*Minufiya J. Agric. Res. Vol.40 No. 1(2): 195 - 212 (2015)* **"http://www.mujar.net"**

# INTERACTION BETWEEN HUMIC ACIDS AND NEUTRAL SALTS ON PLANT GROWTH

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**(Received: Sep. 23, 2014)**

**ABSTRACT:** *This study was carried out evaluate the combined interaction between two humic acids varied in their sources and chemical compositions and three neutral salts. i.e. NaCl, $CaCl_2$ and $FeCl_2$ on barley variety Giza 123 (Hordium vulgar L. ) growth and its content of Na, Ca and Fe elements. This investigation was conducted on pots experiment in a completely block design with three replicates using sandy culture. The used humic acids were extracted from alluvial soil (HAS) and compost of clover straw (HAC) and added to sandy culture at application rates of 0, 10, 20, 40 and 100 mgkg$^{-1}$ sand. The application rates of neutral salts were 0, 250, 500 and 1000 mgkg$^{-1}$ sand. After 42 days of planting, the plants of each pot were harvesting. The dry matter yield of either of shoots or roots of the harvested plants were weighted and statically analyzed for LSD value at 0.05.*

*The dry weights of both shoots and roots of barley plants increased significantly with increasing added humic acids. The found increases of dry weights in the plants treated with HAC were higher relatively than those associated the treatments of HAS. With different treatments of humic acids, the found dry weights of shoots were higher than those of roots. The response of barley dry weight for the tested treatments of neutral salts were varied widely according to the used neutral salts and its application rates. Agronomical efficiency of humic acids was decreased with the increasing rate of added NaCl, but it increased with added $CaCl_2$ up to 500 mg/kg and also with the increase of added $FeCl_2$ up to 1000 mg/kg. Shoots and roots of barley plants content of Na, Ca or Fe increased with the increasing rates of added NaCl, $CaCl_2$ or $FeCl_2$, Application of humic acids played a major role in the decrease of harmful effects of salinity and its effect on both plant growth and elements uptake.*

***Key words:*** *Barley, Humic acids, Neutral salts, Agronomical efficiency, Chemical composition and Elements uptake.*

## INTRODUCTION

Humic acids are a commercial product contains many elements which improve the soil fertility and increasing the phyto-availability of nutrient elements and consequently affected plant growth and yield. Humic acid particularly is used to remove or decrease the negative effects of mineral fertilizers and some chemicals forms in the soil. Humic substances have many beneficial effects on soil and consequently on plant growth and are shown highly hormonal activity. These materials not only increase macronutrients contents and ions uptake but also enhance micronutrients of the plant organs (Brunetti *et al*., 2005 ).

In other study, Liu (1998) found that the application of humic acids during salinity stress did not increase the uptake of N, P, K or Ca. Also, in their study; foliar application with 0.1% humic acid treatment increased the dry weight, N, P, K, Ca, Mg, Na, Fe, Zn, and Mn amounts in plants with 60m*M* NaCl treatment when compared with the control and 0.2% humic acid treatment.

El-Gundy (2005 ) ; Emam (2011)Nada and Tantawy (2013) showed that, increasing added HA and salinity level of irrigation water resulted in an increase of soil content of available Ca. Also Aydin *et al.* (2012) showed that shoot growth was more inhibited by NaCl than root growth. Humic acid (HA) application to the soil was ameliorated to the adverse effects of salinity on the shoot and root dry matter. The highest salt doses (120 m*M*) of NaCl, $CaCl_2$, $MgCl_2$ and $KCl_2$ without HA applications caused plant death, but no plant death was obtained when applied HA (0.05 and 0.1%) doses of all the salt types and doses with exception for $CaCl_2$. Soil salinity is characterized by high amounts of $Na^+$, $Mg^{+2}$, $Ca^{+2}$, $Cl^-$, $HCO_3^{\ -}$, $SO_4^{-2}$ and B ions which have negative effects on the plant growth. Generally, NaCl causes salt stress in nature. Aydin *et al.* (2012) found that salinity negatively affected the growth of corn; it also decreased the dry weight and the uptake of nutrient elements except for Na and Mn. Humus application of soil increased N uptake by corn while foliar application of humic acids increased the uptake of P, K, Mg, Na, Cu and Zn. Although the effect of interaction between salt and soil humus application was found statistically significant. The interaction effect between salt and foliar humic acids treatments were not found significant. Under salt stress, the first doses of both soil and foliar application of humic substances increased the uptake of nutrients. Atiyeh *et al*. (2002) found that, the root to shoot ratios of tomato seedlings increased significantly with increasing concentrations of humic acids in the soiles container medium, indicating greater resource allocation towardes the roots than the shoots.

Thise study was carried out to:- 1- Study the effect of some neutral salts i.e., NaCl, $CaCl_2$ and $FeCl_2$ applied at different rates on plant growth and its chemical composition, .2- Study the effect of humic acids different in their chemical composition on plant growth and its chemical composition and .3- Study the interaction of both neutral salts and humic acids onplant growth and its chemical composition.

## MATERIALS AND METHODS

This study was conducted on Soil Science Department, Faculty of Agriculture, Minufia University to study the combined interaction between two humic acids extracted from two different sources and three neutral salts varied in their cationic valences on barley variety Giza 123 (*Hordium vulgar L* ) growth and elements uptake content and their uptake.

The first humic acid (HAS) used in this study was extracted from the alluvial soil collected from the Experimental Farm, Faculty of Agriculture, Minufia University were as the second one (HAC)was extracted from the composted clover straw. These humic acids were extracted, fractionated and purified according to the methods described by Kononova (1966), Posner(1966), Chen *et al.* (1978) and Schnitzer & Khan (1978). The purified humic acids content of C,N,P and H was determined according to Cottenie *et al.* (1982) for total organic-C; Bremner & Mulvaney (1982) for total-N; Olsen and sommers (1982); Mann and Sounders (1966) (1966) for H-content respectively. Humic acids content of oxygen (O) was calculated by subtracting the content (%) of C. N, P and H from the total of 100 % Ash content (%) of these humic acids was estimated by burninig the oven dry humic acid at 750 $^oC$ for 24 hrs (Holder and Griffth, 1983). The obtained results of the elemental composition and the calculated atomic ratios for the two humic acids were recorded in Table (1-a ). Also, the studied humic acids contents of total acidity and some functional groups. i.e. carboxyl (COOH), total-OH, phenolic-OH and alcoholic –OH were determined according to the methods described by Dragunova (1958) ; Kukhareko (1937) and Brooks *et al.* (1958) and the obtained data were recorded in Table (1-b ).

### Sandy culture preparation.

Sand used in this study was taken from desert part of Quessna region, Minufia Governorate.Sand was sieved through a 2 mm sieve, washed by tap water, treated with diluted HCl (6%) and $H_2O_2$ (30%) to remove the carbonate and oxidize the organic matter, respectively. The treated sand was washed several times with tap water followed by distilled water. The refined sand was air-dried kept for using.

**Table (1-a): Elemental composition (%), atomic ratios and ash content (%) of the studied humic acids.**

| Humic acids | Elemental composition (%) | | | | | Atomic ratios | | | | Ash content (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | H | N | P | O | C/H | C/O | C/N | C/P | |
| HAS | 46.54 | 6.15 | 2.25 | 0.85 | 44.21 | 7.57 | 1.05 | 20.68 | 54.75 | 1.85 |
| HAC | 43.85 | 5.28 | 2.70 | 0.63 | 47.44 | 8.30 | 0.92 | 16.24 | 69.60 | 1.70 |

**Table (1-b): The tested humic acids content (meq / 100g HA ) of total acidity and some functional groups.**

| Humic acid source | Total acidity | COOH | Total - OH | Phenolic - OH | Alcoholic - OH |
|---|---|---|---|---|---|
| HAS | 580.4 | 270.1 | 445.8 | 310.3 | 135.5 |
| HAC | 710.50 | 330.4 | 527.6 | 380.1 | 182.5 |

## Stooks of Hoagland solution were prepared as:

### a- Macronutrients:-

Solutions of the macronutrients were prepared by dissolving each salt in one liter solution, namely. 236 g of $Ca(NO_3)_2$. $4H_2O$, 101 g of $KNO_3$, 136 g of $KH_2PO_4$ and 246 g of $MgSO_4.7H_2O$.

