EFFECT OF SPRAYING WITH DIFFERENT CONCENTRATION OF LICORICE EXTRACT AND PLANT DENSITIES IN GROWTH AND YIELD OF SORGHUM BICOLOR L.

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ABSTRACT

A field experiment was condueted at the experimental Farm, College of Agriculture University of AL-Anbar in replace location (Abu-Gheaib) in spring season of 2017. While in Fall season it was applied at AL-saqluwiya-Anbar Province 10 km west north of Falluga city to study the effect of four levels of licorice extractor (*Glycyrrhiza glabra* L.) (0,2,4 and 6) g.L^{-1} water and three (53,333, 66,666 and 88,888 plant) plant.ha^{-1}. On growth and grain yield of Sorghum cv. Rabih. The experiment was applied using R.C.B.D. arranged in split plots with three replications. levels of plant densities were used as main-plot, while licorice extractor were used as sub-plot. Foliar application of licorice extractor was applied during vegetative growth. The results showed that, high plant density (88888) plant.h^{-1} significantly increase plant height and leaf area index, while most of traits were not significantly influenced by plant density including grain yield. Results revealed that foliar application of licorice extractor with 2,4,6 g.L^{-1} of water significantly influenced grain yield in spring season compane with control treatment and it is amounted to (9.62, 9.55 and 9.78) t.h^{-1} respectively. There were significant interaction between Licorice extractor and plant density in spring and fall season in grain yield. The higher grain yield of 10.31 and 10.33 t.h^{-1} were obtained when sorghum plants were sowing at hight density and sprayed with Licorice extractor at level 4 g.L^{-1} respectively

Keywords: Plant Extractors, grain yield, cv. Rabih, grain yield, plant density.
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تأثير الرش بتراكيز مختلفة من مستخلص عرق السوس والكثافات النباتية في نمو وحاصل الذرة البيضاء

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المستخلص

نفذت تجربة حقلية في محطة ابحاث قسم المحاصيل الحقلية–كلية الزراعة–جامعة الانبار الموقع البديل (أبوغريب) خلال الموسم الربيعي 2017 أما في الموسم الخريفي 2017 فقد نفذت التجربة في منطقة الصقلاوية 10كم شمال غرب الفلوجة لدراسة تأثير اربع مستويات من مستخلص عرق السوس (*Glycyrrhiza glabra* L.) 6,4,2,0 غم.لتر$^{-1}$ ماء وثلاثة كثافات نباتية (88888,66666,53333) نبات.هـ$^{-1}$ على نمو وحاصل الحبوب للذرة البيضاء (صنف رابح) طبقت التجربة بأستخدام تصميم R.C.B.D وبثلاث مكررات حيث أحتلت حيث احتلت الكثافات النباتية الالواح الرئيسية بينما احتلت تراكيز المستخلص الالواح الثانوية. رش المستخلص على المجموع الخضري للنبات. أظهرت النتائج تفوق الكثلفة النباتية العالية بارتفاع النبات ودليل المساحة الورقية بينما لم تختلف الكثافة النباتية في تأثيرها على اغلب الصفات وخاصة حاصل الحبوب. أظهرت تراكيز الرش 6,4,2 غم.لتر$^{-1}$ تأثيراً معنوياً في حاصل الحبوب للموسم الربيعي مقارنة بعدم الرش وبلغ الحاصل(9.78,9.55,9.62) طن.هـ$^{-1}$ بالتتابع. كما أظهرت النتائج وجود تداخل معنوي بين العاملين في حاصل الحبوب ولكلا الموسمين ومنه نتج أن رش النباتات بالتركيز 4 غم.لتر$^{-1}$ ماء على النباتات بالكثافة العالية 88888 نبات.هـ$^{-1}$ قد اعطت أعلى متوسط لحاصل الحبوب بلغ (10.31و10.33) طن.هـ$^{-1}$ ولكلا الموسمين الربيعي والخريفي بالتتابع.

