

The effect of drought stress on transport trend and nutritional elements accumulation in corn plant roots

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Abstract: The research was performed in research field of Islamic Azad University in the south west of Ahvaz city in Iran with average raining 256mm/ year with dry and semi dry weather as split plat plan in completely random blocks plan (Main plot: the different volume of watering and sub plot: plant grow phases) by 4 repetitions in year 2006-7. Root sampling was done by using the drilling of three solid depth (A=0-20, B=20-40, C=40-60 cm) to determine nutritional elements nitrogen, phosphor, potassium and sodium. The transmission process nitrogen and potassium elements in different levels of water stress was from top of the root to aerobic organs and by increasing the stress stringency this moving process was fasted. Equation line gradient depth regression A of root $Y = -0.239x + 2.515$ presents the rapid process of transmission and discharge azoth element, the most high percent of nitrogen and potassium density was in depth A, the equation line gradient of linear regression the process of moving potassium in depth A shown $Y = -0.506X + 2.38$ that the discharge and transmission process of potassium in stress water conditions is more and faster than azoth, the phosphor moving process in the root length is low and it was same as nitrogen element with this different that the turnover volume of phosphor was lower than nitrogen and the most aggression of phosphor is in the depth C of root and it was by the more intense stress of water, the aggregation of phosphor element is not decreased considerably, the gradient of sodium linear regression equation $Y = 0.09x - 0.005$ shows the most high percent of sodium aggregation in the top of root, the transmission of sodium to up was very limited in the root by the water stress, the most aggregation and density of ion sodium in B,C depths and specially in C depth and the transmission process in this two highs is very little toward the A depths and the most absorption sodium has been aggregated in C depth and the sodium aggregation was increased in C depth by the more aggregation stress of water.

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1. Introduction

Withes and Erlanger (2003), Naropandi (2007), Chap man & Easton (2005), Santos, Lopez, Cole & Paranoti (2002-2006) in separately reports noticed that one of the more detrimental effects of drought stress is disorder in absorption process of nutritional elements that in the first step is caused the decreased of seed and provender and in the next step continue lost of fertilizer. This damage is calculated and reported for energy expenditure in the most country of the world such as: Yugoslavia, Peru, France, Italy, Colombia, Ethiopia, Argentina, and Ecuador

In the all presented samples the root absorption mechanism, the root making factors such as volume, length of the root show the more effects on water and nutritional elements absorptions and each factor such as drought stress that cause the changes of them in this characters. The effects of drought stress based on the opinions of Orтели (2003) Boveir (2001) Richard (2004) cause the growth limitation and develop corn root and the components of roots such as

the numbers of filament roots, the sum of the length of them and root developing decreased hardly. In the result, it disorders the water and nutritional elements absorptions. (Table 1) The absorption process and nitrogen aggregation in corn is rapidly in the first level of growth and the volume azoth in 5-7 leaf is 3.5-5 percent of the total of azoth. This process continue to rapid azoth aggregation to maturation, to start the seed making, 88 percent of azoth is absorption and only remained 12 percents was absorption. The decrease of wet because of the decrease of azoth solvable in soil solution cause the decrease absorption process of it but after absorption because of the high azoth stimulus the process of it is to the aerobic organ of plant, the absorption process and phosphor aggregation by attention to the plant necessities in different periods was different and 75-25 days after greening almost 55 percent of the phosphor is absorption. The absorption of this element during the growth period is done simultaneity by saving the dry material. Taband etal (1990), ware noticed in soil scientist congress that in comparison to phosphor absorption in wet traction 1/3

times with 100 percents of phosphor absorption decrease in one time traction 80 percents and in 3 times traction 50 percents, the layers of water between root and soil particle get finer and the length of the

moving course get longer by increasing the soil wet traction. This subject causes to decrease the speed of ion diffusion toward roots.

Table 1: the different modules of water and nutritional elements absorption by root and the effect of drought stress on it.

