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Combined effect of tow Stresses(Boron and Salinity) on Growth Parameters ion balance in Fenugreek plant (*Trigonella fenum-graecum*)

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Abstract

The idea of research was due to the high raw materials of the water agricultural land of the shatt al-Arab in the province of Basra ,Where the level of salinity has increased, as aresult of the rise of the Arab Gulf water .It shows that the Fenugreek plant by pot experiment to study effect boron treatment 0,2,5,10 mg/kg combined with salinity 0,3,6,12ds/m to evaluate growth parameters mineral balance B , K ,N , ,Na ,Cl in shoot and root , ELP , dry biomass ,show by result declined biomass lower value and upper fined (1.93 mg/gm and 6.68mg/gm fined in combined 10mg/kg B with 12ds/m salinity, and 2mg/kg B and 3ds/m salinity .plant high ,root length reduced significantly under 5,10 mg/kg boron and 6ds/m salinity and combined excess boron with excess salinity ,but 5mg/kg boron combined with 6ds/m salinity disappearance of boron toxicity (necrosis and burning of leaves edges) and improved in plant growth and number and size of nodules when combined 2mg/kg boron with 3ds/m salinity or treatment alone,B concentration increased significantly with boron treatment also NaCl with increased salinity treatment. B and Salinity effect significantly in balance of minerals : B ,N ,K ,Cl, Na concentration by different treatment .ELP increased significantly (50%) with salinity treatment and excess B but reduced (15.33%) with 2mg/kg boron and combined with 3ds/m salinity , Conclusion there are antagonistic and synergistic relationship between boron and salinity with different concentration in Fenugreek plant , B concentration reduced with salinity treatment , Also effect of salinity in little levels can reduced by excess B , but moderate concentration of B and Salinity can less effect reduction on plant growth.

Keywords: Fenugreek plant,B,Salinity, growth appearance, mineral balance.

Introduction:

The trace element boron is one of the elements that the plant needs in small quantities, it enters the cellular wall synthesis and the transfer of suger through its association with the (OH^-) group and increasing its concentration above the permissible elimit causes toxicity to the plant because it affects physiological and metabolic processes (Fareeha *et al* ,2016) the extent between the need the boron and its toxicity is very few,so it's considered one of the factors the task is determine plant growth and plant production in many regions of the world that are characterized by arid and semiarid lands such as Iraq ,Syria , Egypt ,Libya and Turkey (Tanka and Fugiwara ,2008) wich characterized by low of rain and high percentage of ground water which causes water evaporation from soil due to high temperatures thus , boron accumulation in its tissues especially the leaves through the transpiration cause (Maria *etal*,2019).

Water suitable for irrigation is one of the major problems that has spread widely in the world (Yingchou *etal* ,2018) it is an increasing problem that directly affects agricultural production and the quality of plants and the viability of human nutrients (Sada *et al* ,2015) Also , frequent irrigation with water that contains apercentage of salinity leads to change in the properties of the soil and this lose its suitability for cultivation with the passage of time this lead to a reeducation in agricultural land less agricultural production (Yadava *et al*,2011).

In southern region of Iraq where the Tigris and Euphrates river meet ,forming the shatt al –Arab is one of the important sources in irrigating agricultural lands in Basra governorate and this river has recently polluted by the sea water coming from Arabian Gulf ,during irrigation with the water of this river led to high salinity levels in the arable land, coinciding with the high salinity associated with boron in the grand water ,there for amounts of boron are deposited on the soil surface as a result of evaporation of the capillary property and depositing it on the surface of agricultural soils ,this study was conducted to evaluate the amounts of mineral elements associated with appearance of growth in the fenugreek plant.

The combined of salinity and boron causes numerous metabolic and physiological deviations and there imposes significant restrictions on quantitative and qualitative plant production and the high level of boron concedes with the high levels of salinity in many regions of the world and plant species differ in the extent of their response to this overlap (Tanaka and Fujiwara ,2008).

There are studies that have observed that salinity in soil or irrigation water may be reduced or exacerbating the effect of the boron and other studies that prove that the salinity exacerbates the effect of boron ,which reached the plant and the option of the researchers concluded through their experiences that the salinity is down the amount of penning that effects on boron absorption ,which is determined to boron from soil (Goldberg *et al*,2000) there are many researchers agreed that increase the salinity can limits of boron absorption causes by changing in PH to basement Motaium *et al*.,1994) Fenugreek plant is a

local vegetable that is widely used from the visual herpes for its nutritional and medicinal importance and it is a dual plant that uses its seeds and leaves for medicinal purpose (Bradlees*et al*.,2019) this plant belongs to the leguminaceae which is annual herbs (Ahmed *et al*.,2016) which are plants tolerant of salinity and boron (Gupta.,2016) ,the current study aims to assess the extent of the change in the balance of mineral elements in the leaves and roots and appearance of Fenugreek plant.