الكلمات المفتاحية: المستخلصات النباتية،حبوب، الصنف رابح،, حاصل الحبوب، الكثافة النباتية.
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INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is one of the five most important cereal crops in the world and is ranked fifth after wheat, rice, maize and barley. Sorghum is a drought resistance fodder crop (3). Under Iraqi condition, this crop mainly cultivated for forages or for seed production and their seeds in some parts of the world regions is consumed as staple food grain. The mean seed yield under Iraqi conditions is low, no more than 1200kg. ha^{-1}, this low productivity can be attributed mainly to a lack of suitable agronomic practices including plant density. The within the row Al-Janabi (7) referred to the significant impact of plant density on plant height, where the spacing within the row 10 cm gave the highest value of plant height reached (179.89 cm), while, the lowest value (166.42) was at spacing of 15 cm. He also mentioned to the reduction of leaf area due to increased plant density where the high density had the highest mean reached 3664 cm^{-2}. $plant^{-1}$ and that was in his study of three plant densities with three planting space during spring season, the reason might be because of plants compete for growth requirements. It was confirmed by Al- Janabi (7) that the harvest index is reducing with increased plant density and that due to increased cereal production, where inter-rows spacing of 70 cm had the greatest value (31.03 %) of harvest index while 60 cm inter-rows spacing had the lowest (25.89 %) harvest index. Abdul-Hamid (2) Clearfield that increasing plant density will increase the yield where density of plant ha^{-1} gave 5.79 $ton.h^{-1}$ with increasing rate of 6.62%, 13.67% respectively compared to plant per hectare for the spring season, while for the fall season the same density showed increasing percentage in the yield reached 5.90% and 16.66% compared to density of thousand $plant.ha^{-1}$ respectively. Results of Wahib (24) showed the impact of plant density on plant leaf area index as the highest density showed value of 2.38 which considered as a results of increased plants number per unit area, in addition to that their results showed increased grain yield due to increased plant density. Liquorice is a wild perennial plant known as Glycyrrhiza which means sweet root and is belong to Fabaceae which includes more than 20 species and glabra is an important one Al-Waeli(11). Liquorice is worldwide used as medicinal and therapeutic plant in addition to use its roots as active natural sweetening source as it is 17 – 50 time sweetest than sucrose. Researches worked on Liquorice root extraction reported an important impact for this substance.Al- Qaisi (8), demonstrated that the foliar application of Liquorice root extraction in two concentrations (100% and 50%) on sunflower plants was led to significant increase in plant height, leaf area and leaf area index, likewise, Nasrallah (21) mentioned to significant increase in total grain yield and grain contain of protein in sunflower for plants treated with Liquorice root extraction (50%) compared to plants sprayed with water only which considered as a consequence of increased number of seeds and seeds weight of treated plants. Nasrallah(20) found significant differences in total grain yield for treated pop corn plants with 50% concentration of Liquorice root extraction.

MATERIALS AND METHODS

A field experiment was conducted during spring and fall seasons of 2017. The spring season was applied at experimental farm, College of Agriculture University of Al-Anbar in replace location (Abu-Graib, 20km west of Baghdad), while, in fall season the experiment was applied at special farm located west of Fallujah city – Anbar province. Soil analysis for the two seasons shows in Table 1. The experiment was carried out in a R.C.B.D arranged in split plot with three replications. Four concentration of Liqourice roots extraction (0 , 2 , 4 and 6) $g.L^{-1}$ reffered as C_0 , C_1 , C_2 and C_3 respectively were used as a foliar application and occupied the main plots, three plant population densities were occupied the subplots i.e (53.333,66,666 and 88.888) plant. ha^{-1} reffered as D_1 , D_2 and D_3 respectively. The net plot size was $3 \times 3m^2$ with 4 rows. The desired plant densities were achieved with inter-row spacing of 15cm in $D_1, 20cm$ in D_2 and 25cm in D_3 and 75cm inter-row spacing in all treatments. All crop and soil management were done as recommended. Seeds of The preparation of Liquorice root extraction was, made by milling dry roots and then sieved through 0.5 mm screen. Sorghum variety Rabih were sown on

10th of march 2017 for the spring season and 19th of June 2017 for fall season. was added for each concentration and left for 24 hours and then filtered before used. Foliar application of concentration was done early in the morning started one month after sowing date and repeated three times with one month interval between each one Al-Adai(4).

Table 1. Chemical and physical properties of soil and irrigation water for spring and fall season of 2017

Characters		Values for two seasons		Unit
		Spring season	Fall season	
PH	Soil	8.4	7.5	---
	Water	8.2	7.6	
Electrical Conductivity EC (1:1)	Soil	3.5	2.3	$Ds.m^{-1}$
	Water	4.11	3.8	
Organic matter	O.M	1.85	1.72	%
Available N	N	58.3	57.4	PPM
Available P	P	12.70	11.5	
Available K	K	275.0	285.4	
Soil separates	Sand	52.7	52.1	%
	Silt	33.2	35.4	%
	Clay	14.1	12.5	%
Texture		Silty clay	Silty clay	--

Data were collected on the following parameters:

1- Plant height at maturity (cm): Ten plants were selected randomly from the middle row in each plot. Their height was measured from the soil surface to the tip of head House (14).