### b- Micronutrients:-

Solutions of the micronutrients were prepared by dissolving each salt in one liter solution, namely 2.86 g of $H_3BO_3$, 1.81 g of $MnCl_2$. $H_2O$, 0.22 g of $ZnSO_4.7H_2O$, 0.08 g of $CuSO_4$ $5H_2O$ and 0.02 g of $H_2MoO_4.4MnO$, Iron citrate in 100 ml distilled water.

## Prepared Hoagland solution:-

Hoagland solution was prepared by mixing 5ml of $Ca(NO_3)_2$. $4H_2O$, 5 ml of $KNO_3$, 1 ml of $KH_2PO_4$ , 2 ml of $MgSO_4.7H_2O$ and 1 ml from all micronutrient solution stooks and completed with distilled water to one liter volume.

## Expermintal greenhouse setup.

Their study was conducted on soil Sciences Department . Faculty of Agrieclture , Minufia University.

A 360 plastic pots with 20 cm inter diameter and 18 cm depth were used in this study. Each pot was filled by 1 kg clean and dried prepared sand. Each pot was planted by 12 grains of barley plants(*Hordium vulgar L.*) and irrigated every three days using Hoagland solution alternated with tap water to maintain the moisture content of the sandy culture 60 % of water holding capacity of sand. After 10 days of planting, the plants of each pot were thinned at 8 plants. After 21 days of planting, the pots were divided into two main groups (180 pot /main group ) representing the main factor or humic acids (HAS and HAC ) treatments. The pots of each main group were divided into equal five subgroups (36 pot for each sub group ) which treated by one application rate of humic acid (0, 10, 20, 40 and 100 $mgkg^{-1}$ ).

At the same time, the pots of each subgroup were divided into three sub subgroups representing the treatment of neutral salts (NaCl, $CaCl_2$, and $FeCl_2$).Finally, the pots of each sub sub group were divided into equal four groups ( 9 pot for each group ), where the pots of each final group were treated by one concentration of the used neutral salts i.e. 0, 250, 500 and 1000 mg $kg^{-1}$. The studied treatments were arranged in completely block design with three replicates. After 42 days of planting, the plants of each pot were taken as a whole, cleaned gently from sandy particles using current tap water, divided into shoots and roots, air- dried and oven-dried at 70 $^oC$ for 24 hrs and weighted to record the dry weights (g/pot ) for bot shoots and roots. The dried plant materials were finned and kept in glass bottles for its chemical analysis. The statistical design analysis for the dry matter yield carried out according to Gomez and Gomez (1984). The significant differences among means were tested using the least significant differences (L. S. D. ) at 5 % level of significance.

## Plant Analysis: -

A 0.5 g of oven-dried plant sample was digested separately using 5 ml of mixture of conc. $H_2SO_4$ and conc. $HClO_4$ at ratio of 3:1 on sandy hot plate up to become colorless( Chapman and Pratt, 1961 ). Then the digestied product was diluted using distilled water and complete the volume up to 100ml.The final solution was kept in clean glass bottles for the following chemical analysis

- Sodium was determined using flame photometer as described by Cottenie *et al*. (1982).
- Calcium was determined by titration natbod with EDTA standard solution and ammonium perpurate as indicator according to Lanyon and Heald (1982) as reported by Page *et al.,* (1982) .
- Iron was determined using atomic absorption according to the methods of described by Olsen and Ellis (1982) as reported by Page *et al.,* (1982) .

# RESULTS AND DISCUSSION

## Effect of Humic Acid and Neutral Salts Application on Plant Growth.

The present data in Table (2) show the effect of both source and application rate of humic acid individually or in presence of one chloride salts, i.e., Na, Ca and Fe at four application rates on dry weight (DW ) of both shoots and roots of barley plants as g/pot. These data reveals that, increasing rate of added humic acids individually was associated by an increase of DW of both shoots and roots of barley plants. This trend was found under different application rates of the tested chloride salts. Such increases were related it the elemental composition and functional content of the tested humic acids. So, the highest values of dry weight of barley (shoots and roots) plants were found with the plants treated by HAC which characterized by low ratios of C/N and C/O. The inhanced effect of humic acids on plant growth was attributed to its content of many essential nutrients and improving growth media conditions.These results are in agreement with those obtained by Abou Hussien (1997) ; Atiyeh *et al.* (2002) ; Veronica *et al.* (2010) and Sadek and Sallam (2011).

With studied humic acids at different application rates under all treatments of NaCl, $CaCl_2$ and $FeCl_3$, the found DW of shoots were higher than those of roots. These increases were significant for both shoots and roots and with the two humic acids. With different application rates of each humic acid, the obtained DW of barley plants varied widely according to the added salt and its application rates ( Table,2 ) this table show that, individual applications of NaCl, $CaCl_2$ and $FeCl_2$ appeared a wide effects on DW of shoots and roots.For example, with shoots and roots, increasing rates of added NaCl were associated by decrease of DW compared with that found with the control treatment. Such decreases may be resulted from the hazard effect of either of $Na^+$ or $Cl^-$ on plant growth and many metabolic processes with in plant tissues. In this respect, similar decrease effect of NaCl on plant growth was found by El-Gundy (2005) and Nada and Tantawy (2013).

**Table (2): The combined effect of both humic acids and neutral salts on shoots and roots dry weights (g/pot ) of barley plants.**

