

Effect of planting date, plant density and spraying with organic nutrients on growth and quantitative and qualitative yield for garlic plant (*Allium sativum* L)

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ABSTRACT

The experiment was conducted in one the fields belonging to the Directorate of Agriculture in Basra (Tomato Developing Project in Khor Al-Zubair) during the agricultural season (2015-2016) in order to study the effect of the dates and density of cultivating and spraying with seaweed extract (ALGIDEX) and the licorice root extract on the growth and yield of garlic (*Allium sativum* L.) and the cloves content of the elements of NP.PK.S., where the experiment included three-factor which are the interaction between three planting dates (10/25, 11/10, 25/11), two plant densities (1, 3 clove/pit), and spraying with five concentrations of organic nutrients are organic fertilizer (ALGIDEX and *Ascophyllum nodosum*) with two concentrations of (2, 4 ml.L⁻¹) and licorice root extract with two concentrations (6, 8 g.L⁻¹). In addition to the control treatment of (spraying with distilled water only), with the rate of four sprayings (two weeks between one spraying and another after completing the emergence of cultivated seedling with a month of cultivating for each date). The results showed that the second and third planting dates were significantly excelled in the leaf area (dm²), the percentage of potassium in the cloves, the weight of the head (g) and the cloves content of phosphorus, While the first planting date has excelled in the total number of heads (tons.h⁻¹) and the percentage of nitrogen and sulfur in cloves. The cultivated plants with a density of (3 cloves/pit) were significantly excelled in leaf area (dm²), the total number of heads (ton.h⁻¹) and the percentage of phosphorus and potassium in the cloves. The plants that were sprayed with licorice extract at a concentration of (8 g.L⁻¹) are excelled in plant height, leafy area (dm²), the weight of the head (g), total head yield (tons.h⁻¹), Percentage of nitrogen, phosphorus, potassium, and sulfur in cloves, the plants that sprayed with ALGIDEX extract at a concentration of (4 ml.L⁻¹) are also significantly excelled in plant height. Bi-interactions and triple interactions showed significant superiority in most of the studied traits.

* Research paper from the Ph.D thesis for the first Author

Keywords: Cultivating date, Plant density, Organic nutrients, Garlic.

1. INTRODUCTION

Garlic (*Allium sativum* L.) is considered the second most important vegetable crop belonging to the Alliaceae family after the onion and it is believed that Central Asia, its original country (12). A plant needs a cool and mild atmosphere in its early growth phases to form a good vegetative growth before the plants begin to form the bulbs, therefore, the planting date has a significant role in increasing the yield and improving its quality, especially the distinctive flavor in the taste of cloves, where the results of the studies showed an increase in its productivity at the appropriate planting date. Qaryouti and Kasrawi, (20) explained that the delay in planting date from October to January led to the small diameter of heads and reducing their fresh and dry weight and then reducing yield, in other studies some researchers indicated that the productivity of garlic can be increased by increasing the number of plants per unit area. Mohammed et al., (15) mentioned that the plant density (300,000 plant.h⁻¹) was significantly excelled in all yield traits, while the plant density (900,000 plant.h⁻¹) has excelled in total yield. In recent years, non-harmful manufactured organic fertilizers, such as nutrient solutions containing amino acids or organic compounds added at low concentrations, have been used by spraying them on the plant or adding them with irrigation water to the soil in order to accelerate growth

and improving production, as well as to improve soil properties, Because good crop production requires the nutritional needs for the plant in its growth environment, one of the most important means to do so is to develop an appropriate fertilization program that represents optimal plant growth, including the licorice root extract and organic manure (ALGIDEX), which is organic fertilizer with the seaweed extract (*Ascophyllum nodosum laminaria*). Al-Marsoumi et al., (11) mentioned that the spraying of onion plants with licorice extract led to giving the largest leaf area and reducing the number of planting days to forming bulbs compared to non-spraying. Al-Othaimeen (7) recommended that adding seaweed extracts (*Sargassum crassifolia*) that widely spread on the Red Sea coasts in Saudi Arabia to lettuce plant, where it led to increase the height of the plant and its fresh and dry weight in general and increasing the production rates and improving the quality of plants, Al-Bayati et al.,(1) found that the spraying of garlic plant with foliar fertilizer at concentration of (1 g.L⁻¹) showed a significant increase in the number of leaves (11.3 leaf.plant⁻¹), the fresh weight of root system (9.85 g.plant⁻¹), the dry weight of the root system (9.8 g.plant⁻¹), the percentage of dry weight for root growth / dry weight of the total vegetative (5.5%). In order to the absence of previous studies on the garlic plant in Basra region generally and the desert region

particularly, so it has been trend to cultivating this plant, in order to evaluate the efficiency of organic fertilizer (ALGIDEX) and the Licorice root extract in increasing the yield and improving its quality by controlling the planting dates and plant densities represented by the number of cloves in pit.

