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EFFECT OF INTERCROPPING SYSTEMS ON GROWTH, YIELD COMPONENTS, GUARAN PRODUCTION AND CHEMICAL CONSTITUENTS OF GUAR PLANT

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ABSTRACT: **The present work aimed to study the effect of intercropping systems on growth, seed yield components, guaran production and chemical constituents of guar plant when intercropped with roselle plant.**

The intercropping systems used were (1+1), (1+2), (1+3), (2+1) and (3+1) of roselle and guar, respectively. Furthermore, solid system of guar was used as control. The obtained results refered to that using most of intercropping systems, except that of (1+1), increased plant height, number of branches or leaves, fresh and dry weights of leaves, shoots or root and root length per plant compared to solid planting system of guar. Using of intercropping system of one row of roselle with one row of guar (1+1) gave the highest values of pods number and weight of seeds per plant comparing to solid planting system and the other intercropping systems. In addition, the intercropping system of one row of roselle with three rows of guar (1+3) gave the highest values of seed yield per faddan as well as total carbohydrates phosphorus and potassium percentages and contents in guar seeds compared to the solid planting system . In the same time, total nitrogen and protein contents per plant seeds were increased by using of intercropping system of (1+1) compared to solid planting system or the other systems. Generally, it could be concluded that using of intercropping system of alternating one row of roselle with three rows of guar resulted in the highest values in seed yield per faddan, guaran production as well as some chemical constituents of guar plant cultivated under Sharkia Governorate conditions.

INTRODUCTION

Guar is generally grown for feed, fodder and provides edible pods which are used as vegetable. In addition, guar has an industrial importance due to the presence of gum in its endosperm. Guar gum, in highly mucilaginous, is being used in various industries such as textiles cosmetics explosive and papers, also as a stabilizer or stiffiner in foods and various other products. The fodder of guar as well as its grain are quite nutritive, rich in protein, fat and minerals.

Intercropping may be considered as one of the most effective methods followed in Egypt to maximise the out put of the limited cultivated lands. Results of many researchers found that, maximum net profit could be obtained from the same area if two crops were intercropped together.

Consulting the available review of literature , there was no information regarding the effect of intercropping systems [not mono intercropping system] on medicinal plants including those of between roselle and guar on growth seeds yield components , guaran production and chemical constituents of guar seeds. Therefore, the following available review of literature on other plants or organs might be useful in this respect. However, Bonapart and Brawn (1976) found that mean leaf number of two maize cultivars was significantly higher when intercropped with soybean plant. Shahien (1991) indicated that, intercropping tomato and some leguminous crops increased plant height of tomato. Abd El-Baky (1994) reported that intercropping cowpea or squash on the ridges of okra decreased dry weight of cowpea or squash plants. El-Gamili (1994) found that fresh and dry weights of leaves were decreased in intercropped onion with strawberry and carrot compared to those grown alone. Shahien *et al.* (1996) stated that intercropping cowpea with 2/3 of its area with maize gave the highest total yield for both crops. Itulya *et al.* (1997) mentioned that intercropping of collard with cowpea had more total leaves dry weight and

branches than those monocropped. Ali (1999) reported that intercropping of strawberry with phaseolus decreased plant height, number of branches and number of leaves of phseolus. Ghobashi and El-Aweel (1999) found that faba bean seed yield was significantly reduced by 29.9 and 20% due to association with onion and garlic, respectively. Sidky *et al.* (2003) found that the growth characters (No. of branches and leaves /plant, fresh and dry weights /plant and weight of 100 fruits) of intercropped plants (chinese garlic with each of fennel, coriander or caraway) were significantly decreased by intercropping, while plant height of fennel, coriander or caraway was slightly increased. Intercropping significantly decreased the yield of each crop as compared to the pure stand treatments of each one .

Consulting the available review of literature, there was no information regarding the effect of intercropping systems on guaran production, total carbohydrate, nitrogen, phosphorus and potassium percentages or content of guar seeds. Therefore, the following available review of literature on other organs or plants might be useful in this concern. However, Chang and Ho (1969) found that intercropping of groundnut with sugar cane or sweet potato increased P_{32} and K absorption in both crops of sugar cane or sweet potato. El-Shamma (1980) found that percentage of N, P and K and their total uptake in leaves and stem of pepper plants seemed to be higher in intercropped plants than that of pepper plants grown in pure stand. On the contrary, Moursi (1968) reported that intercroppping garlic in rows on the both sides of the cotton ridges decreased the absolute contents of N, P and K .