The effect of water stress on module	Module description	Module
Decrease L(Z), t Decreasing the depth of soil for use of plant	L(Z): root length t=EtT , K(θ): hydraulic lead S(Z,θ): The volume of absorption water	$S(Z, \theta) = \frac{t.L(Z).K(\theta)}{\int_0^z L(Z).K(\theta)_a}$
Decrease α, Sz Decrease the speed of water absorption, Increase h,	S max: The max speed of absorption α: The root volume for water absorption h: Traction of water soil: Sz: Discharge depth	$S_Z = S \max \times \alpha(h.z)$ $S(x, t) = \frac{[Hr - h(z, t)]RDFK_0}{\Delta X \Delta Z}$
Decrease j(v), L Low water absorption	Jv: Flow speed in system L: The volume of influence and hydraulic Formula: $\pi_x L : \psi_s \text{ xylem}, \pi_e : \psi_s \text{ extenal}$	$Jv = L(\pi_x - \pi_e)$ $JV = Lt$ $Jv = L(\pi_x - \pi_e + t)$
Decrease TAW, Decrease Zr , RAW	θ: Massy wet Zr: The depth of developing root TAW: The total available water Dr: Wet discharge:	$TAW = 1000(\theta FC - \theta WP)Zr$ $K_s = \frac{TAW - Dr}{TAW - RAW} = \frac{TAW - Dr}{(1 - P)TAW}$

The moving distance of phosphor is low and about 3mm. Santee (2002) and Barbara (1992) declared in separate reports in corn decrease or change of phosphor absorption is a bit by changing the soil wet between FC and PWP. But if the volume of soil wet get fix or lower in PWP point, the phosphor absorption get stop completely. The potassium absorption process in the first step of growth is so vigorous in comparison to the density of dry material of the plant. The moving distance of ion K+ (6mm) is twice to the diffusion distance of phosphor 3mm. At the end the phosphor absorption process get more disorder by water leakage so the moving radius of this element is lower than potassium. In land strain conditions , the active absorption mechanism cause to increase potassium absorption that the plant increases the K+ density in the root and organs for increasing defense to its dryness by energy unless the diffusion phenomena. The uptake of nutritional elements is influenced by soil moisture directly and by water indirectly on parameters like root growth and its development, percentage of solubility of soil saline, change of plant growth and development metabolism. The entire uptake and transport mechanism of nutritional element in plants such as, Mass flow, dissemination or uptake and transport by a phenomenon, more and less, is a function of existing soil moisture and root. (Sidico and sidly 2004).

Physiologically, a moisture stress occurs when the potential of cells water is less than zero. In

this case, the roots exposing to moisture stress, accumulate more elements so that supply and growth are continued. Under these conditions, the elements accumulation will be increased and also, conductivity of water into root is decreased and causes its high resistance from ecological and agricultural viewpoint, it is a significant limitation in plant growth.

In maize, the uptake of nitrogen, phosphorus, potassium and magnesium is variable in different growth records which it has been caused different water stress effects on uptake trend of these elements (zing 2007).

Birmatof (2003) stated that percentage of nutritional elements accumulation in root during drought stress is the same as percentage of accumulation in aerial organs and as the moisture soil reduces in root is decreased.

Sidico and sidly (2005) reported that the effect of drought stress reduces concentration of nitrogen, phosphorus and potassium in maize root in spite of gradual increase of above elements in soil and application of constant water stress levels. It is attributed to reduction of growth and development and insufficient solubility of those elements during low moisture. A similar experiment was conducted on maize leaf which showed the same results as root experiment; however, the reduction of these elements in leaf is reported much more than the root.

Charousa et al (2001) have seen that the excess of soil moisture from withered point to field

capacity point led to uptake increase of nitrogen, phosphorus and potassium in maize hence, unless the plant reaches to withered point, the amount of adsorbed phosphorus does not depend on water stress and time of withering, it has significant decreased phosphorus however, the experiment has been done in small containers which its phosphorus continually decreases and to avoid of withering. It is necessary to moisten it frequently.

Sirmenta (2001) stated that moisture stress leads to increased interrupt in N amount, phosphorus decrease and has different effects on uptake potassium trend and soil profile, the interaction of moisture degree and phosphorus and its deepening into soil has been reported to complicate very much during drought stress and moisture deficit. Briefly in can be stated that in dry soil profile, applying the fertilizer in a area whose moisture is high, increases the phosphorus absorption, though there are limitations in such important, correlation because phosphorus is immobile in to soil and it does not move by water flow, therefore, establishing the phosphorus in dry soil, changes the uptake trend.

