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GROWTH AND PRODUCTIVITY OF SUGAR BEET, ONION AND GARLIC GROWN ALONE AND ASSOCIATIONS UNDER DIFFERENT INTER AND INTRASPACING

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ABSTRACT

The effect of intercropping sugarbeet with onion and garlic under different inter and intraspacing, were studied in the Horticultural Farm in Toshky region (Upper Egypt) during 2002/ 2003 and 2003/ 2004 seasons. Eight intercropping treatments, which were the combinations of two ridging distances systems, as 60 and 70 cm apart and two plant spacing as 25 and 35 cm between sugarbeet plants intercropped with onion and garlic either were examined and checked against sugar beet, onion and garlic grown in pure stand at the same levels of inter and intraspacing. Data indicated that sugarbeet in nor any of the intercropping treatments outyielded the pure stand sugarbeet at the same respective treatments, of inter and/ or intraspacing. Highest yield of intercropped beet was obtained when sugarbeet was arranged in ridges 60cm apart and 25 cm between beet plants and intercropped with onion, whereas, lowest yield was obtained when beet was grown in the ridging system 70 cm apart and spaced at the widest intraspacing 35 cm apart and intercropped with garlic. Total soluble sugars (T.S.S) and sucrose percent were in parallel with tuber weight. Decreases in T.S.S., sucrose and purity percents were observed with tuber weight which gradually increased with increasing inter and intraspacing of sugarbeet plant.

Yields of onion and garlic per feddan were governed by plant density of both crops per unit area of land. Gradual decreases in yields of onion or garlic per feddan were evident with increasing inter and intraspacing either or both, i.e., intercropped onion orientated on ridges 60 cm apart and spaced at 25 cm apart outyielded all other intercropped treatments. On other hand, the yields of any component in the intercrop association could not exceed the corresponding pure stand at the same level of plant orientation. The data also indicated that there was apparent loss in the marketable yield of onion and garlic with the narrowest ridging and plant spacing (60 X 25 cm).

The data on land equivalent ratio (LER) indicated that all plant geometric orientations achieved yield advantage, except in case of intercropping of beet with garlic at 70 x 35cm orientation. Highest LER was achieved when both components in the intercrop were grown at the heaviest densities (60 X 25 cm). The data also revealed that LERs obtained from sugar beet-onion associations were higher at any plant population density than those obtained from sugar beet-garlic associations. The relative crowding coefficient (RCC) behaved the same trends. There were no any heavy competitive pressure exerted when either onion or garlic intercropped with sugarbeet at any plant geometric orientation.

INTRODUCTION

Toshky region is characterized with marginal and fluctuated thermal indices in addition to the clear sky all the year round. It is considered a bonus for researches, regarding the efficiency in interception and utilization of solar radiation as well as in land usage. Sugarbeet (C3 crop) has a slow rate growth, especially at early growth stages. It needs long duration till the crop canopy can develop and be able to receive not less than 75% of the incident sun irradiance which encourage researchers to relay some other crops to sugarbeet and diminish losses in solar energy. One of the most important yield advantage of intercropping is based on differences in leaf morphological characters (leaf inclination, size and shape) supporting onion and garlic as very pertinent and favorable companion crops.

In the old land (Nile Delta and Upper Egypt), sugarbeet was frequently intercropped with several legumes, onion and garlic and some other crops. El-Borai and Radi (1993), Amer *et al.* (1997), Hussein and El- Deeb (1999) and Wafaa Mohammed and El- Metwally (2004) intercropped sugarbeet with faba been, chick pea and lentil. They all revealed that legumes are considered compatible companion crops for intercropping with beet. El- Borai and Radi (1993), reported that decreasing faba been ratio in association with sugarbeet from 100% to 50% or 33.3% had favorable effect on sugarbeet yield and tuber qualities. Sucrose, total soluble sugar and purity percent were not affected or improved. Amer *et al.* (1997) found, on other hand, that intercropping significantly reduced sugarbeet yield/ fed, as well as, sugar yield/ fed. Furthermore, Hussein and El-Deeb (1999) reported that plant densities of legumes could affect yielding and tuber qualities of sugar beet. Maria- Beshay *et al.* (2000), Toaima *et al.* (2001) and Saleh (2003) intercropped sugarbeet with other winter crops. They revealed that intercropping sugarbeet with onion or garlic increased roots and sugar yield compared to sole cropping of beet, but most other intercropped crops negatively affected sugarbeet yield and tuber qualities. They also added that the deleterious effects on beet yield and tuber qualities were dependent not only on intercropped crops but also upon their densities in the associations. Maria- Beshay (2000), further added that onion and garlic were more compatible companion crops to sugarbeet rather than wheat and beans. Toaima *et al.* (2001) further added that 60 cm ridging gave higher yield, yield components and improved tuber qualities when sugarbeet was intercropped with onion or garlic. They also reported that higher yields of onion and garlic were obtained when they were raised on ridges 120cm wide.

In recent investigations, Saleh (2003) intercropped onion with sugarbeet on 60 and 120 cm ridge widths. He found that yield, yield components and tuber qualities; (sucrose, total soluble sugars and purity percents) on 60 cm ridges were superior to those obtained from beet grown in pure stand on same ridging system. On other hand, growing onion or garlic on ridges 120 cm apart had yield and yield components of both crops higher than those obtained on ridges 60cm width El-Naggar *et al.*, 1996.

Competitive relationships were also reported by several investigators Kamel *et al.*(1992), El-Habbak and Abo Kresha (1993) and Maria-Beshay (2000) reported that onion was more compatible companion crop as compared with other winter crops. El- Borai and Radi (1993) and Amer *et al.* (1997), revealed that decreasing faba bean ratio in beet-bean cropping systems reduced the intercropping efficiency, but, they further added that the advantage reached maximal with full plant density of the overstory crop. Toaima *et al.* (2001), also reported that growing both components in the intercrop on 120cm ridges gave higher values of land equivalent ratios (LERs) than on 60 cm ridges. Same trends were observed for relative crowding coefficient values. Sugarbeet was the dominant component, whereas, the intercropped crops were dominated. Saleh (2003) also obtained higher LERs when raising both components on 120 cm ridges. Onion was the dominant component, whereas, sugarbeet was dominated.