2. MATERIALS AND METHODS

The field experiment was conducted during the winter season (2016-2015) in the Tomato Developing Project belonging to the Directorate of Agriculture in Basra, Khor Al-Zubair in sandy soil with a pH of 7.31 and a degree of conductivity (6.48 ds.m^{-1}), contains 0.62% organic matter, and (23.8, 12.9, 19.2 g.kg^{-1}) elements of nitrogen, phosphorus and potassium availability in soil, respectively. the experiment included three-factor which are the interaction between three planting dates (10/25, 11/10, 25/11), two plant densities (1, 3 clove/pit), and spraying with five concentrations of organic nutrients are organic fertilizer (ALGIDEX and *Ascophyllum nodosum*) with two concentrations of (2, 4 ml.L^{-1}) and licorice root extract with two concentrations (6, 8 g.L^{-1}). In addition to the control treatment of (spraying with distilled water only), with the rate of four sprayings (two weeks between one spraying and another after completing the emergence of cultivated seedling with a month of cultivating for each

date). The Randomized Complete Block Design (RCBD) is used as a factorial experiment, with three Split-Split Plot Design where the planting date is considered Main plots, plant density is Sub-Plot and spraying with organic nutrient is Sub-Sub-Plot. Thus, the number of factorial treatments is 30 factorial treatments and with a rate of three replicates to be the number of experimental units are 90. Results were statistically analyzed using the genstat program, and the least significant difference (L.S.D.) was used to compare the averages at a probability level of (0.05) (5). The field soil was prepared by plowing its twice perpendicular, smoothed and then divided into 18 lines, the decomposed animal fertilizer (cows' residue) was added in the middle of each line at a rate of ($10 \text{ m}^3.\text{dunum}^{-1}$), and the compound fertilizer NPK 20-20-20 was added with it at a concentration of ($10 \text{ cm}^3.\text{dunum}^{-1}$) (16), The organic fertilizer (ORGEVIT) produced by Maimon company was added with rate of (5 mg/line), which consists of 65% organic matter, 4.6% nitrogen, 2.5% P_2O_5 dissolved in water, 2.5% K_2O potassium oxide, EC (18 ds.cm^{-1}), pH 7, and 10% humidity, the lines were then divided into three plots, each plot contains six main lines, with a distance of one meter between the line and another and length of 30 m, width of 50 cm and depth of 15 cm, each line divided to five experimental units with 6 m length and area of 6 m^2 to be the number of plants in the

experimental unit is 40 plants for one side and left a distance of 50 cm at the beginning and end of each line as guardian plants. The field was irrigated before two days of cultivating the seeds to moisten the soil, where the drip irrigation system was used to irrigating the plants depending on the water of the artesian wells and the desalination system. The cloves were cultivated for the local garlic cultivar (garlic of Al-Zubayr) on 25/10/2015, 10/11/2015 and 25/11/2015 in the field directly after sorting the infected and damaged and unify its suitable weights for cultivating, with a diameter of (1-1.5 cm), equivalent to 1 - 2 g and with a distance of (15 cm) between pit and another after conducting the calibration irrigation, with two densities (1, 3 clove/pit) and on both sides of the dotted for both seasons. All the service operations were conducted for all the treatments as followed in the production of this crop, the fertilization process was conducted by adding NPK fertilizer to the soil with a rate of (100 kg.dunum⁻¹) after about three weeks from cultivating, a second batch was added after one month from the first batch, followed by urea fertilization with 100 g of urea (46% nitrogen, 100 L⁻¹ water) was added with irrigation water between one week and another. Manual weeding was conducted as needed. Plants were cut down on 20/20/2016. Ten plants were randomly selected to measure the indicators of vegetative growth such as plant

height (cm), leaf area (dm²), the average of total heads (tons.ha⁻¹) and the cloves content of nitrogen, potassium, sulfur (19) and phosphorus (8).