Sinha (2001) showed that the mature maize exposed to water stress, have represented. The accumulation of phosphorus, nitrogen, magnesium and potassium 40%, 50%, 60%, 65% and 91% relative to plant without water stress and for plant such as maize and tiny grain corns which there growing season is short, the solubility of phosphorus in water is very important, however for plant with long growing season such as pasture plants it is of less important because throughout the long growing season, the solubility of P_2O_5 is gradually occurred. Increased phosphorus solubility into soil lead to increase the maize crops significantly.

Sinha (1992) reported that the uptake potassium trend and its storage in plants like maize and wheat is increased during water stress and contribute to high resistance against water deficit. The mechanism of potassium uptake, mass movement, contact of root with ion and ion dissemination by soil which is the distance of ion K, 6 mm two times of 3 mm. Therefore, due to smaller movement radial of phosphorus than the potassium, the phosphorus uptake trend is disordered by water deficit.

Likerman (2002) stated that under drought tension, the degree of potassium uptake is increased 2-3 times above desired conditions, also with presence of potassium ion, the water stress and its effect on dry matter accumulation trend, leaf area index, plant height is adjusted. The reason of such phenomenon

can be attributed to high capability of photosynthesis by increasing the capturing carbon and enzyme robisco and encouraging synthesis and matter transport.

Zhiang (2002) stated that during water deficit, the sodium causes a balance in plant water system by regulation the stomata, with sudden reduction of water, the stomata by receiving Na^+ ion compared to supply of K^+ ion, are quickly closed. This experiment with two treatments (a) 5 K^+ m mol (b) 4/75 Na^+ + 0/25 K^+ m mol was conducted to find out the closing trend and its speed in stomata. The speed in latter treatment was higher than the former due to presence Na^+ ion.

Jaques and Peterson (1991) with application of different N fertilizer amounts have evaluated the variations and percentage of decreasing different components of grain yield and stated that amongst those components, the grain number with 66 percent decrease had been taken the greatest effect from water stress and it is followed by grained maize number with 17 percent decrease.

Sidly and sidico (2003) said that drought stress lead to yield decrease in both grain and forage and then it causes to waste the fertilizer. They have reported damage, incurring cost and wasting energy in many countries: Italy, France, Peru, Colombia, etc.

Smith (1999) showed that the trend of increased maize product during drought, ordinary and wet years is 4800 kg, 900 kg and 5400 kg respectively. Therefore, under drought condition, the trend of potassium absorption in order to improve the plant resistance against water deficit shows move severity and as the potassium uptake increases when emerging maize tuft, the product will increase. When the water stress is applied the potassium uptake be increased during flowering stage or by root or the transport of this element from lower leaf toward upper leaf is quickly conducted, so that the water potential in aerial point is greatly decreased and water moved in to these organs.

2. Materials and methods

The experiment conducted in Ahwaz Azad university research farm 3 km to south of Ahwaz city during in year 2006-7. Average of rain was 256mm based on split plot design and along with complete random block pillar, two factors and four repetitions. Chemical features of soil before planting and using fertilizers and after harvesting the farm has shown in table 1 in order to use these data for evaluate the process of nutrient element absorption (Table 2).

Table 2: Results of soil analysis

soil	Deep (cm)	EC	Organic matter (%)	PH	Nitrogen (ppm)
Silty	0-15	6.5	0.6	7.7	635
Silty	15-30	6.6	0.3	7.6	648
Clay loam	30-60	5.7	-	7.3	211

Table 3: Review of different treatments tested

Main plot: Drought stress Levels	Sub-plots: Different growth phases
I ₀ : Full irrigation point of FC, control, without water stress	S ₀ : growing phase, the establishment of the plant stem to the emergence
I ₁ : 75% of the amount of irrigation treatments I ₀ , mild stress	S ₁ : natal phase: to stem the rise of coffee being resilient and end silk pollination
I ₂ : 50% of the amount of irrigation treatments I ₀ , severe stress	S ₂ : grain filling phase: the end of pollen grain maturity and the emergence of black layer
I ₃ : 25% of the amount of irrigation treatment I ₀ , very severe stress and point of PWP	-

For conducting water pressure care we used pressure layers, Field capacity points (FC), permanent wilting point (PWP) that equals 24.6 and 14.7 respectively, then we measured the special apparent weight of soil by using cylindrical, volume meter equals to 1.3 pa g/ cm³. These three parameter: FC, PWP, Pa are considered as constant during experiment. Soil moisture means every other day calculated in sampling by the following formula:

Weight moisture percentage:

$$\% \theta_V = \frac{W_1 - W_2}{V} \times 100$$

Volume moisture percentage:

$$\% \theta_M = \frac{W_1 - W_2}{V_2} \times 100$$

W₁: the weight of moist soil.