Material and Method:

The region of experiment was conducted in green house condition in Biology department of science collage at Basra University. Mixture soil was used in this experiment properties of this soil are showed in table (1) soil was dried and smashed in a sieve 2mm ,layout planners of the experiment as complete randomized design CRD with 16 treatment and three replication on a Fenugreek plant (*Trigonellafenum-graecum*) cultivar RMT-1 , a solution used as nutrient was mixed with soil content which haveNH_2NO_3 and $KH2PO_4$ 0.5 gm /kg soil ,$MnSO_4.H_2O$, $CuSO_4.5H_2O$, $ZnSO_4$ 5mg/kg soil 0.4mg/kg H_3BO_3).for experiment ,the treatment include: 0(without Boron and NaCl) , 2,5,10mg/kg B ,3,6,12ds/m salinity ,2mgB+3ds/m NaCl , 2mg B +6ds/m NaCl ,2mg B+12ds/m NaCl .5mg B+2ds/m NaCl 5mg B+6ds/m NaCl , 5mg B +12ds/m NaCl .10mg B+3ds/m NaCl , 10mg B+6ds/m NaCl,10mg B+12ds/m NaCl.B levels treatment adding to soil by mixing the calculated amount of boric acid 17.48%B witch soil by spry , and for salinity sodium chloride were maintained by irrigated water twice a week , fifteen seeds were sterilized by 2% hypochlorite and then D.W., grown in plastic pots 30cm in diameter and containing three kg mixed soil, fifteen seeds were grown for 4 weeks ,after seeding with various treatments than harvested and Data immediately collected from fresh plant after harvested was measurements for plant high and root length , number and size of root nodules, shoots and roots dried at 75 ^{0}C for 24h, shoots and roots dry weight were collected. The dried plant for every treatment were N,Microkjeldahl method (Brenner and Furman,(1962) digestion by HNO_3: $HClO_4$ Curcomine method (APHA,2017),K and Na concentration determined by flame photometer method according to Crasser and Parsons,(1979) ,Cl concentration determined by titration with $AgNO_3$,N concentration determined by titration method.

Statically analysis : of Variance (ANOVA) was used to obtained data and significant differences among treatment means with L.C.D test at 5% level and regression was used to evaluate amount of Correlation among treatment , SPSS version 21 statically computer software package was used to data analysis (Steel *et al* .,1977).

Results:

1-**plant appearance:** Treatment for 2 weeks showed that treatment with 2mg/kg B & 3ds/m salinity and combined with each other plants appear like standard, Signs with boron toxicity began with 5mg/kg ,and more aggravating in 10mg/kg B, the signs began with dryness and stiffness in the end wrapping the edges of the leaves in first

week (picture 1:a,e),than these signs turned into burning in the edges of the leaves and necrosis at the second week (picture 1; bcc'd), as well as salinity treatment Causewilting, yellowing ,stunting and increase this signs at beginning of second weekin 6ds/m,12ds/m(picture 1:f). borontoxicity continuous in 10 mg/kg B& 3ds/m, salinity, salinity toxicity appearance continuous in 12ds/m with all B treatment .

2-1-Parametersof plant growth in shoot high, rootlength, shoot and roots and total dry Wight were increase significantly with 2mg/kg B,3ds/m salinity and their combined,whereas decrease with 5mg/kg,10mg/kg B and all salinitytreatment and their combined between excess and treatment of salinity, ombined 6ds/m salinity and 5mg/kg B have less severity from treatment alone ,Table (2).

2-2-Size and number of root nodules: nodules were significantly reduced with 5g/kg,10mg/kg B and they combined with excess salinity treatment correlated with reduction of size of nodules but the effect less with treatment B or salinity alone ,the number and size of nodules has improved with 2mg/kg B and combined with salinity3ds/m and there alone. Reduction in number and size of nodules in salinity treatment, but 3ds/m they improved (picture 1: g,h,I,k,m,n),Table(2).