2- Leaf area ($cm^2, plant^{-1}$): Five plants were selected randomly at completely flowering stage from the middle row in each plot using the equation below. Leaf area = leaf length X maximum width x 0.75 Liang (18).

3- Leaf area index: measured by dividing leaf area of the plant on area occupied by plant.

4- Number of grain per head and grain yield ha^{-1}. At maturity stage, Ten plants were selected randomly from the middle rows and the number of grain in each head were counted averaged and recorded. grain yield per plant was also recorded. grain yiled t. ha^{-1} calculated by multiplying mean yield per plant by the density.

5- Protein % in grain: this triat was measured using semi micro Kjeldahi A.O.A.C(1) to estimate N% and then converted to protein %= N% X 6.25.

All collected data from this study were analysis according to analysis of variance method as described by Al-Rawi and KHalaf Allah Al-Rawi (10). Means were compared using L.S.D test at 5% level of significant.

RESULTS AND DISCUSSION

Plant height

Results in Table 2 shows that in spring season, plant height was significantly affacted by plant densities, Licorice extract concentration and their interaction, while in fall season. This trait was only significantly influenced by the interaction between the two factors. Short statured plants (129.44cm) were recorded in D_1 (53333 plant, ha^{-1}) and it was significantly different than D_2 and D_3 which wene not significantly different to each other. Such increases in plant height with increase of plants densities may be due to increase of shading and this inturne. increase auxin and gibberdine activity and their by increase internods elongation Attia(12). Similar findings were also reported by Jwad(17). Foliar application of licorice extrate at concentration C_2 ($4g.L^{-1}$) significantly increase plant height (134.53cm) compare with C_0, C_1 and C_3 (132.27, 131.44 and 132.52) respectively (Table 2). In this study it is appear

that concentration 4g. L^{-1} is more effective in increases in plant height and the increment of the concentration beyond that limit significantly reduce the plant height this may be explain that this conc. is the proper level for encourage stem elongation. their were significant interaction between the two factors. This interaction on probably due to the variation in response for the plant densities to different conc. of Licorice extract, since, low plant density (D_1) gave highest plant height when it spray with high conc., while in D_2 and D_3 highest plant height were abstained after spraying with low conc.

Table2. Effect of plant density and foliar application of Licorice root extraction on Sorghum plant height (cm) in spring and fall season of 2017

Spring season (2017)				
Licorice extraction concentration	**Plant density plant ha-1**			**Concentrations**
	D1	**D2**	**D3**	**Mean**
0	**126.33**	**134.53**	**135.93**	**132.26**
2	**126.73**	**135.30**	**132.30**	**131.44**
4	**132.30**	**133.50**	**137.83**	**134.54**
6	**132.40**	**132.60**	**132.57**	**132.52**
L.S.D $_{0.05}$		**1.31**		**0.78**
Densities Mean	**129.44**	**133.98**	**134.66**	
L.S.D $_{0.05}$			**0.82**	
Fall season (2017)				
Licorice extraction concentration	**Plant density plant ha-1**			**Concentrations Mean**
	D1	**D2**	**D3**	
0	**141.93**	**144.90**	**144.50**	**143.77**
2	**146.33**	**146.50**	**146.90**	**146.57**
4	**144.97**	**143.03**	**142.63**	**143.54**
6	**144.10**	**143.27**	**146.83**	**144.76**
L.S.D $_{0.05}$		**2.09**		**N.S**
Densities Mean	**144.33**	**144.45**	**145.21**	
L.S.D $_{0.05}$			**N.S**	

Plant leaf area (cm^2)

Results in Table 3 refer to non – significant effect of plant population densities and spraying with licorice root extraction on leaf area of plant in both spring and fall seasons. However the interaction between the two factors significantly affects this character only in fall season. The low plant population density, D_1 and spray licorice extraction (C_3) gL^{-1} gave the highst average of leaf area 5587 $cm^2\ plant^{-1}$ while the same density (D_1) when it is spranged with distilled water gave the lowest average $5176 cm^2\ plant$

Table3. Effect of plant density and foliar application of Licorice root extraction on Sorghum plant leaf area cm^2 plant in spring and fall season of 2017