W₂: the weight of this sample soil after soil dried. Since the volume of sampling drill cylinder (V) is stable so calculate soil moisture volume percentage and using calculated parameters, calculate the amount of water entered into each part of land (each small part of land is enclosed so that water could not flow out) by using this formula:

$$V = \frac{\theta_v \cdot A \cdot D_s}{E} = \frac{\theta_m \cdot P_a \cdot A \cdot D_s}{E} = \frac{(Fc - pwp) p_a \cdot A \cdot D_s}{E}$$

V: is equal to amount of water necessary for each irrigation

$\theta_v (Cm^3)$: equals to volume moisture percentage

θ_m : equals to weight moisture percentage

P_a: equals to apparent weight of soil. (G/cm³)

Fc: Field capacity points

PWP: permanent wilting point.

A: equals to experimental plate level (cm²)

E: equals to irrigation efficiency

D_s: equals to depth of root penetration (used tranche excavation) by installing parshal folum and meter we measured the amount of water entered into each part of land.

Sampled each plate based on 1m length (100×75cm²) one time in fourteen days. In each sample we planted 4-5 corn plant in plastic bag so that we could analyze the nutrient elements in plants.

Some of these samples were used for determine the nutrient elements as follows:

To determine and analyze the root nutritional elements, a sampling was done from three soil depths. They are:

A=0-20, B=20-40, C=40-60 cm

By use of TRANSHE digging method for three soil depths, a sampling was conducted to determine nitrogen, phosphorus, potassium and sodium. The estimation of nitrogen was done by Kjeldal method and distillation still, the phosphorus was measured by ammonium molybdenum calorimeter, finally the potassium and sodium were calculated by photometry at a specialized lab. Measurement and calculation of amount of nitrogen in plant using Kjeldal method and distillation system as follows:

Amount of nitrogen in sample (N₁):

$$N_1 = (T - S) \times N \times \frac{14}{1000} \times \frac{100}{\text{Dryweight}(g)}$$

Percent calculation:

Acid sulfuric standard solution normalization:

N (ml) equals to amount of acid sulfuric applied to tarnish the plant sample, T (ml) equals to amount of acid sulfuric applied to tarnish the care sample, S equals to measurement and calculation of phosphorus of sample using calorimeter molybdenum ammoniums

in which 2 grams of dry plant conducted. Then this sample mixed with nitrate magnesium and after accumulation of ashes, these ashes solved in HCL and then this solution were cleared and finally phosphorus measured by calorimeter method for measuring K and Na in plant, we grind 2 gram of sample plant then we accumulate ashes using 480° heat.

Data were analyzed by SPSS and Minitab. The averages were compared on the basis of Duncan test on level 1%. The charts were drawn by Excel 2007.

3. Results

Transport and Accumulation of Nutritional Elements along Root:

3.1. Nitrogen:

The trend of transport and accumulation of nitrogen through different soil depths showed that effect of irrigation cycle, developmental phases and their interaction on level 1% had significant effect on nitrogen accumulation percentage in different depths while the replication effect was not significant (Table 5). Study of means of nitrogen accumulation trend showed that the highest root nitrogen percentage in depth 0-20cm and also in complete irrigation treatment (control) was obtained and the lowest at 20-40cm. Therefore, with more water stress, the total percentage of root nitrogen decreased while its amount in depth A increased (Table 4, 6).

By application of different water stress levels, accumulation of nitrogen decreased. The highest nitrogen in root was at control treatment while the lowest was at treatment I₃, so in stress treatment I₂, there was more nitrogen accumulation than I₁ whose stress was mild. Trend of nitrogen accumulation in three depths sampled of root representing more nitrogen accumulation in treatment depth A than both C and B ones at control treatment and by applying more intense water stress, the nitrogen accumulation in depth A increased more significantly than two other ones and amount of this element in both C and B depths decreased due to reduction of uptake and transport of this element toward aerial organs (Table 4, 6).

The Duncan test at 5% level for developmental periods presented two to three mean groups for a three-year-experiment in which the treatments S₂ and S₃ are given the highest and lowest accumulation respectively. A high need for nitrogen in this period, lead the plant to absorb more nitrogen (Table 4, 6).