MATERIALS AND METHODS

Two field trials were carried out in the Horticultural Research Farm in Toshky region (Upper Egypt), Aswan governorate in the winter seasons of 2002/ 2003 and 2003/ 2004 to study the effect of intercropping onion and garlic with sugarbeet under different inter and intraspacing on growth associated, yield and yield components and qualities of sugarbeet (the main crop) and the associated crops. The geometric distributions of the main or intercropped crops were the combination of two ridging systems 60 and 70 cm apart and two plant spacing, 25 and 35 cm apart. The treatments were as follow:

A- Cropping systems

- Sugarbeet intercropped with onion.
- Sugarbeet intercropped with garlic.
- Pure stand Sugar beet.
- Pure stand onion.
- Pure stand garlic.

Pure stand plots of each component in the association were as check for the intercropping treatments at same respective geometric distribution.

B- Geometric distribution of sugar beet, onion and garlic

- 60 cm ridge, 25 cm beet onion and garlic spacing (28000 plants/ fed)
- 60 cm ridge, 35 cm beet onion and garlic spacing (20000 plants/ fed)
- 70 cm ridge, 25 cm beet onion and garlic spacing (24000 plants/ fed)
- 70 cm ridge, 35 cm beet onion and garlic spacing (17140 plants/ fed)

A total of 20 treatments were thus compared, and established in randomized complete block design with four replicates during the two seasons.

Implementation and layout

Land has been ploughed twice and ridged at 8.75 meter in length for each ridge . At bottom of each ridge chicken manure at a rate of 25 kg/ ridge, 0.75 kg of calcium superphate fertilizer (15.5% P_2O_5) and 0.5 kg of potassium sulphate (48% K_2O) were mixed and soil was healed on the mixture which was burried at 20 cm in depth. Thereafter the drip irrigation net was established where drips were at 25 or 35 cm apart and hoses at 60 and 70 cm apart. Each six (70 cm apart) or seven (60 cm apart) ridges were considered as an experimental plot (36.75 m^2 in area), leaving alleys in between each two plots. Treatments were laid out randomly in the three replication.

Nitrogen fertilizers was added in the form of urea (46.5% N) at a rate of 100 kg fertigated in six split up doses throughout the vegetative growth of sugar beet. Sugarbeet cv. Martine (*Beta Vulgaris L.*) was seeded on the first and fifth of November in 2003 and 2004 winter seasons and was harvested on 10^{th} and 15^{th} May in 2002/ 2003 and 3003/ 2004, respectively. Onion cv. Giza 6 Mohassen was transplanted after one month from seeding sugar beet, whereas garlic cv. Balady was seeded ten days before seeding sugarbeet in both consecutive winter seasons. Harvesting onion was on mid of March and 20^{th} March whereas garlic was on first of March and mid of March in both seasons, respectively.

The soil of the experimental site was virgin, untouched with no preceding crop. The physical and chemical analysis of the experimental site is presented in Table 1.

Table (1): The mechanical and chemical characteristics of soil.

Mechanical analysis			Chemical analysis		
	30cm	60cm		30cm	60cm
Coarse Sand %	18.07	17.21	SP	25	27
Fine Sand %	36.52	44.31	Organic matter	0.57	0.56
Silt %	35.16	30.37	E. C m mohs /cm	5.35	8.80
Clay %	10.25	8.11	Cations meg/ L		
Textural Class	Sandy loam	Sandy loam	Ca++	21.06	40.00
$CaC0_3$ %	1.2	1.13	Mg++	7.27	6.65
			Na++	28.74	40.00
			K+	2.10	3.84
			Anions meg /L		
			C03--	4.16	5.72
			S04--	45.11	81.47
			Cl-	9.90	13.30

The name of the textural class was ascertained from the textural triangle given by Alexander (1977).

The other normal cultural treatments were practiced for the three crops grown in the associations as recommended in the intercrop and in the pure stand systems.

Measurements

Ten plants were taken at random from the inner ridges of each plot to estimate yield components of each crop in the associations. Yield/ fed. was estimated on the whole plot basis.

I. Records for growth, yield components and yields were as follow:

Onion and garlic: plant height (cm), bulb diameter (cm), bulb weight (g), bulb yield/ fed (ton) and marketable yield/ fed (ton).

Sugar beet: foliage fresh weight (g), tuber length (cm), tuber diameter (cm), tuber fresh weight (kg), number of dual tubers and total yield/ fed (ton).

Quality attributes of sugarbeet tubers: samples of 30 g fresh weight from Sugarbeet tubers were taken from each treatment to determine:

Total soluble sugars percent (T.S.S), using refractometer according to A.O.A.C (1984). Sucrose percent, using saccharameter, according to Le-Doct (1927). Purity percent using the following formula (sucrose/ T.S.S) X 100.

II- Competitive relationships

1- Land equivalent ratio (LER)

LER is determined as the sum of the fractions of the yield of the intercrops relative to their sole crop yields (Willey, 1979 a). Land equivalent ratio LER was determined according to the following formula:

$$LER = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

where:

Y_{aa} = Pure stand yield of species a.
Y_{bb} = Pure stand yield of species b.
Y_{ab} = Mixture yield of a (when combined with b).
Y_{ba} = Mixture yield of b (when combined with a).

Pure stand yield of species a or b were chose as the heaviest plant density of the crops (Willey, 1979 a)

2- Relative crowding coefficient (RCC)

Relative crowding coefficient RCC was determined according to the following formula: for species (a) in a mixture with species (b)(De-Wit, 1960)

$$Kab = \frac{Yab \times Zba}{(Yaa - Yab) \times Zab}$$

Where:

Z_{ab} = Sown proportion of species a (in a mixture with b).
Z_{ba} = Sown proportion of species b (in a mixture with a).

$$Kba = \frac{Yba \times Zab}{(Ybb - Yba) \times Zba}$$

If a species has a coefficient less than, equal to, or greater than I, it means it has produced less yield, the same yield, or more yield than the "expected", respectively.

The component crop with the higher coefficient is the dominant one. To determine if there is a yield advantage of mixing, the product of the coefficient is formed by multiplying Kab x Kba.

If $k > 1$, there is a yield advantage, if $K = 1$ there is no difference and if $K < 1$ there is a yield disadvantage.

3- Aggressivity (A)

This parameter was proposed by McGilichrist (1960). It gives a simple measure of how much the relative yield increase in species (a) is greater than that of species (b). Aggressivity "A" is determined according to the following formula:

$$A_{ab} = \frac{Yab}{Yaa \times Zab} - \frac{Yba}{Ybb \times Zba}$$

An Aggressivity value of zero indicates that the component species are equally competitive. For any other situation, both species will have the same numerical value but the sign of the dominant species will be positive and the dominated negative. The greater the numerical value the bigger the difference in competitive abilities and the bigger the difference between actual and "expected" yield.