The present work was designed to study the effect of intercropping systems between roselle and guar plants on the growth, seed yield components, guaran production and chemical constituents of guar under Sharkia Governorate conditions.

MATERIAL AND METHODS

The present work was conducted at an special Farm in

Inshas El-Raml District, Sharkia, Governorate during the two successive growing seasons, of 1997 and 1998 to study the effect of intercropping systems between roselle and guar on growth characters , seeds yield components and chemical constituents of guar plant under Sharkia Governorate conditions.

The seeds of both roselle [*Hibiscus sabdariffa* L., Fam, *Malvaceae*] and guar [*Cyamopsis tetragonoloba* Taub., Fam, *Leguminosae*] plants were kindly obtained from Research Center of Medicinal and Aromatic Plants , Dokky, Giza.

The seeds of both roselle and guar crops were sown on the first of May in the two tested seasons of 1997 and 1998. The seeds were handly sown, immediately irrigated. After three weeks from planting germinated plants were thinned to be one plant / hill for roselle and two plants / hill for guar. The physical and chemical properties of the used soil are shown in Table 1.

The plot area was (2 x 7.80 m) and included twelve rows, each row was 60 cm apart and 2 m in length. The seeds were sown on row in hills on one side. The distances between successive hills were 50 cm for roselle and 30 cm for guar plant.

The intercropping system treatments were as follows:

1. One row of roselle + one row of guar (1:1) intercropping system: planting one row of roselle alternated with one row of guar. This provides the proportional area of 50: 50 to each crop.
2. One row of roselle + two rows of guar (1:2) intercropping system: planting one row of roselle alternation with two

Table 1. The physical and chemical properties of the used soil.

Physical properties (%)		Chemical properties	
Sand	17.4	Total nitrogen	0.52%
Silt	36.10	Water soluble phosphorus	0.05%
Clay	46.50	Available potassium	0.59 Meg/l.
Organic matter	1.75	pH	7.90

rows of guar. This was equal to 33.3: 66.7 proportion area of roselle and guar, respectively.

3. One row of roselle +three rows of guar (1:3) intercroppping system: planting one row of roselle alternated with three guar rows to provide 25:75 proportional area for roselle and guar, respectively.
4. Two rows of roselle + one row of guar (2:1) intercropping system : planting two roselle rows alternated with one guar row. This provides 66.7: 33.3 proportional area of roselle and guar, respect-ively.
5. Three rows of roselle + one row of guar (3:1) intercroppping system: planting three rows of roselle (75%) in alternation with one guar row (25%).
6. Solid planting system of roselle, since it was practices on one side of the row, one plant / hill, in 50 cm distance apart hills. Such treatment was used as control for roselle characters.
7. Solid planting system of guar, since it was applied on one side of the row, two plants/ hill, in 30 cm distance apart hills. Such treatment was used as control for guar characters.

The experimental design was simple in complete randomized block design with three replicates. Each replicate contained twelve rows.

All the plants received normal agricultural practices whenever they needed. All plants received eight irrigations. All plants received NPK fertilization at the rates of 200kg of ammonium sulphate (20.5%N), 150 kg of calcium super phosphate (15.5% P_2O_5) and 100 kg of potassium sulphate (50% k_2O) per faddan, respectively.

The following data were recorded

The outer two rows (1^{st} and 12^{th}) of each plot were considered as belt. For measuring growth analysis, samples were taken from guarded plants in center of each plot. The central rows were kept for yield and yield attributes determinations.

Recorded characters were plant height (cm) , number of branches per plant, number of leaves per plant, fresh and dry weights of leaves , shoots or root per plant (gm) and root length (cm) . Pods of guar were harvested during the period of 15-20 October in the two seasons to determine number of pods and weight of seeds per plant (gm) as well as seed yield per faddan (kg). Yield of seeds/ faddan (fad) = seed yield / row x 2 No. of rows of guar/plot x 4200 / plot area (m^2).