3.2. Phosphorus:

The effect of irrigation cycle, developmental phases, and their interaction at 1% level on percentage of the root phosphorus accumulation in different soil depths had significant effect, while the replication effect had not (Table 5).

By applying different water stress levels, the degree of phosphorus accumulation in root was decreased. The highest phosphorus accumulation in root in the control treatment at 20-40cm and the lowest one in the treatment I₃ at 40-60cm were obtained by 1.55ppm and 0.328ppm respectively. The trend of phosphorus accumulation in all three sampling depths shows that the degree of phosphorus in C depth was above the two other depths (A and B) at the control treatment and also there was not any change in this element accumulation trend at longitudinal intervals in different depths. During low moisture, the transport of phosphorus toward upper part of the root was not considerable due to its highly limited movement radius. However, in severe water stress, the overall phosphorus amount in root was reduced (Table 4, 6).

The Duncan test separated three mean groups for developmental phases on which the highest degree of phosphorus accumulation was obtained by treatment S₃ with 1.63ppm (Table 6).

3.2. Potassium:

The study of accumulation and transport in root at different depths showed that the irrigation cycle, developmental phases, and their interaction as well as replication effects at 1% level on percentage of potassium in root were significant (Table 5). The Duncan test also showed that the more stress increase the more potassium accumulate in the root, so that the highest accumulation percentage was seen in treatment I₃ (the most severe water stress) with 2.71ppm and under non stress condition the root took the lowest potassium. The trend of potassium accumulation in three sampling depths represented the greatest potassium in C depth at control treatment and with application of different water stresses, especially in the most severe stressed treatment, the potassium accumulation in both C and A depths increased. The reason is possibly related to high uptake of this ion in severe stress at C depth and also its transport trend at A depth (Table 4, 6).

The Duncan test presented the growth periods of three mean groups in a two-year-experiment in which S₂ treatment showed the highest potassium accumulation percentage.

3.3. Sodium:

The effect of irrigation cycle, growth stages, and their interaction as well as replication effect on sodium accumulation at different depths was not significant (Table 5).

By increasing the stress the sodium accumulation increases in root. The highest accumulation was in I₃ treatment with 0.64 ppm and non stress treatment with 0.12ppm was the lowest. The study of accumulation trend of sodium in three

sampling depths showed that the highest accumulation was at C depth and when different stress levels were applied the highest accumulation was observed only in B depth.

The sodium was accumulated at lower parts of root and the preventative state was seen in relation to its transport into A depth (Table4, 6).

Duncan test showed that this ion accumulation at S₂ treatment through three different mean groups was the highest (Table5).

4. Discussion

The more positive gradient values (m line) of the linear equation show the incremental trend of the element into root, the negative gradient values give the transport and discharge trend in plant and the smaller the number the greater this element discharge (the gradient is given in table 2 as solid) (Table4).

With regard to table (4) the gradient

$Y = -0.293x + 2.515$ shows a fast trend of transport and discharge of N at A depth, since this transport gradient is smaller than both C and B depths and as the gradient to be small, the transport and discharge is great (Table4, 6).

The gradient showed the discharge of V element at B depth and by applying the severe water stress treatment, the trend of N accumulation at this depth increased. In the other word, N accumulation in this depth was much greater than its transport to C elevation. At C depth, the transported nitrogen is high as well which clearly evident from negative gradient as it show the nitrogen transported toward aerial organs (Table4, 6).

In I₂ treatment, N accumulation in root was significantly increased which by becoming severe the water stress. In this treatment, the N accumulation would have decreased however, the increase can be only attributed to osmotic pressure regulation and material accumulation like praline that increased when the stress become intense.

Zhiguou (2005) reported that under water deficit, N uptake is highly decreased during which the grain yield and forage will be dropped.

Birmatov (2003) stated that the percentage of nutritional accumulation in root during drought stress is corresponding to that of aerial organs and with soil moisture deficit, the percentage of N and P in root decreases.

The transport trend of phosphorus along root, more and less was similar to nitrogen but the movement trend of the transport phosphorus quantitatively was much lesser than the nitrogen and the difference the phosphorus with nitrogen was that the transport of phosphorus at B and C depths was much greater than of phosphorus at A and B depths. This phenomenon is related to small movement radius

and as the severity of stress increased, the trend of phosphorus accumulation lowers, especially at upper layer of root which it is attributed to immobility of this element (Table4, 6).