RESULTS AND DISCUSSION

Table (1) shows that the planting date did not significantly affect the trait of plant height. As for the effect of plant density, the cultivated plants with three cloves in the pit were significantly excelled compared with those cultivated with one clove in this trait. As for the effect of spraying with organic nutrients, plants that sprayed with licorice root extract at concentration of (8 g.L⁻¹) were significantly excelled in plant height, followed by and with non-significant difference than those sprayed with a concentration of (6 g.L⁻¹) and those which were sprayed with ALGADEX at a concentration of (4 ml.L⁻¹). The lowest height was observed in the plants that were sprayed with ALGADEX at a concentration of (2 ml.L⁻¹). The results of the table show that all bi-interactions were significant except for the interaction between planting date and plant density was insignificant. As for The triple interaction between treatments, the cultivated plants at the second date with the density of three cloves in pit, which was sprayed with a licorice root extract at a concentration of (8 g.L⁻¹) have excelled by giving it the highest plant height amounted to (63.36 cm) compared to the lowest height which resulted from triple

interaction of the date and density plants for the control treatment, which amounted to 50.67 cm.

Table 1: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the plant height (cm) for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					Date × density
		Control	ALGADEX (g.L ⁻¹)			licorice roots (g.L ⁻¹)	
		0	2	4	6	8	
First date 25/10	One clove	51.61	57.16	58.54	58.78	58.43	56.90
	Three cloves	51.68	56.28	56.49	64.34	61.32	58.02
Second date 10/11	One clove	52.68	56.40	58.63	60.12	59.11	57.39
	Three cloves	50.67	58.67	62.88	59.76	63.36	59.07
Third date 25/11	One clove	52.62	56.01	59.44	57.62	58.18	56.77
	Three cloves	53.21	56.99	57.53	58.81	61.99	57.71
							Average date
Date × Concentration	25/10	51.65	56.72	57.51	61.56	59.88	57.46
	10/11	51.67	57.53	60.76	59.94	61.24	58.23
	25/11	52.92	56.50	58.49	58.22	60.09	57.24
							Average density
Density × Concentration	One clove	52.30	56.52	58.87	58.84	58.57	57.02
	Three cloves	51.85	57.31	58.97	60.97	62.23	58.27
Average Concentration		52.08	56.92	58.92	59.91	60.40	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
NS	1.21	1.90	NS	4.13	2.59	5.12	

Table (2) show the effect of the treatments and their interaction on the leaf area for the plant, where the plants cultivated at the second and the third planting date were excelled with non-significant differences between them on those cultivated on the first planting date. The plants cultivated with three cloves in the pit were also significantly excelled on those cultivated with

one clove. The plants that sprayed with licorice root extract at a concentration of (8 g.L⁻¹) showed significant excelling in this trait, followed by and with significant difference those which sprayed at a concentration of (6 g.L⁻¹) and those which were sprayed with ALGADEX at a concentration of (2 ml.L⁻¹) which did not differ significantly between

them. It was followed by the plants that were sprayed with ALGADEX at a concentration of (4 ml.L^{-1}), then the control plants that showed the least leaf area for the plant. The results in the table showed a significant effect on all bi-interactions between the treatments. Triple interaction between the treatments showed a significant effect on the leaf area for the plant, where the plants of second planting date which cultivated with three cloves in pit, which was sprayed with licorice root extract at a concentration of (8 g.L^{-1}) have excelled by giving it an average amounted to (17.119 dm^2), while the plants cultivated in the first planting date at the same density for the control treatment gave the lowest leaf area for the plant amounted to (3.050 dm^2). The increase in plant height when treated with licorice extract was attributed to the role of the extract in stimulating vegetative growth for the plant by encouraging the dormant buds because of its similar role to the gibberellin because of its combination with the mevalonic acid in the biosynthesis process for both and because the extract contains many Terpenoid. Thus, the behavior of gibberellin in its effect on increasing vegetative growth, increasing elongation and cell division due to its effect on the enzymes involved in the transformation of complex compounds into simple compounds that are exploited by the plant to build the new protein substances needed for its growth. It then

gave large vegetative growth caused an increase in the leaf area for the plant (dm^2), or perhaps plant cells have been able to absorb part of the sugar of the extract and make use of them in its bio-activities and then increase the plant height (10). These results agree with (3) that found the spraying of onion plants with licorice root extract gave the highest plant height, also agree with [2, 6].