3-1-Mineralcontent in shoot and roots:(B)content : B treatment resulted in significant effects in B content in shoot and root of fenugreek plant, the effect in shoot more than in the roots , the boron concentration increased significantly with increase of individual boron concentration and their combined with level of excesses salinity . Reduction in the B content occurred at the all salinity treatment, as well as when it combined with levels ofexcess B , minimum B content was recorded in shoot and roots at treatment with 2mg/k B and its combined with 3ds/mof salinity ,Table (3,4)

3-2-Na content in shoot and roots: significant reduction in the sodium content was observed in treatment with 2mgk B and when combined with 3ds/m of salinity in shoot and roots, whereas significant increase of Na content was observed in all salinity treatment and combined with excess B,Table(3,4).

3-3-K content in shoot and roots: significantly increase in K content by the B treatment in leaves and roots maximum K^+ in 10mg/kg B. this is evidenced by the high K+/Na+ ratio in plant. reduction in K^+ content in leaves and roots in all salinity treatment , K content decrease significantly in combined excess salinity with excess B this is indicated by the low K^+/Na+ratio of the plant Table(3,4).

3-4- Cl content in, shoot and, roots: was reduced significantly with, B treatment but increase in, salinity treatment and combined with excess boron. Minimum amount, record in 2 mg/kg B, and combined with 3ds/m of, salinity in shoot and roots, of fenugreek plant, Table (3,4).

3-5-Ncontent in shoot and roots **:** maximum in N content was observed in 2mg/kg Band then reduced with increase of Btreatment . reduced significantly was observed in all salinity treatment and combined with excess B , improve in N

content was observed in 2mg/kg B+ 3ds/m of salinity ,Table (3,4).

4-Electron leakage (ELP) : reduced in ELP was observed in leaves of fenugreek plant at 2mg/kg B and combined with 3ds/m of salinity , but intensified ELP was recorded in 10mg/kg B and combined ELP observed

in 12ds/m of salinity treatment, Figure(2).

4-1 ph: was observed in all B treatment ph=6.25-6.35 and ph = 6.49 in 2mg/kg B + 3ds/m of salinity , ph= 8.5 -9.8 in salinity treatment and combined excess salinity with B treatment.

Discussion:

For 2 weeks B and NaCl applied at 5 mg/kg B by necrosis and burning edges of old leaves firstly, than new leaves which related by increase of B in 5,10 mg/kg whole leaves of plant (Reid *et al* 2004) this agreed with Grieve *et al* (2010) in *Gossipium* plant they observed signs of B toxicity in high B treatment 5,10 mg/kg related with B accumulation by transpiration stream .salinity effect in at 6,12ds/m by wilting, yellowing , which related by increase concentration of NaCl in plant ,this observation agreed with Lark *et al* ,(2016) in *Mustered* plant and Maria *et al*,(2018)in *Gerbera*plant ,improving plant growth in combined 5mg/kg B and 6ds/m salinity have antagonistic relationship between B and salinity reduced B and B reduced salinity (Leteye*t al* ,2001), this reduced also observed in *Melon* plant by Edelstein *et al*,(2005) and *Tomato* plant y Alpaslan *et al*,(2001). In current study Fenugreek plant moderate tolerant to B and NaClup to 5mg/kg rabidly increase of B concentration in leaves induced the sings of B toxicity in high level of B Cause inhibition of growth significantly, similar result are observed in *Tomato* plant with excess B (Carmassi*et al* ,2013) the shoots Fenugreek plant more sensitive than roots in B treatment , other plants such as *Hordeumvulgare* L.cv schooner , T*riticum*spp cv. Kenya farme,Metrosiders excels, shoots also more sensitive to B toxicity than roots (Bann *et al* ,2012) while in others such as *Capsicum annum* L. *Laurustinus tines* and *Jurupa cruces* ,the root system is more sensitive to B toxicity than the aerial organs (Banon*et al* ,2012).

B concentration increase in Fenugreek plant by increase external level B is transported to the shoot in the xylem by veins of leaves terminate at the edges, so this location have severe symptoms of B toxicity (Shelp *et al*., 1995) .B toxicity symptoms appeared at older leaves firstly than young leaves in Fenugreek plant causetranslocation via they xylem from the root leaves (Wimmer *etal*.,2015). Na in shoot and root rapidly increase in plant by increase the salt in roots zone (6ds/m , 12ds/m) high concentration of NaCl in plant which transport by roots favored the leaf Accumulation (Faroq *et al* ,2015) So the concentration of B decrease with increase of salinity concentration, Also the saline induced changed in PH of soil towered basely , in this condition the plant cant absorbed the B because it transform to ionic $B(OH)^-4$(Goldberg *et al*.,2000) the results are agreed with other findings in other crops (Banon*et al*,2012).

transport by roots favored the leaf Accumulation (Faroq *et al*, 2015),So the concentration of B decrease with increase of salinity concentration, Also the saline induced changed in PH of soil towered basely , in this condition the plant cant absorbed the B because it transform to ionic $B(OH)^{-}4$(Goldberg *et al*.,2000) the results are agreed with other findings in other crops (Banon*et al*,2012).