| Humic acids treatment | | Shoots | | | | | Roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Add nautral salt mg/Kg | | | | Means | Add nautral salt mg/Kg | | | | Means |
| Source | Added | 0 | 250 | 500 | 1000 | | 0 | 250 | 500 | 1000 | |
| NaCl | | | | | | | | | | | |
| HAS | 0 | 1.40 | 1.20 | 1.04 | 0.963 | 1.155 | 0.662 | 0.646 | 0.620 | 0.500 | 0.607 |
| | 10 | 1.56 | 1.31 | 1.09 | 0.997 | 1.245 | 0.680 | 0.669 | 0.654 | 0.592 | 0.649 |
| | 20 | 1.65 | 1.41 | 1.10 | 1.025 | 1.300 | 0.731 | 0.698 | 0.673 | 0.601 | 0.676 |
| | 40 | 1.77 | 1.48 | 1.12 | 1.096 | 1.369 | 0.752 | 0.712 | 0.699 | 0.650 | 0.703 |
| | 100 | 1.89 | 1.51 | 1.32 | 1.101 | 1.456 | 0.760 | 0.723 | 0.701 | 0.699 | 0.721 |
| | Mean | 1.66 | 1.38 | 1.13 | 1.036 | 1.305 | 0.717 | 0.690 | 0.669 | 0.608 | 0.671 |
| LSD(0.05) | | 0.63 | 0.43 | 0.35 | 0.371 | | 0.497 | 0.278 | 0.193 | 0.115 | |
| HAC | 0 | 1.40 | 1.20 | 1.04 | 0.963 | 1.155 | 0.662 | 0.646 | 0.620 | 0.500 | 0.607 |
| | 10 | 1.58 | 1.46 | 1.29 | 1.201 | 1.385 | 0.989 | 0.901 | 0.819 | 0.796 | 0.876 |
| | 20 | 1.61 | 1.53 | 1.48 | 1.376 | 1.501 | 1.001 | 0.966 | 0.867 | 0.801 | 0.909 |
| | 40 | 1.86 | 1.81 | 1.77 | 1.573 | 1.756 | 1.630 | 1.136 | 1.000 | 0.899 | 1.166 |
| | 100 | 2.00 | 1.99 | 1.98 | 1.667 | 1.913 | 1.920 | 1.165 | 1.240 | 1.018 | 1.336 |
| | Mean | 1.69 | 1.60 | 1.51 | 1.356 | 1.542 | 1.240 | 0.963 | 0.909 | 0.803 | 0.979 |
| LSD(0.05) | | 0.74 | 0.51 | 0.40 | 0.444 | | 0.566 | 0.338 | 0.232 | 0.164 | |
| $CaCl_2$. | | | | | | | | | | | |
| HAS | 0 | 1.409 | 1.940 | 1.825 | 1.610 | 1.696 | 0.662 | 0.730 | 0.630 | 0.621 | 0.661 |
| | 10 | 1.569 | 2.187 | 2.023 | 1.876 | 1.914 | 0.680 | 0.930 | 0.720 | 0.698 | 0.757 |
| | 20 | 1.657 | 2.358 | 2.245 | 2.102 | 2.091 | 0.731 | 1.112 | 0.966 | 0.745 | 0.889 |
| | 40 | 1.775 | 2.669 | 2.920 | 2.540 | 2.476 | 0.752 | 1.365 | 1.516 | 1.110 | 1.186 |
| | 100 | 1.896 | 2.879 | 3.089 | 2.830 | 2.674 | 0.760 | 1.430 | 1.621 | 1.356 | 1.292 |
| | Mean | 1.661 | 2.407 | 2.420 | 2.192 | 2.170 | 0.717 | 1.113 | 1.091 | 0.906 | 0.957 |
| LSD(0.05) | | 0.274 | 0.643 | 0.982 | 0.913 | | 0.211 | 0.417 | 0.771 | 0.603 | |
| HAC | 0 | 1.409 | 1.940 | 1.825 | 1.610 | 1.696 | 0.662 | 0.730 | 0.630 | 0.621 | 0.661 |
| | 10 | 1.582 | 2.410 | 2.354 | 2.214 | 2.140 | 0.989 | 1.230 | 1.031 | 0.953 | 1.051 |
| | 20 | 1.613 | 2.920 | 2.731 | 2.464 | 2.432 | 1.001 | 1.985 | 1.552 | 1.310 | 1.462 |
| | 40 | 1.866 | 3.462 | 3.654 | 3.365 | 3.087 | 1.630 | 1.996 | 2.113 | 1.985 | 1.931 |
| | 100 | 2.000 | 3.950 | 4.120 | 3.984 | 3.514 | 1.920 | 2.263 | 2.326 | 2.122 | 2.158 |
| | Mean | 1.694 | 2.936 | 2.937 | 2.727 | 2.574 | 1.240 | 1.641 | 1.530 | 1.398 | 1.452 |
| LSD(0.05) | | 0.384 | 0.747 | 1.124 | 1.102 | | 0.561 | 0.549 | 0.804 | 0.737 | |
| $FeCl_2$ | | | | | | | | | | | |
| HAS | 0 | 1.41 | 2.19 | 2.59 | 2.50 | 2.172 | 0.66 | 0.93 | 1.00 | 0.95 | 0.886 |
| | 10 | 1.57 | 2.37 | 2.69 | 2.55 | 2.295 | 0.68 | 0.95 | 1.14 | 1.01 | 0.946 |
| | 20 | 1.66 | 2.56 | 2.80 | 2.65 | 2.415 | 0.73 | 1.08 | 1.21 | 1.19 | 1.050 |
| | 40 | 1.78 | 2.65 | 3.14 | 2.99 | 2.638 | 0.75 | 1.15 | 1.24 | 1.20 | 1.084 |
| | 100 | 1.90 | 2.87 | 3.28 | 3.44 | 2.872 | 0.76 | 1.19 | 1.34 | 1.38 | 1.167 |
| | Mean | 1.66 | 2.53 | 2.90 | 2.83 | 2.478 | 0.72 | 1.06 | 1.18 | 1.15 | 1.026 |
| LSD(0.05) | | 0.289 | 0.392 | 0.699 | 0.823 | | 0.532 | 0.804 | 0.737 | 0.813 | |
| HAC | 0 | 1.41 | 2.19 | 2.59 | 2.50 | 2.172 | 0.66 | 0.93 | 1.00 | 0.95 | 0.886 |
| | 10 | 1.58 | 2.51 | 2.66 | 2.65 | 2.352 | 0.99 | 1.38 | 1.62 | 1.47 | 1.365 |
| | 20 | 1.61 | 2.63 | 3.04 | 2.80 | 2.520 | 1.00 | 1.58 | 2.48 | 2.23 | 1.821 |
| | 40 | 1.87 | 2.69 | 3.59 | 3.38 | 2.882 | 1.63 | 2.59 | 2.86 | 2.70 | 2.445 |
| | 100 | 2.00 | 3.03 | 3.94 | 4.04 | 3.253 | 1.92 | 2.71 | 3.00 | 3.12 | 2.687 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | 1.69 | 2.61 | 3.16 | 3.07 | 2.636 | 1.24 | 1.84 | 2.19 | 2.09 | 1.841 |
| LSD(0.05) | | 0.332 | 0.424 | 0.734 | 0.871 | | 0.586 | 0.817 | 0.783 | 0.890 | |

The obtained DW of barley (shoots and roots ) plants in relation to added rates of $CaCl_2$ individually as presented data in Table (2) show that, these weights were increased up to rate of 500 mg $CaCl_2$ / kg compared control treatment and decreased at application rate of 1000 mg $CaCl_2$ / kg compared with that found at low rates of added $CaCl_2$. These results were attributed to benificial and promote effects of Ca on plant growth at low and medium rates of added $CaCl_2$ in the growth media, but at added rate of 1000 mg / kg may be resulted in decrease of some metabolic processes especially in presence high concentration of $Cl^-$ in growth media. These results are in agreement with these obtained by Hammad and Abou El-Khir (2005) and Fayed (2009). In addition, the presented data in Table (2) show that, individual application of $FeCl_2$ at all application rates were associated by an increase of DW of barley (shoots and roots ) plants. These increases are related with positive and important role of Fe on plant growth and activity rates of metabolic processes (Alloway, 2008 ). These results are in agreement with these obtained by Abou Hussien (1997) ; Katkat *et al.* (2009) and El-Noamany (2013).

The data of interaction between different application rates of humic acids isolated from different sources and have varies chemical components and the three neutral salts i.e., NaCl, $CaCl_2$ and $FeCl_2$ which added at four application rates effects on DW of barley (shoots and roots ) plants as presented in Table (2) show that, decrease effect of NaCl on DW of barley shoots and roots was decreased as a result of plants treated by humic acids. In addition the increase effect of either of $CaCl_2$ or $FeCl_2$ on the obtained DW of shoots and roots were become more greater when these salts applied in combination with the humic acids. These increases were increased with the increase added rate of humic acids and varied from one to another. Under different treatments of the tested neutral salts, the highest values of DW of shoots and roots were associated the treatments of HAC. These findings were in clear relations with the used humic acids elemental composition, atomic ratios and the content of functional groups (Abou Hussien, 1997 and Nada and Tantawy, 2013).

Data of the statistical (LSD at 0.05 ) of DW of barley (shoots and roots ) plants in relation with the studied treatments of humic acids and neutral salts individually or in combination are listed in Table (2). These data show that, individual application of humic acids resulted in a significant increase of DW, but there are a significant different between the used two humic acids effect on barley plants yield. The same data, also show that, the significant effect of individual applications of NaCl, $CaCl_2$ or $FeCl_2$ was varied from one to another, where the high negative effect was associated the treatments of NaCl and the lowest one was found with $FeCl_2$ treatments. The significant effects of neutral salts were become more positive when its applied in combination with humic acids. The latter effect was more clear with the plants treated by HAC. These findings are in harmony with used humic acids chemical composition and its content of functional groups.These results are in agreement with these obtained by Aydin *et al*. (2012) and Abd El-Kader *et al.* (2013).

