبات والتربة ويمكن تلخيص أهم النتائج فيما يلى :

١- زيـــادة ملوحة مياه الرى من ٠,٥ إلى ٨ ملليموز/سم أدت إلى نقص الأوزان الطازجة والجافة للقمح أثناء مراحل النمو الثلاثة.

٢- زيادة ملوحة مياه الرى من ٠,٥ إلى ٨ ملليموز/سم أدت إلى نقص معنوى فى محتوى النيتروجين والنيتروجين الممتص بالمادة الجافة للقمح خلال مراحل النمو الثلاثة.

٣- زيـــادة ملوحـــة مـــياه الـــرى من ٠,٥ إلى ٨ ملليموز/سم أدت إلى نقص معنوى فى محصول القش والحبوب للقمح.

٤- زيادة ملوحة مياه الرى من ٠,٥ إلى ٨ ملليموز/سم أدت إلى نقص معنوى فى محتوى النيتروجين والنيتروجين الممتص فى قش وحبوب القمح.

٥- زيادة ملوحة مياه الرى أدت إلى نقص المحصول البيولوجي جم/ أصيص.

٦- زيـــادة ملوحة مياه الرى من ٠,٥ إلى ٨ ملليموز/سم أدت إلى تثبيط محتوى نيتروجين التربة.

٧- زيـــادة ملوحة مياه الرى من ٠,٥ إلى ٨ ملليموز/سم أدت إلى زيادة معنوية فى ملوحة التربة.