Statistical Analysis

All data of the treatment imposed were subjected to statistical analysis according to the procedures outlined by Snedecor and Cochran (1980), using MSTAT-Computer V4 (1986) L.S.D. test at 0.05 level was used to compare between treatments means.

RESULTS AND DISCUSSION

1- Effect of intraspacing on sugarbeet growth, yield components, yield and chemical attributes under different cropping systems

Data in (Table 2) indicate clearly that growth, yield components and yield/ fed of sugarbeet were significantly influenced by intercropping with onion or garlic. It is evident that the values of all these traits of pure stand sugarbeet were significantly higher than those recorded in case of beet intercropped with onion or garlic, except, in case of average number of dual tubers, the trend was reversed, where the number of dual tubers minimized when sugarbeet was grown in pure stand. Reductions in sugarbeet growth, yield components and yield/ fed of

Table 2. Effect of intercropping systems on sugarbeet growth , yield components, yield and chemical attributes under different cropping systems in 2002/2003 and 2003/ 2004 seasons

Treatment	Foliage fresh wt.	Tuber wt.	Tuber length	Tuber diameter	Dual tubers	Yield/ fed	Sucrose	T.S.S	Purity
	......g......	.....kg......	..........cm....	....	.....no.....	.....ton.....	....	%............	....
					2002/ 2003				
Sole sugarbeet	225.00	1.395	28.94	17.94	1.75	28.25	9.73	14.79	65.70
Intercropping systems									
With onion	188.33	1.105	27.16	14.07	8.15	24.89	11.98	16.98	70.51
With garlic	173.33	0.898	26 37	13.44	10.48	19.56	12.91	17.84	71.89
LSD 0.05	**9.75**	**0.08**	**0.25**	**0.29**	**0.35**	**1.21**	**1.74**	**0.85**	**NS**
					2003/ 2004				
Sole sugarbeet	214.08	1.325	26.83	16.54	1.36	25.64	11.03	16.21	67.99
Intereropping systems									
With onion	180 92	1.045	25.08	12.59	8.00	21.45	12.94	17.99	71.84
With garlic	167 91	0.753	24.50	12.04	10.44	17.14	13.79	18.77	73 39
LSD 0.05	**10.11**	**0.09**	**0.31**	**0.22**	**0.36**	**1.11**	**0.10**	**0.90**	**NS**

intercropped sugarbeet were supported previously by Toaima (2001), Saleh (2003) and Wafaa Mohammed and El-Metwally (2004). The increases in growth, yield components and yield/ fed of pure stand sugar beet, as compared with intercropped beet might be due to the low below and above competition for light intercepted by foliage, nutrient and water uptake. On other hand, onion appeared to be more favourable compatible companion crop rather than garlic. Foliage fresh weight, average length and diameter of sugarbeet tuber, the average weight of tuber/ plant and the yield of tubers/ fed of sugarbeet intercropped with garlic were significantly less than those when beet was intercropped with onion. The data indicated that while yields of sugarbeet were reduced by 30.76and 37.05% in 2002/ 2003 and 2003/ 2004 seasons respectively due to intercropping with garlic, reduction diminished to only 11.86 and 16.34% when beet was intercropped with onion in both successive seasons. The data also revealed that the average number of dual tubers of the intercropped plots significantly exceeded the plots grown in pure stand sugar beet. On other hand, intercropped plots with garlic had higher number of dual tubers than those intercropped with onion. These results are valid in both seasons. The increases in dual tuber associated with intercropped sugarbeet plants might due to the heavy competitive pressure exerted within intercropping systems. It is also worthy to note that the extra growth vigor as well as the super yield potential of beet grown in the first and even in the second season could be attributed much to virgin soil of Toshky region.

Chemical characteristics of sugarbeet tuber were significantly influenced by the cropping systems and the crop species of the associated crop. It is evident that the percents of total soluble sugar, sucrose and purity in sugarbeet tuber tissues when beet plants were intercropped with onion or garlic were higher than those obtained from beet tuber of plants grown in pure stand. Moreover, total soluble sugar, sucrose and purity percents of sugarbeet plants intercropped with garlic were slightly higher than those obtained when sugarbeet was intercropped with onion. Interpretation for this criterion could be attributed to the weight and size of tubers rather than the cropping systems effect. Both traits seemed to be exclusively associated with weight and size of the tubers and governed by the dilution theory. The higher the tuber weight was, the less the total soluble sugars, sucrose and purity percents were obtained. Increases in T.S.S, sucrose, and purity contents when sugarbeet was intercropped were supported by Maria- Beshay (2000), Toaima *et al.* (2001) and Saleh (2003).

2- Effect of interspacing on sugarbeet growth, yield components, yield and chemical attributes under different cropping system

Measurable effects of ridge spacing on sugarbeet plants intercropped with onion and garlic or remained grown in pure stand were indicated in Table 3. Nevertheless, interspacing had no any appreciable effect on the top fresh weight of beet under these cropping systems, although the pure stand had relatively higher growth foliage than the intercropped under both 60 cm and 70 cm ridging systems. Relative larger growth foliage when beet plants were grown associated with onion than when beet plants were grown associated with garlic under both 60cm and 70 cm ridging systems. The data also indicate that foliage weight of beet plants raised on 70 cm ridge spacing tended to be heavier than beet plants

Table 3. Effect of interspacing on sugarbeet growth, yield components, yield and chemical attributes under different cropping systems in 2002/2003 and 2003/ 2004 seasons

Treatment		Foliage fresh weight	Tuber weight	Tuber length	Tuber diameter	Dual tubers	Yield/ fed	Sucrose	T.S.S	Purity
Ridge spacing		...... g	......kg......	............cm......	....	.....no.....	.....ton.....	....	......%......	....
					2002/ 2003					
	Sole sugarbeet	219.17	1.270	28.35	17.54	1.83	29.33	10.09	15.12	66.70
60cm	With onion	184.17	0.925	25.85	13.23	9.39	25.55	12.25	17.25	70.93
	With garlic	169.17	0.860	25.33	12.15	11.41	21.84	13.93	18.28	76.16
	Sole sugarbeet	230.84	1.520	29.54	18.34	1.68	27.17	9.37	14.47	64.70
70cm	With onion	192.50	1.285	28.47	14.91	6.91	24.22	11.72	16.72	70.09
	With garlic	177.50	0.935	27.93	14.74	9.55	17.28	11.90	17.41	67.63
LSD 0.05		**NS**	**0.12**	**0.35**	**0.41**	**0.50**	**1.71**	**NS**	**0.28**	**1.20**
					2003/ 2004					
	Sole sugarbeet	207.33	1 200	26.25	16.18	1 46	27.54	11.45	16.75	68.35
60cm	With onion	170.00	0 875	23.75	11.75	9.16	22.15	13.63	18.63	73.13
	With garlic	157.50	0.690	23.08	10.75	11.39	18.39	14.27	19.24	74.13
	Sole sugarbeet	220.93	1.450	27.48	16.90	1.25	23.75	10.60	15.67	67.62
70cm	With onion	191.83	1.215	26.42	13.42	6.84	20.75	12.25	17.37	70.53
	With garlic	178.33	0 815	25 92	13.32	9.50	15.90	13.31	18.32	72.64
LSD 0.05		**NS**	**0.12**	**0.43**	**0.32**	**0.51**	**1.57**	**0.14**	**0.26**	**1.2**