Santi (2002) and Barber (1992) in separate reports stated that reaction of different products against phosphorus uptake with moisture change is very different. In maize by changing the soil moisture between field capacity and withered point, the change or phosphorus uptake decrease is negligible. However, if the soil moisture at withered point remains low, the uptake of phosphorus will completely stop.

The linear regression equation showed the potassium movement at A depth,

$Y = 0.506 + X + 2.38$. The discharge and transport of potassium, have been performed at different irrigation amounts, that is, by application of more severe stress, the discharge as well as transport of K⁺ ion was increased. The equation gradient (M=0.506) represented a high discharge and transport trend. The regression equation gives the $Y = 0.268 + 1.79$ at 13 depth. It also shows that the accumulation trend of K⁺ ion was increased (Table4, 6).

This phenomenon is at the result of high transport of the element from bottom of root (C depth) to upward of it and also more uptake of that element under stress. At C depth the accumulation of this element is very high because of a need for regulation the osmotic pressure under stressed condition.

Sidico (2004) showed that during drought, the potassium concentration is increased in a single root. The sodium uptake is reported to be very low during the drought stress by maize root. The trend of accumulation and transport of Na⁺ ion in B and C depth, especially at C element, produced the highest accumulation of ion sodium and the transport trend at these two elevations toward A depth was negligible and the most of absorbed sodium in root at C depth was accumulation. By applying more water stress, the accumulation trend was increased. The positive gradient of regression equation showed the incremental trend ($Y = 0.09x - 0.005$). This is because the sodium is not transported by plant toward upper parts, since in the plants like maize in order to confront with adverse effect of sodium its transport toward aerial organs is disordered by endodermic layers. Of course these plant varieties are sensitive to sodium. On the other hand, the plant sodium in the plants like beet root is transported by a resistance to different parts of the plants and causes dilution of salt in a specific tissue.

Investigation of nutritional elements accumulation process in three sampling depth from root, A=0-20, B=20-40, C=40-60 centimeter from land surface show that nitrogen element aggregation in depth A more than C, B depths was evidence in

treatment and with doing various surfaces of water intensive stress, nitrogen element aggregation in A depth in comparison with B,C depths, has considerable increase, amount of this element in B,C depths, decreased which was probably due to decrease of nitrogen absorbance process and also because of nitrogen transmission toward airy organs of plant, considering table 4, numerical number of line slope $y=-0.293x+2.515$, show speed Transmission process and nitrogen element discharge in A depth, since this transmission slope is smaller than two B ,C depths and whatever smaller this slope, we have more transmission process and element discharge, moving equation line slope of B depth, show nitrogen element discharge and with taking intensive stress treatment in water, nitrogen element aggregation process become more in this depth. In other words, nitrogen element aggregation in this depth was more than its transmission to C height, the extent of transmitted nitrogen in C depth is also high which this transmission is displayed by negative process line slope that is transmitted toward airy plant organs. In I₂ treatments, the extent of root nitrogen accumulation, show considerable increase that in fact with more intensive of water stress in this treatment, nitrogen accumulation should become little, but one can attribute this increase only to osmotic Pressure regulation phenomena and aggregation of matters such as praline which increase by intensive stresses. Phosphor moving process in root length was almost Like nitrogen element, but this moving process in respect to transmitted phosphor element, was very little than nitrogen element, and another difference between phosphor element and nitrogen was that transmission process of phosphor element in C depth into B was extremely more than this element transmission from B depth to A, that this phenomena is related to moving radius of phosphor low element, the more water stress severity , the phosphor