The presented data in Table (3) show the relative change (RC) as a percent (%) of the obtained DW of both shoots and roots of barley plants in relation with the used humic acids under different types and application rates of some neutral salts. This table indicated that, at each rate of NaCl, $CaCl_2$ or $FeCl_2$ RC values of DW with either of shoots or roots of barley plants were varied from acid to another. These values were increased with the increase of added HA. According to the found values of RC (%), the tested humic acids takes the order HAC > HAS. This trend was attributed to the humic acid content of functional groups and also its content of N and other nutrients

(Abou Hussien, 1997 ). These results are in agreement with those obtained by Hussein and Hassan (2011) and Nada and Tantawy (2013).

**Table (3): Relative change *"RC" (%) shoots and roots dry weights of barley plants planted in sandy culture as affected by different additives of both humic acids and neutral salts.**

| Humic acids treatment | | Added neutral salt (mg/kg) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Source | Added (mg/kg) | Shoots (g / pot ) | | | | Roots ( g / pot ) | | | |
| | | 0 | 250 | ٥٠٠ | ١٠٠٠ | 0 | 250s | 500 | 1000 |
| NaCl | | | | | | | | | |
| HAS | 10 | 11.350 | 9.136 | 5.470 | 3.530 | 2.71 | 3.56 | 5.48 | 18.40 |
| | 20 | 17.600 | 17.690 | 5.660 | 6.438 | 10.45 | 8.05 | 8.55 | 20.20 |
| | 40 | 25.970 | 23.250 | 7.580 | 13.810 | 13.59 | 10.21 | 12.74 | 30.00 |
| | 100 | 34.560 | 24.660 | 27.150 | 14.330 | 14.84 | 11.91 | 13.06 | 39.80 |
| HAC | 10 | 12.270 | 18.330 | 24.470 | 24.710 | 49.54 | 39.47 | 32.09 | 59.20 |
| | 20 | 14.470 | 27.150 | 42.410 | 42.880 | 51.66 | 49.53 | 39.83 | 60.20 |
| | 40 | 32.430 | 50.330 | 70.440 | 63.340 | 146.90 | 75.85 | 61.29 | 79.80 |
| | 100 | 41.940 | 65.940 | 90.490 | 73.100 | 190.90 | 80.30 | 100.00 | 103.60 |
| $CaCl_2$ | | | | | | | | | |
| HAS | 10 | 11.35 | 12.73 | 11.12 | 16.52 | 2.71 | 27.39 | 14.28 | 12.39 |
| | 20 | 17.60 | 21.54 | 23.01 | 30.55 | 10.45 | 52.32 | 53.33 | 19.96 |
| | 40 | 25.97 | 37.57 | 60.00 | 57.76 | 13.59 | 86.98 | 140.60 | 78.74 |
| | 100 | 34.56 | 48.40 | 69.26 | 75.77 | 14.84 | 95.89 | 157.30 | 118.30 |
| HAC | 10 | 12.27 | 24.22 | 28.98 | 37.51 | 49.54 | 68.49 | 63.65 | 53.46 |
| | 20 | 14.47 | 50.51 | 49.64 | 53.04 | 51.66 | 171.90 | 146.30 | 110.90 |
| | 40 | 32.43 | 78.45 | 100.00 | 109.00 | 146.90 | 173.40 | 235.30 | 219.60 |
| | 100 | 41.94 | 103.60 | 177.90 | 147.40 | 190.90 | 210.10 | 269.20 | 241.70 |
| $FeCl_2$ | | | | | | | | | |
| HAS | 10 | 11.35 | 8.18 | 3.94 | 2.00 | 2.71 | 2.08 | 14.41 | 6.44 |
| | 20 | 17.60 | 17.01 | 7.99 | 5.80 | 10.45 | 15.46 | 20.72 | 25.15 |
| | 40 | 25.97 | 21.17 | 21.06 | 19.55 | 13.59 | 23.52 | 23.72 | 26.00 |
| | 100 | 34.56 | 31.13 | 26.54 | 37.62 | 14.84 | 27.38 | 34.03 | 45.47 |
| HAC | 10 | 12.27 | 14.86 | 2.70 | 5.96 | 49.54 | 48.33 | 62.16 | 54.73 |
| | 20 | 14.47 | 20.11 | 17.36 | 11.91 | 51.66 | 69.28 | 148.04 | 134.70 |
| | 40 | 32.43 | 23.04 | 38.46 | 35.18 | 146.90 | 178.40 | 185.78 | 184.30 |
| | 100 | 41.94 | 38.04 | 51.81 | 61.57 | 190.90 | 191.40 | 199.70 | 228.20 |

Dry matter yield of treated plants – Dry matter yield of untreated plants.

$$* RC = \frac{}{\text{Dry matter yield of untreated plants}} \times 100.$$

In addition the values of RC (%) of DW of shoots and roots varied from low to high values in the treatments of neutral salts according to added salt and its application rate (Table,3). The low values of RC of DW were found with the plants treated by NaCl and become more lowest at high application rate of NaCl especially with low application rate of humic acids. Also, with $CaCl_2$ treatments, the data indicated that, for both shoots and roots,the highest RC (%) values of DW were found with application rate at 1000 mg. These findings were found with the tested humic acids at different application rates. In addition, RC values of the plants treated with $FeCl_2$ takes the reversal trend reported with $CaCl_2$ at different application rates under different treatments of humic acid. These findings were observed with shoots and roots for DW. These findings showed that, humic acids additives with neutral salts decreased its stress or its hazard effects on plant growth. This beneficial effect attributed to the improve effect of humic acids on growing media and its as a good source for many essential nutrients. Morever presence humic acids in growing media increased water availability and uptake by plants, (Hussein and Hassan, 2011 and Nada and Tantawy, 2013).

Also, the obtained values of RC indicated that, NaCl additions were associated by high stress on plant growth, where the lowest one was associated the treatments of NaCl. This trend may be attributed to the type and strong complexes formed between NaCl, $CaCl_2$ or $FeCl_2$ with humic acids, where these complexes strong takes the order: $CaCl_2$ > $FeCl_2$ > NaCl. Many authors showed that, ion humic acid complexes become more stable and strong with the valence ion increase (Stevenson 1994 and Abou Hussien *et al.,*2002 ).

The presented data in Table (4) show, the calculated values of agronomical efficiency (AE) of humic acids as mg dry plant materials / mg humic acid in relation with source and application rates of humic acid individually or in combination with three neutral salts, i.e., NaCl, $CaCl_2$ and $FeCl_2$ used at rates of 250, 500 and 1000 mg / kg with, AE values calculated with the humic acids for both shoots and roots of barley plants were decreased with the increase rate of added humic acids and varied from acid to another. With the same rate of added humic acids and according to AE values, these acids may be arranged in the following order HAC > HAS.

This order in harmony with these humic acids content of total acidity, functional groups and essential nutrients, i.e., C, N, H, O and others. Also, the same data showed that, the values of AE for the humic acids with shoots were higher than these found with roots. These results are in agreement with these obtained by Tonder (2008) ; Celik *et al.* (2008) ; Katkat *et al.* (2009 ) and Aydin *et al.* (2012).

In addition, the AE values of humic acids for DW of barley plants as affected by different additives of humic acids in combination with neutral salts appeared a wide variations depending on neutral salt type and its application rate ( Table,4). For example, with the humic acids, AE values were decreased with the increase rate of added NaCl and increased with the increase of added $CaCl_2$ and $FeCl_2$ up to 500 mg/ kg and decreased at application rate of 1000 mg / kg. These findings were found with DW for shoots and roots, mostly. These findings also reveals that NaCl have a greater stress on plant growth compared with that associated the treatments of either of $CaCl_2$ or $FeCl_2$.These results means that humic acids additives resulted in a decrease of salinity stress and its effect on plant growth. In this respect El-Gundy (2005) ; Emam (2011) and Nada and Tantawy (2013) obtained on similar results.