raised on 60 cm ridge spacing whether beet was grown in association or was grown in pure stand. These trends were valid in both seasons. The very high correlations between rates of net photosynthesis and solar irradiance might interpret the extra growth vigor associated with sugarbeet grown at the wider ridge system (70cm spacing). From another angle, the erectophile canopy of both onion and garlic and the limited growth of both crops seemed to facilitate pass the solar irradiance adequate enough to the photosynthetic organs of sugar beet. Maria- Beshay (2000), Toaima *et al.* (2001) and Saleh (2003) results were in agreement with these observations.

Ridge spacing had significant effects on yield components of beet under different cropping systems. Values obtained on average length, diameter and weight of sugarbeet tuber when plants were raised on 60cm ridges were significantly less than those obtained when plants were raised on 70 cm ridges. These observations were true whether beet was grown alone or in association with onion or garlic. The data also indicate that the values of these traits when beet was intercropped with onion were significantly higher than those obtained when beet was intercropped with garlic under both ridging systems and indicating onion compatibility to intercrop with beet rather than garlic. These results were fairly true in both seasons. On other hand, the average number of dual tuber/ plot when beet plants were raised on ridging at 60 cm apart significantly exceeded those grown on ridges 70cm apart. These results were also true in both seasons and might be due to lesser competition as compared with those growing on ridges 60 cm apart.

The average yield/ fed followed another distinctive pattern of change. Average yield of fresh tubers/ fed was tenaciously associated with beet density per unit area of land rather than due to increases in yield components owing to wider ridge spacing. Hence, yield of fresh tubers/ fed when beet was grown at the interspacing 60 cm apart whether intercropped with onion; garlic or left in pure stand was statistically higher than those raised on 70 cm ridges apart at the same respective cropping systems. These results were true in both seasons. From another angle of data, yield of sugarbeet intercropped with garlic was less than beet intercropped with onion whether it was raised on ridges 60 or 70 cm apart. Differences were also significant. These results were also concordant with those obtained by Toaima *et al.* (2001), Saleh (2003) and Wafaa Mohammed and El-Metwally (2004). Total soluble sugar, sucrose and purity percents were also associated with tuber weight. The heavier and larger the weight and size of tuber were the lower values of these traits were obtained indicating that higher percents of these traits were found in tubers of plants grown at narrower ridge spacing as well as in tubers of plant associated with garlic rather than with onion.

3- Effect of intraspacing on sugarbeet growth, yield components, yield and chemical attributes under different cropping systems

Data in (Table 4) also indicated that the effect of intraspacing on foliage weight of sugarbeet followed the same general tendency of interspacing treatments as a whole. The data revealed that top fresh weight tended to increase with wider distances between beet plants whether in the intercropping systems or

Table 4. Effect of intraspaeing on sugarbeet growth , yield components, yield and chemical attributes under different cropping systems in 2002/2003 and 2003/ 2004 seasons

Treatment		Foliage fresh weight	Tuber weight	Tuber length	Tuber diameter	Dual tubers	Yield/ fed	Sucrose	T.S.S	Purity
Plant spacing		...... g	......kg......	...........cm...	....	.....no.....	.....ton.....	....	....%....	....
2002/ 2003										
	Sole sugarbeet	221.25	1.320	28.01	17.31	1.91	31.08	10.00	15.04	66.51
25cm	With onion	186.67	1.020	26.82	13.17	10.21	26.57	12.70	17.79	71.39
	With garlic	170.00	0.885	26.50	12.59	14.28	21.44	13.61	18.13	74.26
	Sole sugarbeet	228.75	1.470	29.88	18.57	1.60	25.42	9.45	14.55	64.90
35cm	With onion	190.00	1.190	27.50	14.96	6.09	23.20	11.27	16.18	67.64
	With garlic	176.67	0.910	26.76	14.29	6.69	17.68	12.22	17.56	69.52
LSD 0.05		NS	**0.12**	**0.35**	**NS**	**0.50**	**0.54**	**NS**	**NS**	**NS**
2003/ 2004										
	Sole sugarbeet	209.00	1.250	25.90	15.88	1.50	27.50	11.30	16.52	68.43
25cm	With onion	177.50	0.950	24.75	11.59	10.16	23.15	13.50	18.55	72.69
	With garlic	160.00	0.630	24.42	11.15	14.22	18.00	14.31	19.35	73.95
	Sole sugarbeet	219.17	1.400	27.75	17.20	1.22	23.68	10.75	15.90	67.56
35cm	With onion	184.34	1.140	25.42	13.59	5.84	19.75	12.38	17.44	71.32
	With garlic	175.83	0.875	24.58	12.92	6.67	16.29	13.26	18.21	72.81
LSD 0.05		NS	**0.12**	**0.43**	**0.32**	**0.51**	**NS**	**0.14**	**0.26**	**NS**

in pure stand system, although, differences were not wide enough to reach the 5% level of significance. The top fresh weights of beet intercropped with garlic were relatively lower than those obtained from beet plant grown with onion under both intraspacing systems 25 and 35 cm apart. These results were true in both seasons. Yield components of sugarbeet were also influenced by plant spacing. The average length, diameter and weight of tubers of beet spaced at the wider distance, 35 cm apart significantly exceeded those when plants were spaced at 25cm apart. However, nor any of these traits when plants were intercropped could match up those when plants were grown in pure stand at both systems of plant spacing (25 or 35 cm apart). However, the statistical analysis revealed insignificant effect in case of the average diameter of the tubers in the first season. These results were also true in both seasons and were in agreement with those obtained by Amer *et al* (1997). Interpretation for these results is feasible. In explicit, these trends were governed by plant to plant competitiveness for light, minerals and water.