Table (3) shows the excelling of the plants cultivated in the third planting date in the weight of head significantly on those resulting from the plants cultivated in the second and first planting dates which did not differ significantly between them. The plant density did not have a significant effect on this trait. The plants that were sprayed with root extract Licorice at a concentration of (8 g.L^{-1}) were significantly excelled on those sprayed with ALGADEX at a concentration of (4 ml.L^{-1}) which were sprayed with a licorice root extract at a concentration of (6 g.L^{-1}) with non-significant differences between them, followed by a significant difference of the plants that were sprayed with ALGADEX at a concentration of (2 ml.L^{-1}), then the control plants that gave the lowest weight of head. All bi-interactions had a significant effect on the weight of the head. Triple interaction between the treatments showed a significant effect on the weight of the head, where the plants

cultivated at the third planting date, with a density of one clove in the pit, which was sprayed with licorice root extract at a concentration of (8 g.L⁻¹). were significantly excelled by giving it an average amounted to

(46.98 g), compared to the lowest weight at the interaction of the plants cultivated on the second plant date, with three cloves per pit for the control treatment which amounted to (20.73 g).

Table 2: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the leaf area (dm²) for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					date × density
		Control	ALGADEX (g.L ⁻¹)		licorice roots (g.L ⁻¹)		
		0	2	4	6	8	
First date 25/10	One clove	3.175	7.428	9.943	7.534	11.805	7.977
	Three cloves	3.050	8.206	7.282	9.762	13.119	8.284
Second date 10/11	One clove	3.425	8.750	7.998	10.896	13.089	8.832
	Three cloves	4.173	9.673	10.292	10.920	17.119	10.435
Third date 25/11	One clove	4.180	10.144	9.227	8.066	14.214	9.166
	Three cloves	4.768	10.450	8.531	10.429	14.603	9.756
							Average date
date × Concentration	25/10	3.112	7.817	8.613	8.648	12.462	8.130
	10/11	3.799	9.211	9.145	10.908	15.104	9.633
	25/11	4.474	10.297	8.879	9.247	14.408	9.461
							Average density
density × Concentration	One clove	3.593	8.774	9.056	8.832	13.036	8.658
	Three cloves	3.997	9.443	8.702	10.370	14.947	9.492
Average Concentration		3.795	9.108	8.879	9.601	13.991	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
0.588	0.397	0.527	0.653	0.925	0.741	1.289	

Table 3: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the weight of the head (g) for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					date × density
		Control	ALGADEX (g.L ⁻¹)		licorice roots (g.L ⁻¹)		
		0	2	4	6	8	
First date 25/10	One clove	21.76	30.79	34.65	27.28	37.61	30.42
	Three cloves	25.98	27.46	31.19	30.36	36.78	30.36
Second date 10/11	One clove	22.91	27.17	30.53	30.69	42.48	30.76
	Three cloves	20.73	28.79	30.65	30.54	39.83	30.11
Third date 25/11	One clove	25.37	28.54	38.89	40.61	46.98	36.08
	Three cloves	28.44	33.24	34.70	35.70	38.82	34.18
							Average date
date × Concentration	25/10	23.87	29.13	32.92	28.82	37.20	30.39
	10/11	21.82	27.98	30.59	30.61	41.16	30.43
	25/11	26.91	30.89	36.79	38.15	42.90	35.13
							Average density
density × Concentration	One clove	23.35	28.83	34.69	32.86	42.36	32.42
	Three cloves	25.05	29.83	32.18	32.20	38.48	31.55
Average Concentration		24.20	29.33	33.44	32.53	40.42	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
3.57	NS	2.03	3.60	4.21	2.90	5.42	