Increase in B levels reduced the Cland Na in 3ds/m , combined between 6ds/m with 5mg/kg Previous studies also observed that leaves Na and Cldecrease in presence of B (Grieve and poss,2000;Banon *et al*,2012) they showed NaCl decrease in plant cause by reduction of root system by B supply in roots zones ,maybe combination between both elements for uptake by roots (Banon*etal*,2012).K^+ decrease significantly with increasing salinity in soil due to increase a concentration, this agreed with saha *et al*,(2010) in *broccoli* plant they showed ,reduction in K^+ concentration in leaves and roots related by low of K^+/Na^+ ratio . combined between excess salinity and B, excess B and low saline water Cause reduction in K concentration in plant , Also Grieve and poss,(2000); Carter *et al*,(2005) fined elevation of Na it causes reduction in K in *wheat* and *lemon* plantrespectively.

K^+ increase with increasing B supply levels maybe synergistic relationship between B and K^+,Islam,(2005) ,Also showed the increasing in B levels Cause increase in K^+ in *Cicer*,*Wheat*,*Mustared*plant Tayyaba *et al* ,(2018) reported increase significantly in K^+ by increasing in B levels.

ELP don't changed in 2mg/kg, 5 mg/kg by B supply, seem to be good channels in carrying the crossing of this item (Miwa and Fujwara, 2010) , but increase significantly 10 mg/kg and combined with excess salinity. Excess salinity and 2 mg/kg B it appears that the membranes have been affected in these concentration and this agreed with Vahid*et al* ,(2017) that the integrity of the membranes is one of the most important factors that reflect the plants tolerance to stresses and that increased concentration of B Cause damage to the enzymes associated with the membranes leading to the inhibition and thus the membranes lose the property of control and control of the elements entering the cells (Wimmar,2009).

In Fenugreekplant ELP significantly increased in excess B and salinity and combined with each other.

Root nodules and N concentration are phenotypic key for legumes and are responsible for N fixation. Thenumber and size of root nodules are directly related to increased N fixation in the plant (Abdmoumen and Eldrissi ,2009) , in current study it was found that the highest rate of root nodules and it size was foundedat 2 mg/kg B with increased volume is associated with improved plant growth in this level . Also earlier studies showed this improving in 2mg/kg Bin *Cicer*, *Pheasioles*,*Peas* plant , its positively correlated withincreased N content in the plant ,this agreed with Hossain *et al* ., (2011), and increasing in the Btreatment led toreduced the number and size of nodules , previous studies have alsoshowed thatlevel