The data also indicated excesses in the average number of dual tubers when beet plants were intercropped, in particular in case of beet- garlic association. These observations were true under both regimes of intraspacing. They also indicated that dual tubers of the pure stand beet were at minimal, whether, beet was spaced at 25 or 35 cm apart. Nevertheless, the average number of dual tubers of beet spaced at 25 em apart was higher than those grown at 35 cm apart under any cropping system. Differences were also significant in both seasons. It seemed that the competition with narrower spaced beet were the cause and effect for these observations. Yield/ fed followed another trend, since beet yield was very correlated with beet population per/fed . Sugarbeet spaced at 25 cm outyielded plants spaced at 35 cm apart. This trend was true under any cropping system. Pure stand beet yielded more than plants intercropped under any of the two plant spacing regimes. However, the statistical analysis revealed significant differences in the first season, but, differences were insignificant in the second season. The results were also in concordant with those obtained by Amer *et al* (1997), Toaima *et al.* (2001) and Wafaa Mohammed and El-Metwally (2004). Total soluble sugar, sucrose and purity percents followed also regular pattern in both seasons although differences were insignificant except incases of sucrose and T.S.S percent in the second season. Both traits were correlated with the weight and size of sugar beet. Eventually, beet raised on ridges at 25cm apart had the least total soluble sugar, sucrose and purity percents when grown alone, ranked the second when beet was associated with onion and maximized when was associated with garlic. Similar trends were observed when beet plants were orientated at 35cm apart. Toaima *et al.* (2001)and Saleh (2003) came to similar results.

4- The interaction Effect of inter and intraspacing on sugarbeet growth, yield components, yield and chemical attributes under different cropping systems

The combined interactions of the three main variables, inter and intraspacing of sugarbeet under different cropping systems indicated the general tendency of the three main variables as they behaved individually in most cases (Table 5). Within sugar beet-onion associations least fresh weight of top growth, average length and diameter of tubers were obtained when onion was raised on 60 cm ridges and sugarbeet was spaced at the narrowest distance, 25 cm apart, whereas highest values were obtained when onion was raised on 70 cm ridges and beet was spaced at the widest distance, 35 cm apart. Within sugarbeet garlic associations, same traits followed the general tendency of the treatment effect as in sugar beet-onion associations. Within the pure stand sugar beet, these traits were also governed by the general tendency of the interaction effect. These results were true in both seasons. The interaction effect data also indicated that yields within the three associations were influenced by beet population densities. Highest yield were obtained with sugarbeet grown on ridges 60 cm apart and spaced at 25 cm, whereas the lowest yields were with sugarbeet grown on ridges 70 cm apart and spaced at 35 cm. Total soluble sugars, suerose and purity percents behaved also parallel to the average weight of tuber, lowest percents of these traits were associated the heaviest average sugarbeet tuber obtained when beet plants were raised on 70 cm ridges and spaced at 35 cm apart whereas maximum values of these traits were obtained when beet plants were raised on 60 cm ridge and spaced at 25 cm apart. These trends predominated the three cropping systems. From another angle of data, values obtained on growth and yield components and yield/ fed of pure stand sugarbeet were higher than those within the intercrop associations. However, the statistical analysis revealed significant differences among the treatments imposed for most traits in both seasons.

5- The interaction effects of cropping systems, inter and intraspacing of sugarbeet on growth, yield components and yield of onion

Data in (Table 6) indicated that intercropping sugarbeet with onion significantly reduced plant height of onion at any of the inter or intraspacing treatments as compared with the same respective treatments when onion was grown in pure stand. The data also indicated that onion height decreased with increasing ridge spacing and with increasing plant spacing within each ridging system. On other hand in no any of the intercropped treatment onion plants could match up in height with the pure stand onion at the same respective treatment. These results were in accordance with those obtained by Toaima *et al.* (2001) and Saleh (2003). Plant to plant competition for light intercepted by foliage might be the cause to enlength onion height. Yield components, bulb diameter and bulb weight followed reversed trend. There were gradual increases in the values of both traits with increasing ridge spacing as well as with increasing plant spacing, although differences of both traits were insignificant in both seasons, except, in case of bulb diameter in the second season. This tendency of the treatment effects was also due to the low below and above ground competition for light intercepted by foliage and water which was in favour the wider inter and intraspacing effect on onion.

Yield/ fed was governed by plant density of onion per unit area of land, rather than the yield of the individual plant (expressed in bulb weight). Gradual decreases in yield of onion per fed were evident with increasing inter and intraspacing either or both. Onion orientated on ridges 60 cm apart and spaced at 25 cm outyielded all other intercropped treatments. The excesses were estimated

Table 5. The interaction Effect of inter and intraspacing on sugarbeet growth , yield components, yield and chemical attributes under different cropping systems in 2002/2003 and 2003/ 2004 seasons

Treatment			Foliage fresh weight	Tuber weight	Tuber length	Tuber diameter	Dual tuber	Yield/ fed	Sucrose	T.S.S	Purity
			....g......	...kg......	............cm...............		.....no.....	.....ton.....	........................%........................		
2002/ 2003											
60	25	Sole sugarbeet	213.33	1.17	27.17	16.85	1.93	33.63	10.17	15.17	67.04
		With onion	183.33	0.87	25.77	12.50	12.37	26.18	13.13	18.17	72.26
		With garlic	165.00	0.80	25.12	11.58	15.15	22.67	14.73	18.77	78.47
	35	Sole sugarbeet	225.00	1.37	29.53	18.23	1.73	25.03	10.00	15.07	66.35
		With onion	185.00	0.98	25.93	13.95	6.42	24.91	11.36	16.32	69.60
		With garlic	173.33	0.92	25.53	12.71	7.67	21.02	13.13	17.78	73.84
70	25	Sole sugarbeet	229.18	1.47	28.85	17.77	1.88	28.52	9.83	14.90	65.97
		With onion	190.00	1.17	27.87	13.85	8.05	26.96	12.27	17.40	70.51
		With garlic	175.00	0.97	27.87	13.60	13.40	20.21	12.50	17.48	70.06
	35	Sole sugarbeet	232.50	1.57	30.23	18.90	1.47	25.80	8.90	14.03	63.43
		With onion	195.00	1.40	29.07	15.97	5.77	21.49	11.17	16.03	69.68
		With garlic	180.00	0.90	27.99	15.87	5.70	14.34	11.30	17.33	65.20
LSD 0.05			**8.45**	**0.40**	**0.49**	**NS**	**0.70**	**2.47**	**NS**	**0.41**	**NS**
2003/ 2004											
60	25	Sole sugarbeet	203.00	1.10	25.10	15.45	1.60	30.10	11.50	16.90	68.04
		With onion	168.33	0.80	23 67	11.00	12.32	22.80	14.50	19.50	74.35
		With garlic	148.33	0.53	22.83	10.17	15.10	19.20	14.70	19.80	74.24
	35	Sole sugarbeet	211.66	1 30	27 40	16.90	1.33	24.97	11.40	16.60	68.67
		With onion	171.66	0.95	23.83	12.50	6.00	21.50	12.77	17.75	71.91
		With garlic	166.66	0.85	23.33	11.33	7.67	17.57	13.83	18.68	74.03
70	25	Sole sugarbeet	215.00	1.40	26.70	16.30	1.40	25.10	11.10	16.13	68.81
		With onion	186.66	1.10	25 83	12.17	8.00	23.50	12.50	17.60	71.02
		With garlic	171.66	0.73	26 00	12.14	13.33	16.80	13.92	18.90	73.65
	35	Sole sugarbeet	226.66	1.50	28.10	17.50	1.10	22.40	10.10	15.20	66.44
		With onion	197.02	1 33	27.00	14.67	5.67	18.00	12.00	17.13	70.05
		With garlic	185.00	0 90	25.83	14.50	5.67	15.00	12.70	17.73	71.63
LSD 0.05			**7.65**	**0.17**	**0.61**	**NS**	**0.72**	**2.22**	**0.19**	**0.37**	**NS**