accumulation process became little, especially in upper layers of root and this is related to immobility and lack of high transformation, equation linear regression move process in A depth, $y= -0.506x+2.38$, display that potassium element intensive transformation and discharge is accomplished in various extent of irrigation, in other words, with exerting water more intensive stress, K⁺ ion discharge and transformation became more that equation slope ($m=-0.506$) showing high process of transformation and discharge, equation linear regression in B depth, with $y=0.268x+1.79$, showing that K⁺ ion aggregation process, become more which this phenomena is result of high transformation of this element from down of root (from C depth) upward and also more absorbance of this element under water stress condition, in C depth, aggregation of this element is extensive that is because of plant requirement to this element under water stress in order to regulation of osmotic pressure, Na⁺ ion transformation and aggregation process in B, C depths, and especially in C height, highest sodium ion aggregation and accumulation was taken place and transformational process in these two height, was negligible and most of the absorbed sodium in root at C depth find aggregation and with exerting water more intensive stress, this accumulation process, increase that positive slope of equitation regression line displayed this sodium increase process. The reason of this is lack of sodium transportation by plant to plant upper parts, since in plants such as corn, it disrupt its transformation into airy organs by means of endodermic layers to contrast with sodium damaging effect, but these type of plants settle in sensitive status toward sodium, on the other hand plants like sugar beet, by sodium transportation to its various parts present kind of resistance which result in salt thin a special context (Table4, 6).

Table 4: equations linear regression moves process of nutritional elements in various amount of irrigation in root length¹

Depth(Cm)	nitrogen	phosphor	potassium	sodium
A = 0-20	$y=-293x+2.515$	$Y=-0.5.6x+2.38$	$Y=-0.506x+2.38$	$Y=-0.505x+2.38$
B = 20-40	$Y=-0.231x+1.88$	$Y=-0.33x+1.71$	$Y=0.268x+1.79$	$Y=0.118x-0.015$
C = 40-60	$Y=-0.215x+2.095$	$Y=-0.369x+1.91$	$Y=0.3x+1.85$	$Y=0.09x-0.005$

¹ - The review nutrient movement equations in Table 2 and the notes following review is to better understand the problem:

- Values more positive slope (m line) increased more linear equations in the root element provides.

- Negative slope values (m line) equations of linear transfer and discharge process plant element offers and what this number is smaller element of the evacuation process more parts. (Slope line in the table is presented with the following line)

Table 5: summary of variance analysis results (square averages) and meaningful level (nitrogen, phosphorus, potassium, sodium)

sodium			potassium			phosphorus			nitrogen			df	S.O.V
Depth (cm)			Depth (cm)			Depth (cm)			Depth (cm)				
40-60	20-40	0-20	40-60	20-40	0-20	40-60	20-40	0-20	40-60	20-40	0-20		
0.006 _{ns}	0.008 _{ns}	0.007 _{ns}	4.81**	4.71**	3.48**	10.21**	11.02**	13.42**	8.16**	9.21**	7.7**	3	I treatment
0.001 _{ns}	0.003 _{ns}	0.002 _{ns}	3.07**	3.17**	2.11**	4.7**	4.25**	5.75**	2.16**	2.51**	3.8**	2	S treatment
0.001 _{ns}	0.001 _{ns}	0.001 _{ns}	5.31**	6.41**	4.68**	6.7**	5.25**	6.75**	3.56**	3.61**	2.4**	6	Interaction I×S

*, **, ns show meaning fullness at level of 1%, 5% and unmeaning fullness, respective

Table 6: comparison of average with Duncan test at 1% level

sodium			potassium			phosphorus			nitrogen			S.O.V
Depth (cm)			Depth (cm)			Depth (cm)			Depth (cm)			
0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60	
0.11b	0.12c	0.14c	1.96b	2.11b	2.01b	1.38a	1.55a	1.22a	1.83a	1.69a	2.31a	I ₀
0.11b	0.16b	0.15c	2.69b	2.21b	2.08b	0.98b	1.10b	0.94ab	1.69ab	1.29a	1.72a	I ₁
0.32a	0.41a	0.43b	2.84a	2.7a	2.5a	0.86b	0.92b	0.91b	1.71b	1.32b	1.79a	I ₂
0.34a	0.43a	0.51a	2.91a	2.84a	2.59a	0.32c	0.38c	0.48c	1.08b	0.91b	1.31b	I ₃
0.02c	0.01c	0.03c	2.41b	2.1b	1.93b	0.80b	0.73b	0.62b	1.72b	1.52b	1.72b	S ₁
0.71a	0.52a	0.63a	2.87a	2.6a	2.39a	1.63a	1.61a	1.58a	2.56a	2.49a	2.71a	S ₂
0.08b	0.06b	0.09b	1.81c	1.54c	1.61c	0.51c	0.39c	0.42c	0.91c	0.79b	0.98b	S ₃

In each column, being on common article between 2average show unmeaning fullness 1% level.

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