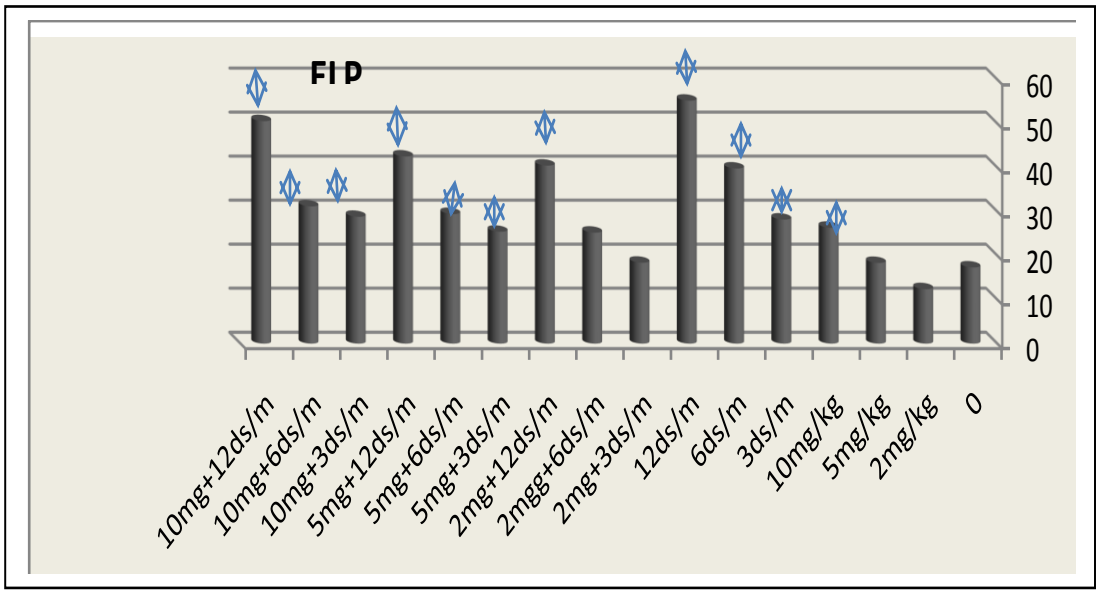
2mg/kg B led to improvement in growth of root nodules in species such as *bean*, *peas* and that an increase beyond this limit leads to their reduction (Grigor and Georgier,(2001) the results agreed with observations of Hossain*et al* ,(2011) they observed throughtheir studies that increased B concentrations lead to N reduction in leaves and roots ,Also the effectiveness of N fixing enzymes reduced its activity while increasing B levels such as enzyme nitrate reductase reduced by elevation of B in root nodules (Bonilla et al ,1980) the Fenugreek plant located under salinity in combined excess B and excess salinity.combined excess salinity with low B , Fahmi*et al*.,(2011) observed that N content reduced by effect B and salinity in high levels by reduced activity of enzymes nitrogenase in *Vicia faba*which related by elevate NaCl , So the improvement in N content in plant is related to the improvement in the growth of nodules and the improvement of plant growth in general.

Conclusion: The relationship between B and salinity is antagonistic and synergistic ,and the excess B or salinity more sever in plant growth and limited the plant productivity and elevate salinity in Shatt-Al-arab river Cause many problems in plant growth.

Table (1) Composition of the experiment soil .

FC% DM	PWP % DM	ph	CEC (cm /kg)	EC(ds/m)	N %	P mg/ kg soil	K mg/ kg soil
22.0	9.0	6.5	1.3	11.0	0.04	13.0	59.0

FC: Field capacity , PWP :Permanent wilting point , EC:Electrical conductivity of mixture soil , CEC : Action exchange capacity , N:nitrogen P: phosphorus , K: potassium .



Fiq:(1) *Effect Tretment of combined B and salinity on ELP in leaves of* Fenugreek *plant. Show significantdifferences among treatment at p≤0.05*

Table 2:Combined effect of B and, Salinity on growth appearance in, Fenugreek plant

Treatment	plant high	root length	No..nodules	Size nodules	T.DW	h/L	
0	25.45	10.12	12.52	4.69	6.24	2.51	
2mgB	27.34*	10.39	12.87	4.93	6.64	2.63	
5mgB	20.22*	8.49*	8.40*	2.51*	5.41*	2.38	
10mgB	17.21*	4.15*	6.94*	2.15*	2.45*	4.14	
3ds/m NaCl	25.50	10.19	12.67	4.72	5.27*	2.50	
6ds/m NaCl	18.48*	5.48*	5.87*	2.24*	3.54*	3..37	
12ds/m NaCl	12.54*	3.98*	2.10*	1.83*	2.51*	3.15	
2mgB+3ds/m NaCl	29.21*	10.51	12.71	4.65	6.68	2.77	
2mgB+6ds/m NaCl	15.95*	7.45*	9.44*	2.88*	4.14*	2.14	
2mgB+12ds/m NaCl	12.40*	6.04*	7.23*	1.54*	2.85*	2.05	
5mgB+3ds/m NaCl	23.29*	10.08	8.14*	2.24*	6.12	2..31	
5mgB+6ds/m NaCl	19.89*	9.13*	10.65*	3.51*	5.90*	3.41	
5mgB+12ds/m NaCl	11.45*	5.81*	5.12*	1.71*	2.53*	1.97	
10mgB+3ds/m NaCl	22.57*	10.03	7.12*	1.87*	4.06*	2.25	
10mgB+66ds/m NaCl	16.23*	5.93*	6.14*	1.77*	2.88*	2.73	
10mgB+12ds/m NaCl	9.77*	3.79*	2.20*	1.25*	1.93*	2.57	

* *Significant differences among treatment at p≤0.05.(h/L)plant high/Root length.*

Table 3: Combined effect of B and Salinity on mineral balance (mg/gm) in Root of Fenugreek plant.