to 42.67 and 46.28% over onion raised on 70 cm ridges and spaced at 35 cm apart, in the first and second seasons, respectively. The data also indicated that yields of onion intercropped with sugarbeet were significantly less than those grown in pure stand at the same respective treatments. These results were true in both seasons and were supported by Kamel *et al.*(1992) and El-Habbak and Abo Kresha (1993). It is also interesting to note that marketable yield of onion behaved parallel to the total yield/ fed whether grown in pure stand or when intercropped with beet. However, there were apparent losses in the marketable yield of onion associated with the narrowest ridging and plant spacing (60 X 25 cm) in both seasons probably due to the deleterious effect of heavy competition on onion quality.

Table (6): The interaction effects of cropping system, inter and intraspacing of sugarbeet on growth, yield components and yield of onion in 2002/2003 and 2003/ 2004 seasons.

Treatment			Plant height	Bulb diameter	Bulb weight	Yield/ fed	Marketable yield / fed
			........cm........		....g....	........ton........	
				2002/ 2003			
60	25	Sole	60.70	4.67	68.98	12.27	10.22
		Intercropped	48.45	4.37	60.70	10.10	8.40
	35	Sole	56.55	5.02	71.83	9.17	8.16
		Intercropped	47.70	4.95	66.00	7.23	6.27
70	25	Sole	52.83	5.33	73.25	10.13	9.16
		Intercropped	43.66	5.18	70.12	9.10	8.17
	35	Sole	48.00	6.40	75.55	8.60	7.90
		Intercropped	43.11	5.42	71.25	6.10	5.17
LSD 0.05			4.60	NS	NS	0.62	0.75
				2003/ 2004			
60	25	Sole	52.66	4.98	60.78	11.60	9.78
		Intercropped	45.33	4.15	57.32	9.50	7.28
	35	Sole	49.33	5.23	65.47	8.40	7.47
		Intercropped	43.66	4.70	61.17	6.40	5.57
70	25	Sole	48.66	5.63	69.82	9.50	8.45
		Intercropped	40.00	4.97	62.17	8.33	7.60
	35	Sole	45.66	5.80	71.82	7.93	6.73
		Intercropped	36.33	5.32	64.16	5.40	4.75
LSD 0.05			5.16	0.33	NS	0.63	0.63

6- The interaction effects of cropping systems, inter and intraspacing of sugarbeet on growth, yield components and yield of garlic.

Plant height of garlic whether intercropped with beet or grown in pure stand was also governed by the competitive relationships between plants. The narrower inter and intraspacing were, the higher the garlic plants were obtained (Table 7). These results were in agreement with those obtained by Toaima *et al.* (2001). On other hand, the trend was reversed in case of the effect on yield components of garlic, the wider ridging and plant spacing were the higher the values of these traits were obtained. These results were true in both seasons, although, differences among the treatment imposed did not reach the 5% level of significance. However, the results were in agreement with those obtained by Kamel *et al.*(1992) and El-Habbak *et al* .(1993). Yield of garlic/ fed was tenaciously bounded with garlic density per unit area of land rather than was effected by the geometric distribution of garlic plants in the field. The excesses in yield when garlic was grown at the heaviest density 60 X 25 cm over garlic grown at the lowest density 70 X 35 were estimated to 77.32 and 104.6% in the first and second seasons, respectively when garlic was intercropped with beet. Whereas, the excesses were 47.45 and 68.96% for the same respective seasons in case of garlic grown in pure stand. Marketable yield of garlic followed the same trend as in onion and same criterion was also observed as in a large losses were observed when garlic was grown at the heaviest density in the intercrop as well as in the pure stand treatment. Further, the statistical analysis also indicate significant differences in yield and marketable yield/ fed in both seasons. These results were also in accordance with those obtained by Toaima *et al.* (2001).

Table (7): The interaction effects of cropping system, inter and intraspacing of sugarbeet on growth, yield components and yield of garlic in 2002/2003 and 2003/ 2004 seasons.

Treatment			Plant height	Bulb diameter	Bulb weight	Yield/ fed	Marketable yield / fed
			......cm......		...g..	.........ton........	
				2002/ 2003			
60	25	Sole garlic	95.00	3.33	43.20	7.27	5.90
		Intercropped	84.00	2.67	35.00	5.50	4.55
	35	Sole garlic	92.33	3.62	47.47	5.73	4.86
		Intercropped	83.33	3.17	36.92	4.60	3.78
70	25	Sole garlic	89.00	3.20	45.85	6.10	3.95
		Intercropped	84.33	3.12	38.87	5.47	4.53
	35	Sole garlic	85.00	3.96	48.15	4.10	3.47
		Intercropped	73.66	3.40	40.83	3.73	3.02
LSD 0.05			7.35	NS	NS	0.96	0.72
				2003/ 2004			
60	25	Sole garlic	85.00	2.70	40.20	6.55	4.58
		Intercropped	81.33	2.60	37.77	4.90	3.92
	35	Sole garlic	82.66	3.62	41.99	4.50	4.10
		Intercropped	79.66	2.80	38.57	3.85	2.80
70	25	Sole garlic	81.00	2.95	42.11	5.27	4.37
		Intercropped	77.00	2.98	38.22	4.70	3.87
	35	Sole garlic	77.33	3.27	42.96	3.20	2.55
		Intercropped	66.66	3.15	40.81	2.90	2.20
LSD 0.05			6.45	NS	NS	0.43	0.71