Table (4) show that there were significant effects for the treatments and their interactions on the number of total heads, where plants cultivated at the first planting date significantly excelled in this trait on the second and third planting dates. The highest yield was obtained from the plant cultivated with the three cloves per pit compared with that cultivated in one

clove per pit. The plants that were sprayed with licorice root extract at a concentration of (8 g.L⁻¹) were significantly excelled in total yield, followed by that was sprayed with Al-GADEX at a concentration of (4 ml.L⁻¹) and with significant difference, then that sprayed with a licorice root extract at a concentration of (6 g.L⁻¹), which was sprayed at a concentration of (2

ml.L⁻¹). The lowest total heads yield obtained from the control treatment. All the bi-interactions had a significant effect on the study, showed the triple interaction between the treatments in the table also showed that the plants cultivated on the first planting date, with three cloves in pit, which was sprayed with a licorice root extract at a concentration of (8 tons.ha⁻¹) have excelled by giving it the highest total yield amounted to (5.649 tons.ha⁻¹). The lowest yield was observed in the plants cultivated at the third planting date that cultivated with a plant density of (three cloves in the pit) for a control treatment amounted to (1.625 tons.h⁻¹). The superiority of the plants sprayed with the high concentration of licorice root extract may be due to its content of Mevalonic acid, the bioassay initiator for the internal Gibberellin, and its high carbohydrate content 94). This may be an additional factor in cell division and elongation. These results agree with (2) in their study on sweet peppers or may be attributed to the role of the licorice root extract in the division and cellular expansion processes, which may cause an increase in the

weight of the bulb as shown in Table (3). This result also agrees [13] that spraying licorice root extract on tomato plants led to a significant increase in plant yield.

Table (5) shows that the plants cultivated in the first and third planting dates have excelled and with non-significant differences between them in the percentage of nitrogen in the cloves than those cultivated in the second planting date. The table indicates a significant difference in the plant density and all the bi-interactions recorded a significant effect on the studied factors, It is noted from the table that there is a significant effect for the triple interactions between the treatments, where the plants cultivated at the third planting date, with the density of a one clove in pit, which sprayed with licorice root extract at a concentration of (8 g.L⁻¹) have excelled by giving it an average amounted to (3,290%) and the lowest percentage was found in the plants cultivated at the second planting date, with a density of one clove in pit for the control treatment which amounted to (2.277%).

Table 4: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the total heads yield (ton.h⁻¹) for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					date × density
		Control	ALGADEX (g.L ⁻¹)		licorice roots (g.L ⁻¹)		
		0	2	4	6	8	
First date 25/10	One clove	2.029	2.844	3.807	3.182	5.354	3.443
	Three cloves	2.148	3.399	5.199	4.797	5.649	4.239
Second date 10/11	One clove	1.699	2.580	2.776	3.077	4.225	2.871
	Three cloves	1.873	2.619	3.198	4.491	4.842	3.405
Third date 25/11	One clove	1.908	3.413	3.693	2.442	3.746	3.040
	Three cloves	1.625	3.154	3.457	2.090	2.354	2.536
							Average date
date × Concentration	25/10	2.088	3.122	4.503	3.989	5.501	3.841
	10/11	1.786	2.599	2.987	3.784	4.533	3.138
	25/11	1.767	3.283	3.575	2.266	3.050	2.788
							Average density
density × Concentration	One clove	1.879	2.946	3.425	2.900	4.442	3.118
	Three cloves	1.882	3.057	3.952	3.793	4.282	3.393
Average Concentration		1.880	3.001	3.688	3.346	4.362	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
0.148	0.169	0.181	0.224	0.300	0.268	0.442	

Table 5: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the percentage of nitrogen in the cloves for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					date × density
		Control	ALGADEX (g.L ⁻¹)		licorice roots (g.L ⁻¹)		
		0	2	4	6	8	
First date 25/10	One clove	2.617	3.170	3.300	3.750	3.670	3.301
	Three cloves	2.730	3.237	3.623	3.657	3.607	3.371
Second date 10/11	One clove	2.277	3.260	3.283	3.343	3.890	3.211
	Three cloves	2.620	3.193	3.313	3.553	3.840	3.304
Third date 25/11	One clove	2.803	3.210	3.670	3.313	3.920	3.383
	Three cloves	2.563	3.530	3.753	3.893	3.593	3.467
							Average date
date × Concentration	25/10	2.673	3.203	3.462	3.703	3.638	3.336
	10/11	2.448	3.227	3.298	3.448	3.865	3.257
	25/11	2.683	3.370	3.712	3.603	3.757	3.425
							Average density
density × Concentration	One clove	2.566	3.213	3.418	3.469	3.827	3.298
	Three cloves	2.638	3.320	3.563	3.701	3.680	3.380
Average Concentration		2.602	3.267	3.491	3.585	3.753	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
0.041	0.047	0.056	0.062	0.092	0.081	0.135	