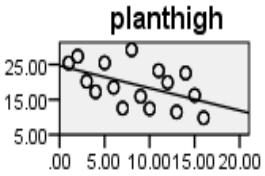
Treatment	B	Na	Cl	K	N	K/Na
0	5.10	6.24	2.75	22.23	4.15	3.51
2mgB	6.45*	6.12	3.52*	25.26*	4.35	4.12*
5mgB	6.83*	5.81*	2.19	25.67*	4.15	4.41*
10mgB	7.22*	4.96*	1.18*	26.78*	3.04*	5.39*
3ds/m NaCl	5.02	7.11*	3.89*	20.62*	4.11	2.71*
6ds/m NaCl	2.92*	11.88*	10.62*	12.22*	2.88*	1.02*
12ds/m NaCl	1.94*	17.82*	20.73*	5.94*	1.82*	0.33*
2mgB+3ds/m NaCl	5.12	6.25	2.47	23.87	4.33	3.81
2mgB+6ds/m NaCl	4.35*	7.97*	10.17*	11.94*	3.29*	1.49*
2mgB+12ds/m NaCl	3.13*	13.57*	24.73*	6.33*	3.18*	1.79*
5mgB+3ds/m NaCl	4.22*	7.82*	2.66	17.78*	3.11*	2.27*
5mgB+6ds/m NaCl	4.91*	6.19	5.88*	19.57*	3.95*	2.83*
5mgB+12ds/m NaCl	3.03*	18.22*	25.28*	6.17*	2.24*	0.95*
10mgB+3ds/m NaCl	4.12*	7.70*	2.61	14.77*	2.12*	1.91*
10mgB+6ds/m NaCl	4.05*	12.84*	8.24*	11.59*	2.08*	1.13*
10mgB+12ds/m NaCl	2.11*	22.18*	26.59*	5.10*	1.13*	0.63*

* *Show significant differences among treatment at p≤0.05.*

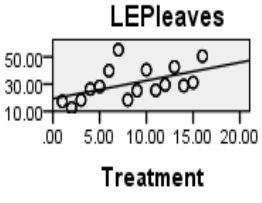
Table 4: *Combined effect of B and Salinity on mineral balance (mg/gm) in Root of Fenugreek plant.*

Treatment	B	Na	Cl	K	N	K/Na
0	3.12	6.43	3.90	18.12	2.532.81	
2mgB	5.45*	6.28	2.52*	18.58	2.55	2.95
5mgB	5.96*	5.30*	2.24*	18.79	2.12*	2.98
10mgB	6.24*	4.24*	2.13*	19.03*	2.02*	3.04
3ds/m NaCl	3.08*	9.56*	9.58*	16.30*	2.38	1.41
6ds/m NaCl	2.77*	19.35*	16.97*	5.47*	2.05*	0.28
12ds/m NaCl	0.92*	22.29*	20.92*	4.92*	1.29*	0.22
2mgB +3ds/m NaCl	4.19*	7.23*	3.60*	18.88	2.59	3.03
2mgB+ 6ds/mNaCl	2.63*	10.38*	10.19*	9.66*	1.80*	1.99
2mgB+12ds/m NaCl	1.45*	10.51*	22.12*	7.82*	1.71*	1.01
5mgB+3ds/m NaCl	4.87*	9.36*	3.77*	15.55*	1.45*	1.66
5mgB+6ds/m NaCl	3.03*	8.93*	5.64*	14.26*	2.29	1.93
5mgB+12ds/m NaCl	1.22*	25.59*	24.18*	9.06*	1.18*	0.58
10mgB+3ds/m NaCl	3.32	9.55*	3.95	13.64*	1.42*	1.42
10mgB+6ds/m NaCl	2.00*	20.82*	8.28*	10.47*	1.16*	1.05
10mgB+12ds/m NaCl	0.55*	22.20*	26.84*	4.17*	1.04*	0.48

**Show significant differences among treatment, at p≤0.05.*



lineal regression tto comper treatment of B and Salinity on plant high of Fenugreek plant.