7- Competitive relationships

Data on the competitive relationships when onion or garlic was associated with sugarbeet indicated that relative yields of both crops in the association was parallel to plant density of either. Table (8 and 9)It is evident that RY values of onion were relatively lower than the relative yield (RY) values of sugar beet, except in case of the heaviest densities of both crops in the associations, (60 X 25) in both seasons. In case of garlic-beet association, the relative yield of garlic exceeded that of the relative yield of sugarbeet except in case of the lowest density in the second season. The data on total land equivalent ratio (LER), indicated also that all treatments imposed except that when sugarbeet was intercropped with garlic at 70 x 35cm orientation achieved yield advantage, since all values obtained exceeded the unit. Highest land utilization rate was achieved when both components in the intercropping were grown at the heaviest density of either (60 X25 cm) whereas minimum values were obtained when both components were grown at lowest density of either. Nevertheless, it is also evident, in all cases, that LER values obtained when both crops were orientated in 60 X 25 were always higher than when orientated at 60 X35 due to more plant population per unit area of land. The data also indicate that values obtained from sugarbeet onion association at any plant population density were relatively higher than those obtained from sugarbeet garlic associations, indicating that onion is considered a more compatible companion crop rather than garlic. These results were true in both seasons and were in agreement with those obtained by Kamel *et al.*(1992), El-Habbak *et al.* (1993) and Saleh (2003).

The relative crowding coefficient (RCC) when the ratio of either component were considered followed the same trends as influenced by plant orientation systems in intercropping. All values obtained exceeded the unit indicating yield advantage what ever when the ratio of either component were considered.

Data on Aggressivity (A) values revealed no any heavy competitive pressure exerted when either onion or garlic were associated with sugarbeet at any of plant orientation systems in both seasons. Sugar beet was the dominant component in all plant orientation system except, in case of growing both crops in onion sugarbeet association at the heaviest plant density. On the other hand, garlic was the dominant component except in case of (70 X 35) it was dominated indicating relative higher competitive pressure rather than onion. Toaima *et al.* (2001) came to similar result.

It could be concluded that yield advantage obtained from all these intercrop systems as compared to sole cropping might be due to the added production due to the substantial leaf canopy. Moreover, both onion and garlic proved to be good compatible companion crop with sugarbeet due to erectophile and limited leaf canopy of both onion and garlic.

Table (8): Effect of inter and intraspacing on competitive relationships and monetary advantage of garlic intercropped with sugarbeet in 2002/2003 and 2003/ 2004 seasons

Charac-ters	Land equivalent ratio (LER)			Relative crowding coefficient (R.C.C)			Aggressivity "A"	
Treat-ment	L_{garlic}	$L_{sugar\ beet}$	LER	K_{garlic}	$K_{sugar\ beet}$	K	A_{garlic}	$A_{sugar\ beet}$
Ridge spacing/ plants spacing								
				2002/ 2003				
60/ 25	0.76	0.67	**1.43**	23.05	0.28	**6.45**	+0.09	-0.09
60/ 35	0.63	0.63	**1.26**	19.95	0.20	**3.99**	+0.01	-0.01
70/ 25	0.75	0.60	**1.20**	23.33	0.21	**4.89**	+0.15	-0.15
70/ 35	0.51	0.43	**0.96**	16.33	0.12	**1.59**	+0.09	-0.09
				2003/ 2004				
60/ 25	0.75	0.64	**1.33**	21.55	0.24	**5.17**	+0.12	-0.12
60/ 35	0.59	0.58	**1.12**	17.52	0.16	**2.80**	+0.01	-0.01
70/ 25	0.71	0.56	**1.23**	21.15	0.18	**3.80**	+0.16	-0.16
70/ 35	0.44	0.50	**0.89**	13.34	0.13	**1.73**	-0.06	+0.06

Table (9): Effect of inter and intraspacing on competitive relationships of onion intercropped with sugarbeet in 2002/2003 and 2003/ 2004 seasons

Charac-ters	Land equivalent ratio (LER)			Relative crowding coefficient (R.C.C)			Aggressivity "A"	
Treat-ment	L_{garlic}	$L_{sugar\ beet}$	LER	K_{garlic}	$K_{sugar\ beet}$	K	A_{garlic}	$A_{sugar\ beet}$
Ridge spacing/ plants spacing								
				2002/ 2003				
60/ 25	0.82	0.78	**1.56**	34.19	0.48	**16.47**	+0.04	-0.04
60/ 35	0.59	0.74	**1.33**	25.31	0.34	**8.60**	-0.15	+0.15
70/ 25	0.74	0.80	**1.53**	31.50	0.41	**12.92**	-.0.06	+.0.06
70/ 35	0.50	0.64	**1.14**	21.58	0.26	**5.61**	-.014	+.014
				2003/ 2004				
60/ 25	0.82	0.76	**1.51**	33.44	0.43	**14.38**	+0.06	-0.06
60/ 35	0.55	0.71	**1.26**	23.30	0.32	**7.46**	-0.16	+0.16
70/ 25	0.72	0.78	**1.43**	29.99	0.36	**10.80**	-0.06	+0.06
70/ 35	0.47	0.60	**1.01**	19.87	0.22	**4.37**	0.13	+0.13

REFERENCES

Alexander, J. C. (1977): Nutrition of laboratory animals with fungi grown on cassava. In Nestel. B., and Graham, M. ed., cassava as animal feed: Proceedings of a Workshop held at the University of Guel ph, 18- 20 April 1977. Ottawa, International Development Research Center IDRC- 095e, 85- 90.

Amer, M.I.; Radi, M.M.; Ali, K.A. and Zalat, S.S. (1997): Intercropping faba been with sugarbeet under different plant densities. Egypt. J. Appl. Sci., 12(1) 155-161.

A.O.A.C (1984): Official Methods of Analysis 14th Ed. Association of Official Analytical Chemist. Alingtion, Virginia. USA.

Attia Zahira, M.A. (1999): Effect of onion transplanting date and intercropping pattern on cotton- onion association. Annals of Agric. Sci., Moshtohor 24(3) 899-909.

Beshay Maria G.; El-Ammari, T.S.; Allam, S.M.; Neamat Alla, E.A. and Abo Ziad, A.A. (2000): Productivity and monetary advantage of intercropping sugarbeet with other winter crops. Egypt. J. Appl. Sci., 15(9).

De-Wit, C.T. (1960): On competition. Verslag Landbou Kindige onder zoek No. 66. 1-82 (C.F. Willy R.W., 1979): Intercropping its importance and research needs part I. Competition and yield advantages (C.F. Field Crop Abst., 32: 1-0).