Guaran percentage was determined in guar seeds according to the method described by Anderson (1949) . Guaran content per plant (gm) was calculated by multiplying total guaran percentage by weight of seeds per plant .Total carbohydrates percentage was determined in guar seeds according to Dubios *et al.* (1956). Total carbohydrates content per plant seeds was calculated by multiplying total carbohydrates percentage by weight of guar seeds per plant.

Total nitrogen percentage was determined in guar seeds according to that reported by Naguib (1969). Total nitrogen content per plant seeds was calculated by multiplying total nitrogen percentage by weight of seeds per plant. Total protein percentage was calculated by multiplying total nitrogen percentage by the factor 6.25. Total protein content per plant seeds was calculated by multiplying total protein percentage by weight of seeds per plant. Total phosphorus percentage was determined according to the method adapted by Hucker and Catroux (1980). Total phosphorrus content per plant seeds was calculated by multiplying total phosphorus percentage by weight of seeds per plant. Potassium percentage was determined by suing flame photometer, according to the method described by Brown and Lilleland (1964). Potassium content per plant seeds was calculated by multiplying potassium percentage by weight of seeds per plant.

Data of the present work were statistically analyzed according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

1.Effect of Intercropping Systems on Vegetative Growth and Root System Characters of Guar Plant

Results presented in Table 2 show that using most of intercropping systems, except that of (1+1), recorded an increase in vegetative growth and root system characters; expressed as plant height, number of branches or leaves, fresh and dry weights of leaves , shoots or root and root length per plant comparing to solid planting system. Moreover, intercropping system of alternating three rows of roselle with one row of guar (3+1) resulted in higher values in plant height, number of branches , root length or fresh and dry weights of shoots and root per plant comparing to that of solid planting and those of the other intercropping systems in the two seasons. In addition, increasing rows number of guar under cropping system with one row of roselle increased plant height , number of branches or leaves , fresh and dry weights of leaves shoots and root per plant as well as root length. In the same time, as rows number of roselle increased under intercropping pattern with one row of guar, most of growth characters were increased. However, such increase by using intercropping treatment was also found by Shahien (1991) on tomato intercrcropped with some legumeinous crops and Sidky *et al.* (2003) on chinese garlic intercopped with each of fennel, coriander or caraway regarding plant height ; Bonaparte and Brawn (1976) on maize intercropped with soybean concerning number of leaves per plant; Itulya *et al.* (1997) on collard intercropped with cowpea as for number of branches and dry weight of leaves per plant; and El-Dokaishy (1999) who reported that cauliflower intercropped with white clover or earth clover gave the highest whole plant fresh weight as well as leaves and stem weight per plant compared to other treatments.

On the other hand, intercropping system of alternating one row of reselle with one row of guar (1+1 system) treatment decreased guar plant height, number of branches or leaves,

fresh and dry weights of leaves or shoots per plant if compared with that of solid system of guar. However, such decrease by using intercropping treatment, was also found by Ali (1999) on strawberry intercropped with phaselous concerning plant height, number of branches or leaves per phaseolus plant; Abd El-Baky (1994) on cow pea or squash intercropped with okra regarding dry weight of each crop; El-Gamili (1994) on onion intercropped with strawberry and carrot concerning fresh and dry weights of leaves and Sidky *et al.* (2003) who found that intercropping of chinese garlic with each of fennel, coriander or caraway decreased plant fresh and dry weights.

2.Effect of Intercropping Systems on Yield Components of Guar Plant

Table 3 shows that number of pods and weight of seeds per plant were mostly increased by using of intercropping systems , except that of (2+1), compared to solid planting. Moreover, using of intercropping system of one row of roselle with one row of guar (1+1) gave higher values of number of pods and weight of seeds per plant comparing to solid planting system and those of the other systems. In the same time, intercropping of one row of roselle with three rows of guar (1+3) gave the highest value of seed yield per fad. in guar plants comparing to those of the other systems in the second season. Furthermore, yield of seeds / fad. was increased with increasing rows number of guar under intercropping system with one row of roselle. In addition, number of pods / plant was increased by increasing rows number of roselle under intercroppping system with one row of guar; also, there was an increase in weight of seeds per plant in this respect. In this regard El-Gamili (1994) reported that intercropping onion with strawberry and carrot gave maximum value of total yield of strawberry comparing with sole crop. Also, Shahien *et al.* (1996) found that intercropping cowpea with 2/3 of its area with aize gave the highest total yield for both crops.