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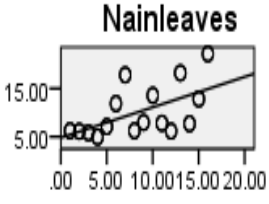
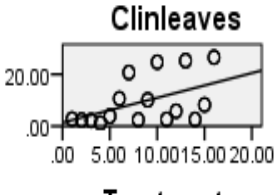
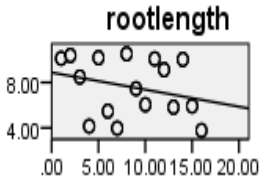
lineal regression to comper treatment of B and Salinity in LEP of leaves of Fenugreek plant .



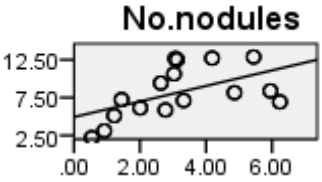
lineal regression to comper B and Salinity on Na content of Fenugreek plant .



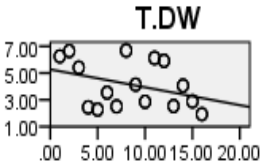
lineal regression to comper treatment of B and Salinity on Cl content in leaves of Fenugreek plant.



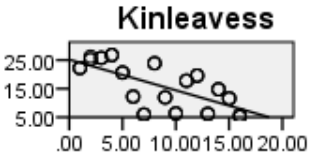
lineal regression to comper treatment of B and Salinity on root length of Fenugreek plant.



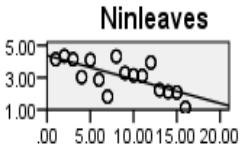
lineal regression to comper B concentration and number of nodules.



lineal regression to comper treatment of B and Salinity in Dry Wight of Fenugreek plant.