El-Borai, M.A and Radi, M.M. (1993): Effect of intercropping faba been with sugarbeet in Kafr El-Sheikh governorate. Report of Fifth Ann. Meeting, Cairo, 12-16 September. Nile Valley Regional Program on Cool Season Food Legumes ARC, Egypt.

El- Habbak, K.E; and Abo Kresha, M.A. (1993): Effect of ridge with and plant density of onion-cotton on yields of intercropped cotton and onion. Egypt. J. Appl. Sci., 8 (6), 882-890.

El- Naggar, H.M.M; El-Habbak, K.E. and Shams, S.A.A. (1996): Effect of intercropping onion with cotton and chemical weed control on growth, yield and associated weeds in both crops. Annals of Agric. Sci., Moshtohor, 34 (3): 839-857.

Hussein, A.H.A. and El-Deeb, M.A. (1999): Evaluation of intercropping faba bean, chickpea and lentil with sugarbeet in Middle Egypt. Arab Univ. J. Agric. Sci., Ain Shams Univ Cairo, 7 (2), 475-485.

Kamel, A.S; Sherif, M.N.; Masry, M.A.; Badr, S.K. and El- Habbak, K.E. (1992): Effect of onion association on yield and yield components of cotton. Agric. Res. Rev. (70) 3: 873-883.

Le-Doct. A (1927): Commercial determination of sugar in beet root using the saches Le Doct process Int. Sug. J. 29, 288-92.

Mc Gilichrist, C.A. (1960): Analysis and competition experiments Biometrics, 21: 975-985.

Mohammed Wafaa, Kh. and El-Mtwally, A. (2004): Intercropping different plant densities with sugarbeet J. Agric. Res. (Accepted).

Saleh, S.A. (2003): Effect of intercropping onion with sugarbeet and bio- nitrogen fertilization on their yields, yield components, chemical analysis and use efficiency. Annals of Agric Sci., Moshtohor, 41 (2): 599-611.

Snedecor, G.W. and Cochran, W.G. (1980): Statistical methods, 7 th ed. the lowa State Univ. Press, Ames lowa, USA.

Toaima, S.E.E.; El-Douby, K.A. and Nafeh, A.I. (2001): Effect of different intercropping systems on sugarbeet yield, yield components and chemical analysis. Egypt. J. Agric. Res. 79(3): 933-1001

Willey, R.W. (1979a): Intercropping- Its importance and research needs. Part I: Competition and yield advantages, and 2. Agronomy and research approaches (c.f. Field Crop Abstr., 32: 1-10, 73-85).

نمو وانتاجية بنجر السكر المنفرد والمحمل مع البصل والثوم تحت مسافات مختلفة من الخطوط والنباتات

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تمت دراسة تأثير تحميل محصول بنجر السكر مع البصل والثوم تحت مسافات مختلفة بين الخطوط والنباتات في مزرعة البساتين في منطقة توشكي بمصر العليا في الموسم الشتوى٢٠٠٢/ ٢٠٠٣،٢٠٠٣/ ٢٠٠٤ في نظام قطاعات كاملة العشوائية في اربعة مكررات. تم اختبار ثمانية معاملات للتحميل هي عبارة عن التوافق بين نظامين للتخطيط (هي إقامة الخطوط على مسافات ٦٠، ٧٠ سم) ونظامين للمسافات بين النباتات هي (الزراعة على مسافات ٢٥، ٣٥ سم) لنباتات بنجر السكر المحمل إما بمحصول البصل أو محصول الثوم والتي قورنت مع محصول البنجر والبصل والثوم في زراعه منفردة تحت ذات المسافات بين الخطوط والنباتات وقد اوضحت البيانات المتحصل عليها .

إن محصول بنجر السكر المحمل في كلا من نظم المسافات كان دائما اقل من مثيله المنزرع بحاله نقية. وجاء اكبر محصول للبنجر المحمل عندما زرع في خطوط على مسافة ٦٠سم وزرع على مسافة ٢٥سم بين النباتات وحمل بمحصول البصل بينما جاء اقل محصول للبنجر بزيادة المسافات بين الخطوط إلى ٧٠سم وبين النباتات إلى ٣٥سم وحمل البنجر بمحصول الثوم.

وارتبط محتوى الدرنات من السكريات الكلية الذائبة والسكروز والنقاوة (كنسبة مئوية) بوزن الدرنة. فقد وجد نقص في تلك المكونات مع وزن الدرنة والذى يزيد تدريجيا بزيادة المسافات بين الخطوط وبين نباتات بنجر السكر.

كما ارتبط محصول كلا من البصل والثوم بالفدان مع الكثافة النباتية لكلا المحصولين بوحدة المساحة من الأرض فقد وجد أيضا نقص تدريجي في محصول كل من البصل والثوم المحمل بزيادة المسافة بين الخطوط أو بين النباتات أو كليهما. فقد أوضحت النتائج إن البصل المحمل المنزرع على خطوط بمسافات ٦٠سم، ٢٥سم بين النباتات قد تفوق على جميع المعاملات المحملة الأخرى إلا أنة على الجانب الأخر أوضحت البيانات إن محصول اى مكون في نظم التحميل المختلفة كان اقل دائما من محصول ذات المكون وبنفس الكثافة النباتية عند الزراعة النقية.

كما أوضحت البيانات أنة كان هناك دائما نقص واضح في كمية المحصول القابلة للتسوق لكل من البصل والثوم خاصة عند اكبر كثافة لهما وهى عند ٦٠سم × ٢٥سم.

وأظهرت البيانات على معدل كفاءة استخدام الأرض إن جميع الكثافات النباتية المختبرة في نظم التحميل المختلفة حققت ميزة محصولية عالية ماعدا تحميل البنجر مع الثوم (٦٠سم× ٢٥سم) . جاء اكبر معدل كفاءة لاستخدام الأرض عندما حمل كلا من المحصولين الداخلين في نظم التحميل عند أعلى كثافة نباتية (٦٠سم×٢٥سم). كذلك أوضحت البيانات إن معدل كفاءة استخدام الأرض عنه في نظم تحميل بنجر السكر مع البصل كان دائما أعلى عند اى كثافة نباتية بوحدة المساحة عنة في نظام تحميل بنجر السكر مع الثوم

وجاءت قيم معامل الحشد النسبي متوافقة مع قيم معدلات كفاءة استخدام الأرض. ومن ناحية أخرى دلت البيانات الخاصة بالعدوانية إن اى من الكثافات النباتية لنظم التحميل لبنجر السكر والثوم لم يخلق ضغطا تنافسيا ملحوظا.