Table (6) shows that the plants cultivated in the third planting date were significantly excelled than those cultivated in the second and first planting dates in the percentage of phosphorus in the cloves. As for effect of plant density, the plants cultivated with three cloves in pit have excelled compared to those cultivated with a one clove in pit, As for the spraying with

organic nutrients, where the plants sprayed with licorice root extract at a concentration of (8 g.L⁻¹) were significantly excelled in the percentage of phosphorus in the lobes followed by a significant difference for the same extract at a concentration of (6 g.L⁻¹), followed by that sprayed with the Al-GADEX at a concentrations (4, 2 mL.L⁻¹) which differ

significantly between them, then the control plants that showed the lowest percentage. All the interactions recorded a significant effect between the bi-study factors and the plants cultivated in the third planting date, with a one clove in pit, which was sprayed with the licorice root extract at a concentration of (8 g.L⁻¹) gave the highest percentage of phosphorus in

the cloves amounted to (0.700%) at the triple interaction between the treatment. The lowest percentage was observed in the plants cultivated in the first planting date, with the densities of three cloves and one clove in the pit for the control treatment, which amounted to 0.277% for both.

Table 6: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the percentage of phosphorus in the cloves for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					date × density
		Control	ALGADEX (g.L ⁻¹)		licorice roots (g.L ⁻¹)		
		0	2	4	6	8	
First date 25/10	One clove	0.277	0.367	0.383	0.427	0.427	0.376
	Three cloves	0.277	0.390	0.453	0.553	0.617	0.458
Second date 10/11	One clove	0.363	0.423	0.477	0.510	0.583	0.471
	Three cloves	0.360	0.537	0.580	0.573	0.527	0.515
Third date 25/11	One clove	0.383	0.473	0.557	0.613	0.700	0.545
	Three cloves	0.373	0.523	0.4900	0.547	0.643	0.515
							Average date
date × Concentration	25/10	0.277	0.378	0.418	0.490	0.522	0.417
	10/11	0.362	0.480	0.528	0.542	0.555	0.493
	25/11	0.378	0.498	0.523	0.580	0.672	0.530
							Average density
density × Concentration	One clove	0.341	0.421	0.472	0.517	0.570	0.464
	Three cloves	0.337	0.483	0.508	0.558	0.596	0.496
Average Concentration		0.339	0.452	0.490	0.537	0.583	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
0.026	0.027	0.023	0.036	0.041	0.037	0.061	

Table (7) shows that the plants cultivated in the third and second planting dates have excelled and with the non-significant difference between them on the percentage for potassium in the cloves on those cultivated in the first planting date. While it was observed that plants cultivated with three cloves in the pit have excelled on those cultivated with a density of one clove, plants that were sprayed with organic nutrients on the control plants that showed the lowest percentage. It was also observed the plants that were sprayed with the licorice root extract at a concentration of (8 g.L^{-1}) are excelled on these were sprayed with the same extract at a concentration of (6 g.L^{-1}), which was sprayed with Al-GADEX at a concentration of (4 ml.L^{-1}), which did not differ significantly between them, followed by that was sprayed with Al-GEDEX at a concentration of (2 ml.L^{-1}) and with significant difference. Table (7) shows that the effect was significant for all bi-interaction treatments. As for the effect of triple interaction between the treatment, the plants cultivated in the second planting date, with a density of three cloves in the pit, which was sprayed with a licorice root extract at a concentration of (8 g.L^{-1}) have excelled by giving it a percentage amounted to (3.760%). The lowest percentage was found in the plants cultivated at the first planting date, with a density of one clove in the pit for the control treatment which amounted to (1.557%).