On the contrary, intercropping system of alternating two rows of roselle with one row of guar decreased number of pods and weight of seeds per plant as well as seeds yield per fad. compared to that of the solid one or those of the other systems in most cases. In this regard, Verma and Dutta (1984) reported that growing maize and soybean in alternate rows gave the highest value of seed yield in soybean in pure stands and decreased with intercropping. In the mean time. Ghobashi and El-Aweel (1999) found that faba bean seed yield was reduced by an average of 29.9 and 20% due to association with onion and garlic, respectively.

3.Effect of Intercropping Systems on Guaran Production of Guar Seeds

Data presented in Table 4 reveal that intercropping systems used decreased guaran percentage comparing to that of solid planting , whereas those of (1+1) , (1+2) and (1+3) systems showed an increase in this respect. Moreover, guaran content per plant was increased by using of intercropping system of one row of roselle with one row of guar (1+1) comparing to solid planting or those of the other systems. In addition, increasing row number of guar under planting pattern with one row of roselle increased guaran percentage, whereas, guaran content per plant was decreased in this respect. Furthermore, increasing rows number of roselle under cropping system with one row of guar increased guaran percentage and content. However, consulting the available review of literature, there was no information regarding the effect of intercropping systems on guaran production in guar seeds.

4.Effect of Intercropping Systems on Chemical Constituents of Guar Seeds

4.1Total carbohydrates percentage and content per plant

Data in Table 4 indicate that using of intercropping systems [except that of (1+3)] decreased total carbohydrate percentage in guar seeds comparing to solid planting system. Whereas, using of intercropping systems, except those of (2+1) and (3+1)

systems, increased the content of total carbohydrate in guar seeds comparing to solid planting of guarn. Moreover, using of intercropping system of one row of roselle with three rows of guar (1+3) recorded higher value in total carbohydrate percentage and content in guar seeds compared to the other intercropping systems including that of solid planting. However, consulting the available review of literature, there was no information concerning the effect of intercropping systems on total carbohydrates percentage or content in guar seeds .

4.2Total nitrogen as well as protein percentages and contents

The results presented in Table 4 show that intercropping system of one row of roselle with three rows of gauar (1+3) recorded higher values of total nitrogen as well as protein percentages and contents in guar seeds compared to that of the solid planting system in the two seasons. On the contrary, alternating two rows of roselle with one row of guar (2+1 system) showed as decrease in this respect. However, Moursi (1968) reported that intercropping of garlic in rows on the both sides of the cotton ridges decreased the absolute content of nitrogen. Whereas, El-Shamma (1980) found that percentage of nitrogen and its total uptake in leaves and stem of pepper plants seemed to be higher in intercropped plants than that of pepper plants grown in pure stand.

4.3Phosphorus and potassium percentages and contents

Table 4 shows that alternating one row of roselle with three rows of guar (1+3 system) increased phosphorus and potassium percentages and contents in guar seeds compared to solid planting of guar in the two seasons, in most cases. On the other hand, intercropping system of two rows of roselle and one row of guar (2+1) recorded a decrease in this regard. In this concern. Change and Ho (1969) found that intercropping of groundnut with sugar cane or sweet potato increased P_{32} and K absorption in both crops of sugar cane or sweet potato. Whereas Moursi

(1968) reported that intercropping garlic in rows on the both sides of the cotton ridges decreased the absolute contents of P and K .

Generally, it could be concluded that using intercropping system of alternating one row of roselle with three rows of guar resulted in the highest values in seed yield per faddan and guaran production as well as some chemical constituents of guar plant cultivated under Sharkia Governorate conditions.