**Table (4): Agronmical efficiency *"AE" of shoots and roots of barley plants (mg/mg HA) planted in sandy culture as affected by different additives of humic acids and neutral salts.**

| Humic acids treatment | | Shoots | | | | | Roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Add nautral salt mg/Kg | | | | Means | Add nautral salt mg/Kg | | | | Means |
| Source | Added | 0 | 250 | 500 | 1000 | | 0 | 250 | 500 | 1000 | |
| $NaCl$ | | | | | | | | | | | |
| HAS | 10 | 16.00 | 11.00 | 5.70 | 3.40 | 9.03 | 1.80 | 2.30 | 3.40 | 9.20 | 4.18 |
| | 20 | 12.40 | 10.65 | 2.95 | 3.10 | 7.28 | 3.45 | 2.60 | 2.65 | 5.05 | 3.44 |
| | 40 | 9.15 | 7.00 | 1.97 | 3.32 | 5.36 | 2.25 | 1.65 | 1.98 | 3.75 | 2.41 |
| | 100 | 4.87 | 2.97 | 2.83 | 1.38 | 3.01 | 0.98 | 0.77 | 0.81 | 1.99 | 1.14 |
| | Mean | 8.48 | 6.32 | 2.69 | 2.24 | 4.93 | 1.70 | 1.46 | 1.77 | 4.00 | 2.23 |
| HAC | 10 | 17.20 | 25.70 | 25.50 | 23.80 | 23.05 | 32.70 | 25.50 | 19.90 | 29.60 | 26.93 |
| | 20 | 10.20 | 16.35 | 22.10 | 20.65 | 17.33 | 16.95 | 16.00 | 12.35 | 15.05 | 15.09 |
| | 40 | 11.42 | 15.15 | 18.35 | 15.25 | 15.04 | 24.20 | 12.25 | 9.50 | 9.97 | 13.98 |
| | 100 | 5.91 | 7.94 | 9.43 | 7.04 | 7.58 | 12.58 | 5.19 | 6.20 | 5.18 | 7.29 |
| | Mean | 8.95 | 13.03 | 15.08 | 13.35 | 12.60 | 17.29 | 11.79 | 9.59 | 11.96 | 12.66 |
| $CaCl_2$. | | | | | | | | | | | |
| HAS | 10 | 16.00 | 24.70 | 19.80 | 26.60 | 21.78 | 1.80 | 20.00 | 9.00 | 7.70 | 9.63 |
| | 20 | 12.40 | 20.90 | 21.00 | 24.60 | 19.73 | 3.45 | 19.10 | 16.80 | 6.20 | 11.39 |
| | 40 | 9.15 | 18.22 | 27.37 | 23.25 | 19.50 | 2.25 | 15.87 | 22.15 | 12.22 | 13.12 |
| | 100 | 4.87 | 9.39 | 12.64 | 12.20 | 9.78 | 0.98 | 7.00 | 9.91 | 7.35 | 6.31 |
| | Mean | 8.48 | 14.64 | 16.16 | 17.33 | 14.15 | 1.70 | 12.39 | 11.57 | 6.69 | 8.09 |
| HAC | 10 | 17.30 | 47.00 | 52.90 | 60.40 | 44.40 | 32.70 | 50.00 | 40.10 | 33.20 | 39.00 |
| | 20 | 10.20 | 49.00 | 45.30 | 42.70 | 36.80 | 16.95 | 62.75 | 46.10 | 34.45 | 40.06 |
| | 40 | 11.42 | 38.05 | 45.72 | 43.87 | 34.77 | 24.20 | 31.57 | 37.07 | 34.10 | 31.74 |
| | 100 | 5.91 | 20.10 | 22.95 | 23.74 | 18.18 | 12.58 | 5.33 | 16.96 | 15.01 | 12.47 |
| | Mean | 11.18 | 30.83 | 33.37 | 34.14 | 26.83 | 17.29 | 29.93 | 28.05 | 23.35 | 24.65 |
| $FeCl_2$ | | | | | | | | | | | |
| HAS | 10 | 16.00 | 17.90 | 10.20 | 5.00 | 12.28 | 1.80 | 2.00 | 14.40 | 5.80 | 6.00 |
| | 20 | 12.40 | 18.60 | 10.35 | 7.25 | 12.15 | 3.45 | 7.20 | 10.35 | 11.95 | 8.24 |
| | 40 | 9.15 | 11.57 | 13.65 | 12.22 | 11.65 | 2.25 | 5.48 | 5.93 | 6.18 | 4.96 |
| | 100 | 4.87 | 6.81 | 6.88 | 9.41 | 6.99 | 0.98 | 2.55 | 3.40 | 4.32 | 2.81 |
| | Mean | 8.48 | 10.98 | 8.22 | 6.78 | 8.61 | 1.70 | 3.45 | 6.82 | 5.65 | 4.40 |
| HAC | 10 | 17.20 | 32.50 | 7.00 | 14.90 | 17.90 | 32.70 | 45.00 | 62.10 | 52.00 | 47.95 |
| | 20 | 10.20 | 22.00 | 22.50 | 14.90 | 17.40 | 16.95 | 32.25 | 73.95 | 64.00 | 46.79 |
| | 40 | 11.42 | 12.60 | 24.92 | 22.00 | 17.74 | 24.20 | 41.52 | 46.40 | 43.77 | 38.97 |
| | 100 | 5.90 | 8.47 | 12.73 | 15.40 | 10.63 | 12.58 | 17.82 | 19.96 | 21.68 | 18.01 |
| | Mean | 8.94 | 15.11 | 13.43 | 13.44 | 12.73 | 17.29 | 27.32 | 40.48 | 36.29 | 30.34 |

$$*AE = \frac{\text{Dry matter yield of treated plants– Dry matter yield of untreated plants.}}{\text{Added humic acid (mg kg -1)}}$$

## Effect of Humic Acids an Neutral Salts on Plant Chemical Composition.

### a. Sodium (Na) content.

The presented data in Table (5) show barley plants (shoots and roots ) concentration (mg/kg ) and uptake (mg / pot ) of Na in relation with both humic acids isolated from different sources and NaCl at different application rates. This table show that, with both shoots and roots of barley plants Na concentration were increased with the increase of added NaCl individually.

Also, at the same individual application rate of NaCl , Na concentration of shoots was higher than that in roots. On the other hand, individual NaCl additions at 250 mg/kg was associated by increase of Na uptake, but at high application rate, i.e., 500 and 1000 mg/kg resulted in a decrease of Na uptake. These findings were found in shoots, while Na uptake in roots was increased with increase rate of added NaCl. The latter results were attributed to the reductions found in the dry matter yield of shoots and roots at high rates of added NaCl. In this respect, similar results were obtained by Hammad and Abo El-Khir (2005) and Nada and Tantawy (2013.

The presented data in Tables (6 ) show that, increasing of added rates individually of the tested humic acids was associated by a decrease of Na concentration (mg/kg ) of both shoots and roots of barley plants. This decrease was attributed to the found increase of barley plants growth associated the treatments of humic acids. This effect namely by dilution effect (Marschner,1998 ). So, most individual treatments of humic acids were resulted in a decrease of Na uptake by both shoots and roots. Such this decrease was become more high at high rates of added humic acids. At the individual application rate of humic acids, the found decrease of Na concentration and its uptake by either of shoots or roots was varied widely from acid to another depending on the chemical composition of the tested humic acids and its effect on plant growth and elements uptake.So, the high Na content was found in the plants treated by HAC. These results are in agreement with these obtained by, Abou Hussien (1997) ; Abou Hussien *et al*. (2002 ) ; El-Desuki (2004) and Shaaban *et al*. (2009).