Table (8) shows that the plants cultivated on the first planting date were significantly excelled on those cultivated in the second and third planting dates in the percentage of sulfur in the cloves. It was also noticed that the plants cultivated in the third date gave the lowest percentage. The results showed no significant difference in the plant density in this percentage, As for the concentrations of spraying with organic nutrient, the plants that sprayed with licorice root extract at a concentration of (8 g.L^{-1}) were significantly excelled in the percentage of sulfur in the cloves followed by that were sprayed with the same extract at a concentration of (6 g.L^{-1}) and with significant difference. Then that sprayed with Al-GEDEX at a concentration of (2, 4 ml.L-1), with non-significant differences between them and then the control treatment plants, which showed the lowest percentage. As for the effect of bi-interactions between the treatments, it was significant in the percentage of sulfur. As for the triple interaction between the treatments, the cloves of the first planting date and the density of one clove in pit, which sprayed with the licorice root extract at a concentration of (8 g.L^{-1}) recorded the highest percentage of sulfur amounted to (1.050%) compared to the lowest percentage observed in plants of the third planting date that cultivated

with a density of three cloves in pit for the control treatment, which amounted to (0.308%).

Table 7: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the percentage of potassium in the cloves for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					date × density
		Control	ALGADEX (g.L ⁻¹)		licorice roots (g.L ⁻¹)		
		0	2	4	6	8	
First date 25/10	One clove	1.557	2.303	2.317	2.480	2.730	2.277
	Three cloves	2.090	2.390	2.220	2.430	2.807	2.387
Second date 10/11	One clove	1.847	2.327	3.060	3.107	2.887	2.645
	Three cloves	1.607	2.437	3.377	2.687	3.760	2.773
Third date 25/11	One clove	2.097	2.443	2.977	2.877	3.210	2.721
	Three cloves	2.140	2.360	2.733	3.213	3.487	2.787
							Average date
date × Concentration	25/10	1.823	2.347	2.268	2.455	2.768	2.332
	10/11	1.727	2.382	3.218	2.897	3.323	2.709
	25/11	2.118	2.402	2.855	3.045	3.348	2.754
							Average density
density × Concentration	One clove	1.833	2.358	2.784	2.821	2.942	2.548
	Three cloves	1.946	2.396	2.777	2.777	3.351	2.649
Average Concentration		1.889	2.377	2.781	2.799	3.147	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
0.114	0.083	0.107	0.131	0.185	0.151	0.260	

Table 8: Effect of planting dates, plant density, spraying with organic fertilizer (ALGADEX and licorice roots) and their interactions on the percentage of sulfur in the cloves for local garlic cultivar for the season 2015 – 2016

Planting dates (day)	Plant density (clove/pit)	The concentration of spraying with organic nutrient					date × density
		Control	ALGADEX (g.L ⁻¹)		licorice roots (g.L ⁻¹)		
		0	2	4	6	8	
First date 25/10	One clove	0.486	0.559	0.625	0.894	1.050	0.723
	Three cloves	0.394	0.657	0.552	0.581	0.715	0.580
Second date 10/11	One clove	0.379	0.449	0.443	0.502	0.753	0.505
	Three cloves	0.402	0.567	0.493	0.793	0.796	0.610
Third date 25/11	One clove	0.340	0.578	0.544	0.491	0.504	0.491
	Three cloves	0.308	0.448	0.564	0.557	0.792	0.534
							Average date
date × Concentration	25/10	0.440	0.608	0.589	0.738	0.883	0.651
	10/11	0.390	0.508	0.468	0.647	0.775	0.558
	25/11	0.324	0.510	0.554	0.524	0.649	0.512
							Average density
density × Concentration	One clove	0.401	0.527	0.537	0.629	0.769	0.573
	Three cloves	0.368	0.557	0.536	0.644	0.768	0.575
Average Concentration		0.385	0.542	0.537	0.636	0.768	
Least Significant Difference (LSD) at a significant level of 0.05							
Date	Density	Concentration	date × density	date × Concentration	density × Concentration	date × density × Concentration	
0.016	N.S	0.012	0.017	0.022	0.017	0.030	

The results of the tables (5, 6, 7, 8) concluded that the plants cultivated on the first planting date have excelled in the percentage of nitrogen and sulfur in the cloves, while the plants cultivated in the third planting date were significantly excelled in the percentage of phosphorus and potassium in the cloves. As for the effect of plant density, the plants cultivated

with three densities were significantly excelled in the percentage of phosphorus and potassium in the cloves. The spraying treatment with the licorice root extract at a concentration of (8 g.L⁻¹) also gave the highest percentage of nitrogen, phosphorus, potassium, and sulfur in the cloves, This may be due to the fact that the licorice root extract contains the elements of nitrogen and

phosphorus which caused an increase in the garlic cloves content with these elements.

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