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Table 2 . Effect of intercropping systems on growth characters of guar during the two successive seasons of 1997 and 1998

Intercropping systems treatments*	Plant height (cm)	Number of branches /plant	Number of leaves /plant	Fresh weight of leaves /Plant (gm)	Dry weight of leaves / plant (gm)	Fresh weight of shoots / plant (gm)	Dry weight of shoots / plant (gm)	Fresh weight of root/plant (gm)	Dry weight of root /plant (gm)	Root length (cm)
					First season					
1+1	108.66	6.77	48.88	31.20	7.28	81.25	21.22	12.83	4.96	24.11
1+2	119.55	6.88	51.11	32.74	8.09	91.65	22.00	12.43	4.64	24.55
1+3	112.55	6.00	54.77	35.38	9.01	100.07	27.97	13.76	5.11	26.11
2+1	116.88	8.11	57.77	35.65	9.06	109.87	34.91	14.68	6.44	28.44
3+1	132.00	10.11	58.88	35.76	9.40	149.94	37.67	16.91	6.78	29.88
Solid	109.11	5.88	50.00	32.34	7.65	80.55	22.25	12.86	4.75	23.11
L.S.D.at 5%	6.55	1.15	8.82	3.57	1.08	11.20	3.76	1.84	0.78	1.24
L.S.D. at1%	8.79	1.55	11.84	4.80	1.45	15.03	5.05	2.47	1.05	1.67
					Second season					
1+1	111.66	5.22	61.66	39.18	11.11	99.49	27.14	15.43	5.54	20.83
1+2	117.50	6.00	76.00	57.45	13.90	118.79	29.91	15.19	5.75	23.66
1+3	117.50	6.72	73.30	74.09	16.80	120.55	30.73	17.36	5.97	27.00
2+1	122.33	6.77	64.05	74.48	16.50	135.22	33.49	20.67	6.88	28.83
3+1	129.16	8.11	65.44	61.76	14.16	152.27	36.62	21.84	7.73	30.50
Solid	115.85	6.22	62.44	39.84	11.15	100.24	27.31	15.00	5.05	23.66
L.S.D.at 5%	2.61	0.92	4.60	14.87	2.40	8.23	3.00	3.76	0.85	1.79
L.S.D. at1%	3.51	1.23	6.18	19.95	3.22	11.04	4.02	5.04	1.14	2.41

*The intercropping systems used were (1+1), (1+2) , (1+3), (2+1) and (3+1) of roselle and guar respectively.

Table 3. Effect of intercropping systems treatments on number of pods, weight of seeds per plant and seeds yield / feddan of guar during the two successive seasons of 1997 and 1998

Intercropping system treatments	Number of pods / plant		Weight of seeds / plant (gm)		Seeds yield / feddan (kg)	
	1st	2nd	1st	2nd	1st	2nd
1 row of roselle + 1 row of guar	95.88	76.30	27.29	19.75	587.76	425.4
1 row of roselle + 2 rows of guar	77.44	58.66	23.08	15.45	662.84	443.6
1 row of roselle + 3 rows of guar	77.77	59.44	21.56	14.12	696.78	456.3
2 rows of roselle + 1 row of guar	58.22	44.77	15.44	9.86	221.70	141.5
3 rows of roselle + 1 row of guar	74.33	53.33	19.40	9.46	208.52	101.8
Solid planting system of guar	69.55	52.22	18.96	9.94	816.92	428.2
L.S.D. at 5%	8.40	6.57	3.47	2.31	107.06	62.97
L.S.D. at 1%	11.28	8.82	4.66	3.09	120.56	84.49

Table 4. Effect of intercropping systems on chemical constituents of guar seeds during the two successive seasons of 1997 and 1998.