In addition application humic acids and NaCl at different rates in combination appeared a wide variations in their effect on Na concentration and uptake by shoots and roots of barley plants (Tables, 6). Humic acids application reduced Na concentration and uptake by shoots and roots compared with these found in the individual treatments of NaCl but this content was higher than associated the individual treatments of humic acids. These results means that, Na may be weakly retained by humic acids and become less available for uptake by plant. Meloni *et al.* (2001 and 2004 ) ; Turan and Aydin (2005) ; El-Gundy (2005) and Aydin *et al.* (2012).

### b.Calcium (Ca) content.

The presented data in Table (6) show individual and combined effect of both humic acids isolated from different sources and $CaCl_2$ at different application rates on barley plants concentration (mg/kg ) of Ca and its uptake (mg/pot ). These data show that, Ca concentration and uptake by both shoots and roots was increased with the increase of added $CaCl_2$ as alone. This may be considered as natural results which attributed to the high concentration of Ca in growth media. With the same rate of $CaCl_2$ individual application Ca concentration and uptake by shoots were higher than those found with roots. In this respect Hammad and Abou El-Khir (2005) and Nada and Tantawy (2013) obtained on similar results. In addition the data reveals that with, both Ca concentration (mg $kg^{-1}$ ) of shoots and roots was decreased with the increase of added humic acids as alone. Such this decrease was resulted from the high dry matter yield of shoots and roots associated the high rates of added humic acids as common by dilution effect (Marschner, 1998 ). The rate of this decrease was decreased with the increase of humic acid application rate. Also, Ca concentration in both shoots and roots was varied with from humic acid to another, where high Ca concentration of shoots and roots was recorded with different application rates of humic acid isolated from soil (HAS).

**Table (5): Sodium concentration (mg/kg) and uptake (mg/pot ) in shoots and roots of barley plants of as affected by source and application rates of humic acids under different application rates of NaCl**

| Humic acids treatment | | Conc. mg-Na/kg | | | | | Uptake mg- Na/ pot | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Add NaCl. mg/kg | | | | Means | Add NaCl mg/kg | | | | Means |
| Source | Added (mg/kg) | 0 | 250 | 500 | 1000 | | 0 | 250 | 500 | 1000 | |
| Shoots | | | | | | | | | | | |
| HAS | ٠ | 1026 | 11596 | 12960 | 14070 | 9913.0 | 1.45 | 13.96 | 13.50 | 13.54 | 10.61 |
| | ١٠ | 1020 | 11520 | 12825 | 14000 | 9841.2 | 1.60 | 15.13 | 14.09 | 13.95 | 11.19 |
| | ٢٠ | 840 | 10560 | 12150 | 12600 | 9037.5 | 1.39 | 14.96 | 13.37 | 12.91 | 10.66 |
| | ٤٠ | 720 | 8960 | 10800 | 11900 | 8095.0 | 1.28 | 13.29 | 12.10 | 13.04 | 9.93 |
| | ١٠٠ | 600 | 8320 | 9450 | 10500 | 7217.5 | 1.14 | 12.48 | 12.52 | 11.56 | 9.42 |
| | Mean | 841 | 10191 | 11637 | 12614 | 8820.8 | 1.37 | 13.96 | 13.12 | 13.00 | 10.36 |
| HAC | ٠ | 1026 | 11596 | 12960 | 14070 | 9913.0 | 1.45 | 13.96 | 13.50 | 13.54 | 10.61 |
| | ١٠ | 858 | 10880 | 12150 | 13300 | 9297.0 | 1.58 | 15.89 | 15.75 | 15.97 | 12.30 |
| | ٢٠ | 686 | 9600 | 11643 | 12460 | 8597.2 | 1.11 | 14.69 | 17.27 | 17.14 | 12.55 |
| | ٤٠ | 429 | 8000 | 9450 | 10500 | 7094.7 | 0.80 | 14.48 | 16.78 | 16.51 | 12.14 |
| | ١٠٠ | 384 | 6880 | 8775 | 10150 | 6547.2 | 0.77 | 13.74 | 17.41 | 16.92 | 12.21 |
| | Mean | 677 | 9391 | 10996 | 12096 | 8289.8 | 1.14 | 14.55 | 16.14 | 16.02 | 11.96 |
| Roots | | | | | | | | | | | |
| HAS | ٠ | 516 | 5824.0 | 7155.0 | 8120 | 5403.750 | 0.341 | 3.762 | 4.436 | 4.807 | 3.34 |
| | ١٠ | 510 | 5760 | 7087 | 7980 | 5334.250 | 0.346 | 3.853 | 4.634 | 4.724 | 3.39 |
| | ٢٠ | 480 | 54400 | 6615 | 7000 | 4883.750 | 0.350 | 3.797 | 4.451 | 4.207 | 3.20 |
| | ٤٠ | 456 | 5120 | 6210.0 | 6720 | 4626.500 | 0.342 | 3.645 | 4.340 | 4.368 | 3.17 |
| | ١٠٠ | 408 | 4736 | 5535.0 | 6300 | 4244.750 | 0.310 | 3.424 | 3.880 | 4.403 | 3.00 |
| | Mean | 474 | 5376 | 6520.4 | 7224 | 4898.60 | 0.338 | 3.696 | 4.348 | 4.502 | 3.22 |
| HAC | ٠ | 516.0 | 5824.00 | 7155.0 | 8120.00 | 5403.750 | 0.341 | 3.762 | 4.436 | 4.807 | 3.34 |
| | ١٠ | 492 | 5760 | 7425 | 8400 | 5519.250 | 0.486 | 5.189 | 6.081 | 6.686 | 4.61 |
| | ٢٠ | 468 | 5376 | 6750 | 7840 | 5108.500 | 0.468 | 5.193 | 5.852 | 6.279 | 4.45 |
| | ٤٠ | 420 | 4864 | 6210 | 7000 | 4623.500 | 0.684 | 5.525 | 6.21 | 6.293 | 4.68 |
| | ١٠٠ | 300 | 3712 | 4995 | 6300 | 3826.750 | 0.576 | 4.324 | 6.193 | 6.413 | 4.38 |
| | Mean | 439.2 | 5107.2 | 6507.0 | 7532.0 | 4896.350 | 0.511 | 4.799 | 5.754 | 6.096 | 4.29 |

**Table (6): Calcium concentration (mg/kg) and uptake (mg/pot ) and its relative change (RC ) percent (%) in shoots and roots of barley plants of as affected by source and application rates of humic acids under different application rates of $CaCl_2$.**