Spring season (2017)				
Licorice extraction concentration	**Plant density plant ha-1**			**Concentrations**
	D1	**D2**	**D3**	**Mean**
0	**4333**	**4280**	**4398**	**4337**
2	**4288**	**4367**	**4343**	**4332**
4	**4364**	**4141**	**4227**	**4244**
6	**4441**	**4349**	**4409**	**4400**
L.S.D .05		**N.S**		**N.S**
Densities Mean	**4357**	**4284**	**4344**	
L.S.D .05			**N.S**	
Fall season (2017)				
	Plant density plant ha-1			**Concentrations**
	D1	**D2**	**D3**	**Mean**
0	**5179**	**5193**	**5436**	**5268**
2	**5202**	**5452**	**5386**	**5347**
4	**5587**	**5291**	**5331**	**5403**
6	**5402**	**5182**	**5418**	**5334**
L.S.D .05		**349.1**		**N.S**
Densities Mean	**5342**	**5280**	**5393**	
L.S.D .05			**N.S**	

Leaf area index

Results in Table 4 indicate that leaf area index was significantly affected by plant population density and its interaction with licorice extra in both seasons and by spraying of licorice in fall season only. High plant population density D_3 recorded the highest averages 3.85 and 4.78 respectively. This may be due to the narrow distances between plants which inturn Leud to increase the leaf area index. This was in agreement with Ibrahim(16) and Al-Dulaimy (5), who found that increased plant population density increased the leaf are index of sorghum. Results of the same Table refer to significant effect of spraying of licorice in the fall spraying only where C_3 gave the highest average 3.74 compared with 3.68 in the control treatment. This may be due to the improvement of vegetative growth characteristics which contains high content of carbohydrates in particular, mevalonic which likes gibberellin in its mode of action i.e. promotion of complicated enzymes to simple compounds to be used in the energy supply, speeding cells division and elongation. This was in agreement with the findings of Saadoon(23) and Badr(13). Concerning the interaction, high plant population density D_3 with the spraying concentration C_4 gave the highest average of this character 3.91 in spring season compared with 4.83 for the control treatment in the fall season.

Table4. Effect of plant density and foliar application of Licorice root extraction on Sorghum plant leaf area index in spring and fall season of 2017

Spring season (2017)				
Licorice extraction concentration	**Plant density plant ha-1**			**Concentrations Mean**
	D1	**D2**	**D3**	
0	**2.31**	**2.85**	**3.90**	**3.02**
2	**2.28**	**2.91**	**3.86**	**3.01**
4	**2.32**	**2.76**	**3.75**	**2.94**
6	**2.36**	**2.89**	**3.91**	**3.05**
L.S.D .05		**0.16**		**N.S**
Densities Mean	**2.31**	**2.85**	**3.85**	
L.S.D .05			**0.09**	
Fall season (2017)				
Licorice extraction concentration	**Plant density plant ha-1**			**Concentrations Mean**
	D1	**D2**	**D3**	
0	**2.76**	**3.46**	**4.83**	**3.68**
2	**2.77**	**3.63**	**4.78**	**3.72**
4	**2.97**	**3.52**	**4.73**	**3.74**
6	**2.88**	**3.45**	**4.81**	**3.71**
L.S.D .05		**0.28**		**0.09**
Densities Mean	**2.84**	**3.51**	**4.78**	
L.S.D .05			**0.28**	

Number of grains per head

Results in Table 5 shows that there was significant effects of plant population densities only in the spring season, their interaction with the concentrations of licorice root extraction in both seasons and no significant effect of licorice in both seasons. The lowest plant population D_1 gave the highest average (2521) grain head^{-1} but it was only significantly different comoane with D_3 (2450) This may be attributed to the less photoassimilates produced by photosynthesis in the high population densities which in turn reduced the fertility percentage and consequently the number of grain $head^{-1}$. This was in agreement with Al-Dulaimi (5). Results of the same Table refers to significant effect of interaction for this character in both seasons where highest population D_3 with the spraying of licorice C_2 gave the highest average 2664 and 2643 grain $head^{-1}$ in both seasons.