Intercropping systems treatments*	Total guaran (%)	Total guaran content / plant (g)	Total carbo ydrate (%)	Total carbohy drate content / plant (g)	Total nitrogen (%)	Total nitrogen content / plant (g)	Total protein (%)	Total protein content / plant (g)	Total phosph orus (%)	Total phosph ours content / plant (g)	Pota- ssium (%)	Pota ssium content / pant (g)
						First season						
1+1	28.53	7.78	8.45	2.30	4.79	1.300	29.93	8.16	0.4182	0.114	2.34	0.638
1+2	29.84	6.88	8.59	1.98	4.84	1.110	30.25	6.98	0.4396	0.101	2.41	0.556
1+3	33.35	7.19	12.62	2.72	4.94	1.060	30.87	6.65	0.5112	0.110	3.00	0.646
2+1	31.84	4.91	9.56	1.47	4.53	0.699	28.31	4.37	0.4747	0.073	2.67	0.412
3+1	32.75	6.35	9.88	1.91	4.77	0.925	29.81	5.78	0.4421	0.085	2.71	0.525
Solid	34.44	6.52	11.06	2.09	4.83	0.915	30.18	5.72	0.7832	0.091	3.26	0.618
L.S.D.at 5%	2.25	1.85	N.S.	N.S.	N.S.	N.S.	N.S.	1.409	N.S.	0.026	N.S.	N.S.
L.S.D. at1%	3.02	2.64	N.S.	N.S.	N.S.	N.S.	N.S.	2.002	N.S.	0.038	N.S.	N.S.
						Second season						
1+1	27.93	5.51	9.84	1.94	4.46	0.880	27.87	5.50	0.3395	0.067	2.27	0.448
1+2	29.48	4.55	9.91	1.53	4.47	0.690	27.93	4.31	0.3560	0.055	2.44	0.376
1+3	31.52	4.45	13.79	1.94	4.49	0.775	34.31	4.84	0.5212	0.073	3.16	0.446
2+1	29.86	2.94	10.42	1.02	4.56	0.449	28.50	2.81	0.4535	0.044	2.66	0.262
3+1	30.05	2.84	10.93	1.03	4.89	0.462	30.56	2.89	0.3884	0.036	2.74	0.259
Solid	31.92	3.17	12.67	1.05	4.81	0.478	30.06	2.98	0.4742	0.047	3.11	0.309
L.S.D.at 5%	0.68	0.70	2.21	N.S.	0.39	0.126	3.908	0.790	0.035	0.009	0.56	N.S.
L.S.D. at1%	0.91	0.99	2.96	N.S.	0.53	0.180	5.558	1.121	0.047	0.013	0.76	N.S.

*The intercropping systems used were (1+1), (1+2) , (1+3), (2+1) and (3+1) of roselle and guar , respectively.

تأثير نظم التحميل على النمو ومكونات المحصول وانتاج الجواران والمكونات الكيميائية لنبات الجوار

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يهدف هذا العمل إلى دراسة تأثير نظم التحميل على النمو ومكونات محصول البذور وإنتاج الجواران والمكونات الكيميائية فى نبات الجوار عند تحميلة مع نبات الكركدية ، وكانت نظم التحميل المستخدمة هى (١+١) ، (١+٢) ، (١+٣) ، (٢+١) ، (٣+١) من الكركدية والجوار على الترتيب . واستخدم نظام الزراعة الفردى للجوار ككنترول .

واشارت النتائج المتحصل عليها إلى أن استخدام معظم أنظمة التحميل [(ماعدا نظام (١+١)] قد أدى إلى زيادة طول النبات، وعدد الأفرع، وعدد الأوراق، والوزن الطازج والجاف للأوراق والافراع أو الجذر، وطول الجذر لكل نبات بالمقارنة بنظام الزراعة الفردي للجوار ، وعلاوة على ذلك، فقد أدى استخدام نظام خط واحد من الكركدية وخط واحد من الجوار (١+١) إلى الحصول على أعلى قيم فى عدد القرون، ووزن البذور لكل نبات بالمقارنة بنظام الزراعة الفردى وبباقى النظم الأخرى، وبالإضافة إلى ذلك ، فلقد أدى استخدام نظام خط واحد من الكركدية مع ثلاث خطوط من الجوار (١+٣) إلى إعطاء أعلى قيم فى محصول البذور لكل فدان وكذلك المحتوى والنسب المئوية لكل من الكربوهيدرات الكلية والفوسفور والبوتاسيوم فى بذور الجوار بالمقارنة بنظام الزراعة الفردى، وفى نفس الوقت ، أدى استخدام نظام (١+١) إلى زيادة المحتوى لكل نبات من كل من النيتروجين والبروتين فى بذور الجوار بالمقارنة بنظام الزراعة الفردى أو النظم الأخرى ، عموماً ، يمكن أن نستنتج أن استخدام نظام تحميل تبادل خط واحد من الكركدية مع ثلاث خطوط من الجوار قد أدى إلى الحصول على أعلي قيم فى محصول البذور لكل فدان ، وانتاج الجواران، وكذلك بعض المكونات الكيميائية لنبات الجوار المنزرعة تحت ظروف محافظة الشرقية.