| Humic acids treatment | | Conc. mg-Na/kg | | | | | Uptake mg- Na/ pot | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Add $CaCl_2$. mg/kg | | | | Means | Add $CaCl_2$ mg/kg | | | | Means |
| Source | Added (mg/kg) | 0 | 250 | 500 | 1000 | | 0 | 250 | 500 | 1000 | |
| Shoots | | | | | | | | | | | |
| HAS | ٠ | 855.0 | 9060.0 | 9600.0 | 10050.0 | 7391.3 | 1.204 | 17.570 | 17.520 | 16.180 | 13.119 |
| | ١٠ | 850.0 | 9000.0 | 9500.0 | 10000.0 | 7337.5 | 1.333 | 19.680 | 19.210 | 18.760 | 14.746 |
| | ٢٠ | 700.0 | 8250.0 | 9000.0 | 9000.0 | 6737.5 | 1.159 | 19.450 | 20.200 | 18.910 | 14.930 |
| | ٤٠ | 600.0 | 7000.0 | 8000.0 | 8500.0 | 6025.0 | 1.065 | 18.680 | 23.360 | 21.590 | 16.174 |
| | ١٠٠ | 500.0 | 6500.0 | 7000.0 | 7500.0 | 5375.0 | 0.948 | 18.710 | 21.620 | 21.220 | 15.625 |
| | Mean | 701.0 | 7962.0 | 8620.0 | 9010.0 | 6573.3 | 1.142 | 18.818 | 20.382 | 19.332 | 14.918 |
| HAC | ٠ | 855.0 | 9060.0 | 9600.0 | 10050.0 | 7391.3 | 1.204 | 17.570 | 17.520 | 16.180 | 13.119 |
| | ١٠ | 715 | 8500 | 9000 | 9500 | 6928.8 | 1.131 | 20.48 | 21.18 | 21.03 | 15.955 |
| | ٢٠ | 572 | 7500 | 8625 | 8900 | 6399.3 | 0.922 | 21.9 | 23.55 | 21.92 | 17.073 |
| | ٤٠ | 358 | 6250 | 7000 | 7250 | 5214.5 | 0.668 | 21.63 | 25.57 | 25.23 | 18.275 |
| | ١٠٠ | 320 | 5375 | 6500 | 6000 | 4548.8 | 0.64 | 21.23 | 26.78 | 28.88 | 19.383 |
| | Mean | 564.0 | 7337.0 | 8145.0 | 8340.0 | 6096.5 | 0.913 | 20.562 | 22.920 | 22.648 | 16.761 |
| Roots | | | | | | | | | | | |
| HAS | ٠ | 430.0 | 4550.0 | 5300.0 | 5800.0 | 4020.0 | 0.284 | 3.320 | 3.339 | 3.601 | 2.636 |
| | ١٠ | 425.0 | 4500.0 | 5250.0 | 5700.0 | 3968.8 | 0.289 | 4.185 | 3.780 | 3.978 | 3.058 |
| | ٢٠ | 400.0 | 4250.0 | 4900.0 | 5000.0 | 3637.5 | 0.292 | 4.726 | 4.730 | 3.725 | 3.368 |
| | ٤٠ | 380.0 | 4000.0 | 4600.0 | 4800.0 | 3445.0 | 0.285 | 5.460 | 6.973 | 5.328 | 4.512 |
| | ١٠٠ | 340.0 | 3700.0 | 4100.0 | 4500.0 | 3160.0 | 0.258 | 5.290 | 6.646 | 6.102 | 4.574 |
| | Mean | 395.0 | 4200.0 | 4830.0 | 5160.0 | 3646.3 | 0.282 | 4.596 | 5.094 | 4.547 | 3.630 |
| HAC | ٠ | 430.0 | 4550.0 | 5300.0 | 5800.0 | C114:F114 | 0.284 | 3.320 | 3.339 | 3.601 | 2.636 |
| | ١٠ | 410 | 4500 | 5500 | 6000 | 4102.5 | 0.405 | 5.535 | 5.67 | 5.718 | 4.332 |
| | ٢٠ | 390 | 4200 | 5000 | 5600 | 3797.5 | 0.39 | 8.337 | 7.76 | 7.336 | 5.956 |
| | ٤٠ | 350 | 3800 | 4600 | 5000 | 3437.5 | 0.389 | 7.584 | 9.719 | 9.925 | 6.904 |
| | ١٠٠ | 250 | 2900 | 3700 | 4500 | 2837.5 | 0.48 | 6.562 | 8.606 | 9.549 | 6.299 |
| | Mean | 366.0 | 3990.0 | 4820.0 | 5380.0 | 3543.8 | 0.390 | 6.268 | 7.019 | 7.226 | 5.225 |

These results takes the the reversible trend for the effect of these humic acids on obtained dry matter yield of barley plants. On the other hand, with individual additives of humic acids, Ca uptake (mg/ pot ) for both shoots and roots of barley plants was decreased with the increase rate of added humic acid (Table, 6 ) in mostly. This decrease effect was varied from humic acid to another. The highest uptake of Ca uptake by shoots and roots was found in the plants treated by HAC. These findings were found with all tested rates of the humic acids. Such this increase was related with found dry matter yield of shoots of barley plants. These results are in agreement with those obtained by Hussein and Hassan (2011) and Aydin *et al.* (2012).

Regarding to the results of combined treatments of humic acids and $CaCl_2$ at different application rates on Ca concentration (mg $kg^{-1}$) and uptake (mg $pot^{-1}$ ) by shoots and roots of barley plants as listed in Table (6) may be observed that, humic acids additives in combination with $CaCl_2$ reduced Ca concentration and uptake at the same rate of added $CaCl_2$ compared with that found in the plants untreated by humic acids. This decrease was become more clear at high application rate of humic acids. The rate of this decrease was varied from humic acid to another depending on its content of total acidity and functional groups. The lowest one was found in the plants treated by HAS at low application rate. This trend was found with all application rates of $CaCl_{2.}$ These findings of decrease of Ca concentration with humic acids additives was attributed to chelating action for these humic acids to Ca as Ca - humate and complex which become less available to uptake by plants (Stevenson, 1994 ). Chelating action or reducing Ca solubility was varied from humic acid to another, where this effect was increased with the increase of humic acid content of total acidity and functional groups. So, at the same application rate of the used humic acids the high decrease of Ca concentration was found in both shoots and roots of barley plants treated by HAC.

## c. Iron (Fe ) content.

The presented data in Table (7) show the effect of individual and combined treatments of humic acids and $FeCl_3$ at different application rates of them on Fe concentration (mg $kg^{-1}$ ) and uptake (mg $pot^{-1}$ ) by shoots and roots of barley plants. These data show that, Fe concentration and uptake were increased with the increase of added $FeCl_2$ as alone. This trend was found with both shoots and roots. Under the same individual treatment of $FeCl_2$, Fe concentration of shoots was higher than that of roots. Nearly similar trend of Fe uptake was found with the individual treatment of $FeCl_2$. These findings attributed to the enhanced effect of Fe on plant growth and enzymes activity. In this respect, Abou Hussien (1997) and El-Noamany (2013) obtained on similar results.

The effect of individual treatments of humic acids on Fe concentration as presented in Table (7) show that, increasing rate of added humic acids was associated by decrease of Fe concentration in both shoots and roots. The rate of this decrease was become more clear at high application rates of added humic acids. Also this effect was varied from humic acid to another. The found decrease of Fe concentration attributed to the found increase of dry matter yield of barley plants associated humic acids treatments. This effect normally named by dilution effect ( Marschner, 1998 ). So, the high concentration was found in the plants treated by HAS. This trend was observived with both shoots and roots. With all combined treatments of humic acids and $FeCl_2$ at different application rates on Fe concentration of shoots was higher than that of roots. In this respect, Abou Hussien (1997) and Abou Hussien *et al*. ( 2002 ) obtained on similar results.

**Table (7): Iron concentration (mg/kg) and uptake (mg/pot in shoots and roots of barley plants of as affected by source and application rates of humic acids under different application rates of $FeCl_2$.**