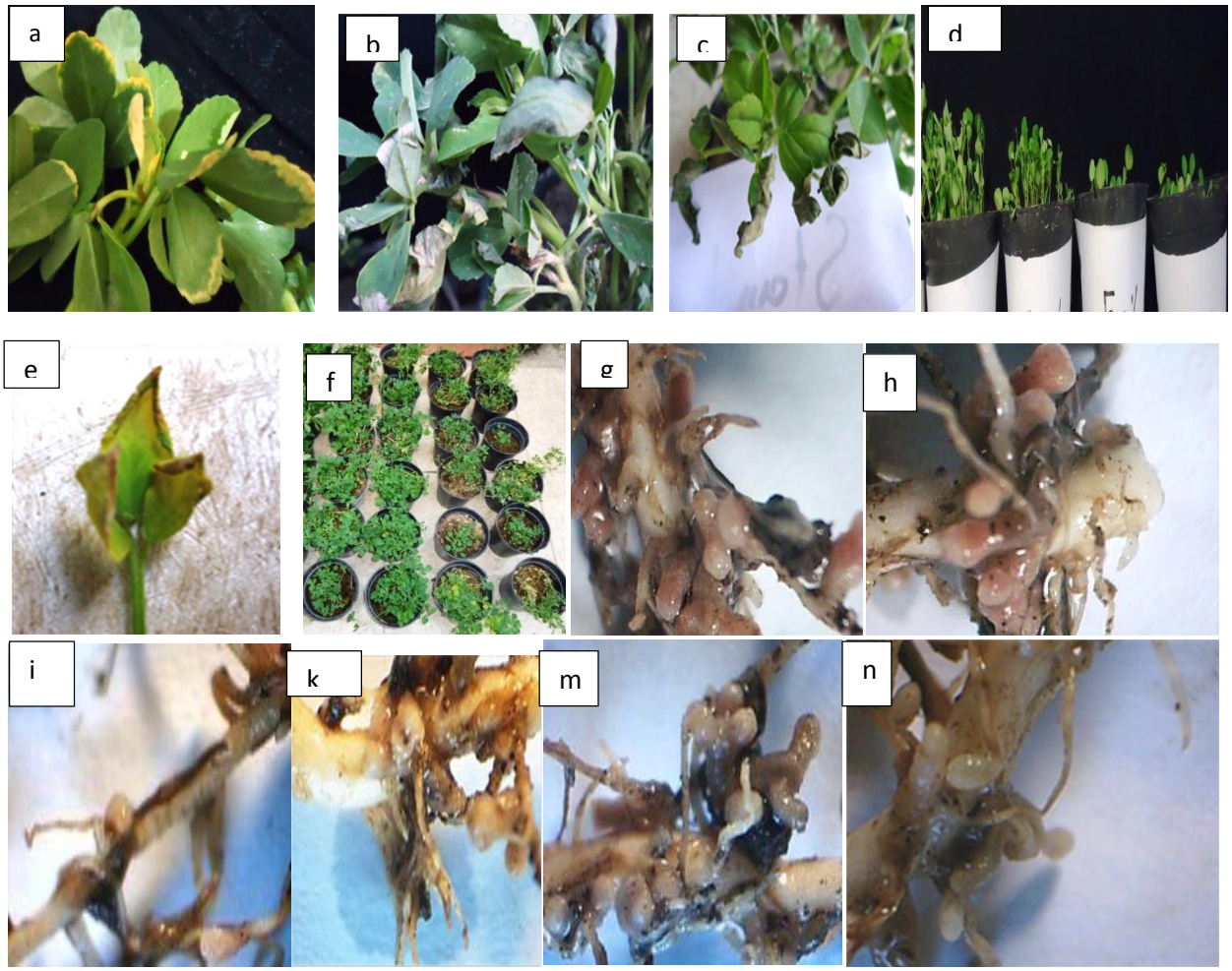


lineal regression to comper treatment B and Salinity in K content in leaves of Fenugreek plant .



lineal regression to comper treatment of B and Salinity in N content in leaves of Fenugreek plant.

Fiqre (2:)*Lineal regression to compare treatment ,of B and Salinity in some attributes of Fenugreek plant*



Picture (1) *show some appearance of* Fenugreek *plant under combined effect of B and Salinity*.

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دراسة تأثير تداخل الاجهادين (البورون والملوحة) في صفات النمو , والتوازن الايوني في نبات الحلبة

Fenugreek plant (Trigonella *fenum –graecum*)

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المستخلص:

فكرة البحث جاءت نتيجة ارتفاع مستوى الاملاح في مياه الري المعتمدة في على مياه شط العرب في محافظة البصرة , عندما ازداد مستوى الملوحة نتيجة ارتفاع مستوى مياه الخليج العربي على مستوى مياه شط العرب , تبين ان نبات الحلبة المزروع في السنادين ضمن تجربة لدراسة تأثير معاملات البورون 0.2,5 ,10 ملغم / كغم وتداخله مع الملوحة 0,3,6,12 ديسي سيمنز . لتقييم مؤشرات النمو والتوازن الايوني البورون النتروجين , والصوديوم , الكلور, والبوتاسيوم . في الأوراق والجذور. التسرب الايوني والوزن الجاف الكلي. أظهرت المعاملات تأثيرا في مقدار الكتلة الحيوية فقد سجلت (6.86 ملغم /غم , 1.93ملغم/ غم) في تداخل 10ملغم / كغم من البورون و 12 ديسي سيمنز من الملوحة) . ارتفاع النبات , اطوال الجذور اختزلت معنويا تحت تأثير 5,10 ملغم /كغم من البورون و 6 ,12 ديسي سيمنز من الملوحة . وتداخل المستويات العالية من البورون والمستويات العالية من الملوحة. ولوحظ كذلك ان المستوى 5ملغم /كغم من البورون والمستوى 6ديسي سيمنز من الملوحة , اختفت سمية البورون (التنخر , واحتراق الأوراق) وتحسن في نمو النبات وعدد وحجم العقد الجذرية عند تداخل 2ملغم /كغم من البورون و 3ديسي سيمنز من الملوحة , او المعاملتين بشكل مفرد . تراكيز البورون تراكيز البورون ازدادت معنويا في انسجة في انسجة النبات مع زيادة تراكيز البورون وكذلك زيادة عناصر الملوحة مع زيادة تراكيز الملوحة والتي أثرت معنويا في التوازن الايوني للبورون والكلور والصوديوم والبوتاسيوم والنتروجين . من خلال مختلف المعاملات . التسرب الايوني أزداد معنويا 50% مع زيادة معاملات الملوحة و والمستويات العالية من البورون , ولكن اختزل التسرب الايوني الى 15.33% ضمن المعاملة 2ملغم /كغم من البورون وتداخلها مع المستوى 3 دي سيمنز من الملوحة . المستخلص من البحث توجد علاقة تضاد ايوني وتعاون ايوني بين البورون والملوحة في نبات الحلبة وحسب التراكيز المختلفة , تراكيز البورون اختزلت مع معاملات الملوحة , وتأثير الملوحة في لمستويات القليلة تستطيع ان تختزل بواسطة تداخل مستويات البورون العالية , ولكن التراكيز المتوسطة من البورون والملوحة تكون اقل تأثير في اختزال نمو النبات . .

الكلمات المفتاحية : نبات الحلبة , البورون , الملوحة , صفات النمو , التوازن الايوني .