Table5. Effect of plant density and foliar application of Licorice root extraction on the number of grains per head of Sorghum plant in spring and fall season of 2017

Spring season (2017)				
Licorice extraction concentration	Plant density plant ha-1			Concentrations Mean
	D1	D2	D3	
0	2204.3	2610.0	2545.0	2453.1
2	2656.0	2305.7	2664.7	2531.8
4	2615.3	2615.7	2270.7	2500.5
6	2611.6	2534.0	2322.7	2489.4
L.S.D .05		93.66		N.S
Densities Mean	2521.1	2516.3	2450.8	
L.S.D .05			55.18	
Fall season (2017)				
Licorice extraction concentration	Plant density plant ha-1			Concentrations Mean
	D1	D2	D3	
0	2631.7	2609.3	2366.3	2535.8
2	2527.7	2304.7	2643.0	2491.3
4	2366.3	2630.3	2554.3	2516.9
6	2611.7	2551.3	2365.3	2509.4
L.S.D .05		79.03		N.S
Densities Mean	2534.3	2523.9	2482.2	
L.S.D .05			N.S	

Grain yield (t. ha^{-1})

Grain yield trait in both seasons, was not significanty influenced by plant densities, but it was significantly influenced by foliar application of licorice extraction concentration in spring season and the interaction in both season, (Table 6). In spring season, the results in Table 6 shaws that foliar application of licorice extraction at concentration 6 g.L^{-1} gave highest grain yield (9.78 t.ha^{-1}), but it was only significantly different compare with control treatment (9.13 t.ha^{-1}) , increases in grain yield after spraying may be due to the content of extraction for sugar and minerals which in turn lead to increase osmotic pressure and their by increase minerals absorption and then increase grain yield. Similar finding was also reported by Saadon (23). In both seasons, the significant interaction between the two factors may be due to the variation in response of densities to different concentration at licorice extraction.

Table 6. effect of plant density and foliar application of Licorice root extraction on Sorghum grain yield (t.ha^{-1}) in spring and fall season of 2017

Spring season (2017)				
Licorice extraction concentration	Plant density plant ha-1			Concentrations Mean
	D1	D2	D3	
0	8.52	10.18	8.69	9.13
2	10.13	9.72	9.02	9.62
4	9.40	8.94	10.31	9.55
6	10.25	10.09	9.02	9.78
L.S.D .05		0.76		0.44
Densities Mean	9.57	9.73	9.26	
L.S.D .05			N.S	
Fall season (2017)				
Licorice extraction concentration	Plant density plant ha-1			Concentrations Mean
	D1	D2	D3	
0	8.54	10.24	9.67	9.48
2	10.17	9.66	9.07	9.64
4	9.74	8.97	10.33	9.68
6	10.29	9.81	9.06	9.72
L.S.D .05		0.45		N.S
Densities Mean	9.69	9.67	9.53	
L.S.D .05				N.S

Protein percentage in grains

Results of Table 7 shows a significant effect of plant population on protein percentage only in the spring season. The interaction was significant in both seasons. However the effect of licorice was significant only in the fall season. the lowest plant population D_1 plant ha^{-1} gave the highest average of protein percentage 9.53% compared with 8.60% for highest plant population D_3. Plant ha^{-1}. This may be due to the high competition between plants on light which in turn reduces the photosynthesis process Nuhbeh(22). This results agreed with the Al-Rawi (10) findings, who reported that increased distances leads to the increase of protein percentage of grains. Results in Table 7 shows that concerning the interaction, results showed that the lowest production D_1 plant ha^{-1} with the $C_4 gmL^{-1}$ of licorice gave the highest protein percentage 10.02 and 10.03% both seasons compared with the highest population D_3 plant ha^{-1} which gave the lowest percentage 8.18 and 8.30%

Table7.Effect of plant density and foliar application of Licorice root extractio protein percentage in Sorghum grains in spring and fall season of 2017

Spring season (2017)				
Licorice extraction concentration	**Plant density plant. ha-1**			**Concentrations Mean**
	D1	**D2**	**D3**	
0	**9.95**	**8.86**	**8.18**	**8.99**
2	**9.12**	**9.70**	**8.36**	**9.06**
4	**9.05**	**8.79**	**9.46**	**9.10**
6	**10.02**	**8.85**	**8.42**	**9.09**
L.S.D .05		**0.46**		**N.S**
Densities Mean	**9.53**	**9.05**	**8.60**	
L.S.D .05			**0.2781**	
Fall season (2017)				
Licorice extraction concentration	**Plant density plant. ha-1**			**Concentrations Mean**
	D1	**D2**	**D3**	
0	**8.93**	**8.49**	**8.30**	**8.57**
2	**8.96**	**10.00**	**9.89**	**9.62**
4	**9.03**	**8.87**	**8.41**	**8.77**
6	**10.03**	**8.86**	**9.37**	**9.42**
L.S.D .05		**0.39**		**0.20**
Densities Mean	**9.24**	**9.05**	**8.99**	
L.S.D .05			**N.S**	

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