| Humic acids treatment | | Conc. mg-Na/kg | | | | | Uptake mg- Na/ pot | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Add $FeCl_2$. mg/kg | | | | Means | Add $FeCl_2$ mg/kg | | | | Means |
| Source | Added (mg/kg) | 0 | 250 | 500 | 1000 | | 0 | 250 | 500 | 1000 | |
| Shoots | | | | | | | | | | | |
| HAS | ٠ | 1150.0 | 5900.0 | 6500.0 | 7000.0 | 5137.5 | 1.620 | 12.900 | 16.840 | 17.500 | 12.215 |
| | ١٠ | 1102.0 | 5850.0 | 5900.0 | 6100.0 | 4738.0 | 1.729 | 13.840 | 15.890 | 15.560 | 11.755 |
| | ٢٠ | 975.0 | 5500.0 | 5800.0 | 6000.0 | 4568.8 | 1.615 | 14.070 | 16.230 | 15.870 | 11.946 |
| | ٤٠ | 967.0 | 5300.0 | 5600.0 | 5900.0 | 4441.8 | 1.716 | 14.040 | 17.570 | 17.640 | 12.742 |
| | ١٠٠ | 890.0 | 5100.0 | 5400.0 | 5700.0 | 4272.5 | 1.687 | 14.620 | 17.710 | 19.610 | 13.407 |
| | Mean | 1016.8 | 5530.0 | 5840.0 | 6140.0 | 4631.7 | 1.673 | 13.894 | 16.848 | 17.236 | 12.413 |
| HAC | ٠ | 1150.0 | 5900.0 | 6500.0 | 7000.0 | 5137.5 | 1.620 | 12.900 | 16.840 | 17.500 | 12.215 |
| | ١٠ | 1080 | 5750 | 5850 | 6000 | 4670.0 | 1.708 | 14.44 | 15.57 | 15.9 | 11.905 |
| | ٢٠ | 965 | 5200 | 5600 | 5800 | 4391.3 | 1.556 | 13.66 | 17.03 | 16.23 | 12.119 |
| | ٤٠ | 940 | 5000 | 5400 | 5700 | 4260.0 | 1.754 | 13.45 | 19.38 | 19.27 | 13.464 |
| | ١٠٠ | 880 | 4950 | 5200 | 5500 | 4132.5 | 1.76 | 15.01 | 20.46 | 22.22 | 14.863 |
| | Mean | 1003.0 | 5360.0 | 5710.0 | 6000.0 | 4518.3 | 1.680 | 13.892 | 17.856 | 18.224 | 12.913 |
| Roots | | | | | | | | | | | |
| HAS | ٠ | 900.0 | 4900.0 | 5200.0 | 6000.0 | 4250.0 | 0.5950 | 4.5610 | 5.1940 | 5.7000 | 4.0125 |
| | ١٠ | 880.0 | 4800.0 | 5100.0 | 5900.0 | 4170.0 | 0.5980 | 4.5640 | 5.8290 | 5.9470 | 4.2345 |
| | ٢٠ | 846.0 | 4400.0 | 4900.0 | 5700.0 | 3961.5 | 0.6180 | 4.7300 | 5.9090 | 6.7770 | 4.5085 |
| | ٤٠ | 805.0 | 4150.0 | 4600.0 | 5400.0 | 3738.8 | 0.6050 | 4.7720 | 5.6850 | 6.4600 | 4.3805 |
| | ١٠٠ | 770.0 | 4000.0 | 4750.0 | 5100.0 | 3655.0 | 0.5850 | 4.7440 | 6.3600 | 7.0480 | 4.6843 |
| | Mean | 840.2 | 4450.0 | 4910.0 | 5620.0 | 3955.1 | 0.6002 | 4.6742 | 5.7954 | 6.3864 | 4.3641 |
| HAC | ٠ | 900.0 | 4900.0 | 5200.0 | 6000.0 | 4250.0 | 0.5950 | 4.5610 | 5.1940 | 5.7000 | 4.0125 |
| | ١٠ | 850.0 | 4650.0 | 4950.0 | 5700.0 | 4037.5 | 0.84 | 6.42 | 8.019 | 8.379 | 5.9145 |
| | ٢٠ | 810.0 | 4300.0 | 4800.0 | 5550.0 | 3865.0 | 0.81 | 6.776 | 11.89 | 12.37 | 7.9615 |
| | ٤٠ | 790.0 | 4050.0 | 4550.0 | 5300.0 | 3672.5 | 1.287 | 10.49 | 12.99 | 14.31 | 9.7693 |
| | ١٠٠ | 740.0 | 3800.0 | 4300.0 | 4900.0 | 3435.0 | 1.42 | 10.3 | 12.87 | 15.27 | 9.9650 |
| | Mean | 818.0 | 4340.0 | 4760.0 | 5490.0 | 3852.0 | 0.9904 | 7.7094 | 10.1926 | 11.2058 | 7.5246 |

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The presented data in Table (7) show the effect of combined treatments of humic acids and $FeCl_2$ at different application rates of them on Fe content in shoots and roots of barley plants. These data show that, at the same rate of $FeCl_2$ application, increasing rate of added humic acids was associated by decrease of Fe concentration by shoots and roots of barley plants while the Fe uptake was increased. The rate of this effect was increased with the increase rate of added humic acids and varied from acid to another. With different application rates of $FeCl_2$, barley plants treated by HAS characterized by high concentration of Fe. This trend was in harmony with the at named by dilution effect. At the same rate of each humic acid application, increasing application rates of $FeCl_2$ was associated by increase of shoots and roots of barley plants content of Fe. This increase resulted from increase of soluble Fe in growth madia, but the found decrease of this content which found with the increase of added humic acids together with $FeCl_2$ attributed to cheliation effect of these acids for Fe and converted to unsoluble form followed by decrease Fe uptake. These results are in agreement with those obtained b Abou Hussien *et al*. ( 2002)

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# التأثير المشترك لأحماض الهيوميك والأملاح المتعادلة على نمو النبات

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## الملخص العربي:

أجريت هذه الدراسة لتقيم التأثير المشترك لاثنين من أحماض الهيوميك مختلفي في مصدريهما وكذلك تركيبهما الكيميائي مع ثلاث من الأملاح المتعادلة على صورة كلوريد صوديوم وكلوريد كالسيوم وكلوريد حديدوز على نمو نبات الشعير (جيزة ١٢٣) ومحتواه من الصوديوم والكالسيوم والحديد وأجريت الدراسة كتجربة أصص في نظام قطع كاملة العشوائية في ثلاث مكررات باستخدام مزرعة رملية. تم استخلاص حامض الهيوميك من الأرض الرسوبية ومن كمبوست قش البرسيم وتم إضافة كل منهما عند معدلات إضافة صفر ،١٠ ، ٢٠ ، ٤٠ و ١٠٠ ملليجرام / كجم. أما عن الأملاح المتعادلة الثلاثة فقد أضيفت عند معدلات صفر ،٢٥٠ ، ٥٠٠ و ١٠٠٠ ملليجرام / كجم تم

حصاد النباتات من كل أصيص بعد ٤٢ يوم من الزراعة وقد قدر الوزن الجاف لكل من المجموع الخضري والمجموع الجذري للنباتات المحصودة كما أجرى لها التحليل الإحصائي عند مستوى معنوية ٠.٠٠٥.

ازداد الوزن الجاف لكل من المجموع الخضري والمجموع الجذري لنباتات الشعير زيادة معنوية بزيادة المضاف من أحماض الهيوميك وكانت الزيادة المتحصل عليها في الأوزان الجافة في النباتات المعاملة بحامض الهيوميك المستخلص من الكمبوست أعلى نسبيا من تلك المتحصل عليها في معاملات حامض الهيوميك المستخلص من الأرض ومع جميع معاملات أحماض الهيوميك كان الوزن الجاف للسوق المتحصل عليه أعلى من مثيله للجذور. كانت استجابة الوزن الجاف لنبات الشعير قد اختلفت باختلاف الملح المتعادل وكذلك معدل إضافته. تناقصت الكفاءة المحصولية لأحماض الهيوميك بزيادة معدل إضافة كلوريد الصوديوم ولكنها تزداد بزيادة المضاف من كلوريد الكالسيوم حتى معدل إضافة ٥٠٠ مليجرام / كجم في حين استمرت هذه الزيادة مع كلوريد الحديديوز حتى معدل إضافة ١٠٠٠ مليجرام / كجم. ازداد محتوى سوق وجذور نباتات الشعير من الصوديوم والكالسيوم والحديد بزيادة المضاف من كلوريد الصوديوم وكلوريد الكالسيوم وكلوريد الحديدوز, على الترتيب. زيادة المضاف من أحماض الهيوميك المستخلصة لعبت دورا كبيرا في إنقاص التأثير المثبط للملوحة على نمو النبات وكذلك امتصاصه للعناصر.