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EFFECT OF INTERCROPPING OF SUGAR BEET WITH ONION AND GARLIC ON INSECT INFESTATION, SUGAR BEET YIELD AND ECONOMICS

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ABSTRACT

Intercropping system greatly contributes to crop intensification and production by its effective utilization of resources as compared with monoculture cropping system. The current investigation was conducted at a sugar beet field at El-Riad Districts, Kafrelsheikh Governorate during 2012/13 and 2013/14 seasons. The study aimed to investigating the effect of intercropping sugar beet with either onion or garlic on the density of major sugar beet insects. Also, the influence of intercropping on sugar beet yield and yield components and quality was a main target. The economics of such intercropping systems were considered. A split plot design with three replications was used. The main plots were assigned to the intercropping pattern and the sub-plot was allocated to the plant spacing of the second crop

The sole sugar beet plots displayed the highest infestations with cotton leaf worm, beet fly, tortoise beetle and beet moth. The lowest infestations were detected in plots having sugar beet intercropped with onion, while the moderate infestations were found in case of sugar beet intercropped with garlic. On the other hand, the insect infestations appeared to be lowest with narrow spacing (25 cm) of onion or garlic hills, but highest with wider spacing (75cm).

Concerning the yield, the sole sugar beet produced the highest foliage, root, sugar percentage and total sugar. The values were less in case of sugar beet – onion system, and least in case of sugar beet – garlic system. Chemical analysis of sugar beet plants revealed no significant differences among intercropping systems concerning with sodium, Alpha amino-nitrogen α-N and potassium.

From the economic point of view, sugar beet intercropped with 25cm- onion gave the highest gross income (14.890 L.E./ fed), followed by that at 50 cm (14.110 L.E./ fed). The sole sugar beet displayed 12.556 L.E., while that intercropped with 75 cm- onion or garlic gave the lowest income 11.90 and 11.520 L.E., respectively.

It could be concluded that intercropping sugar beet with 25 cm – onion maximized the growers' income and reduced insect pest infestations.

INTRODUCTION

Sugar beet crop has been introduced into Egypt by the early 1980s to help, besides sugarcane, in fulfilling the gap between sugar production and consumption. Thus, the allocated area to sugar beet has increased from 16,900 feddans in 1982 to 450,000 feddans in 2012 (Abdel-Motagally and Metwally, 2014).

One of the main problems in the agricultural system in Egypt is the low area of cultivated land per grower; about 44% of the growers own or work in an area of one feddan or less (Ahmed *et al.*, 2009). Thus, crop

intensification has become of great necessity to optimize utilizing land, water and other resources.

Intercropping system greatly contributes to crop intensification and production by its effective utilization of resources as compared with monoculture cropping system (Zhang and Lee, 2003). Onion is a valuable crop, and ranks second after tomato in the list of worldwide cultivated vegetables (FAO, database, 2012).

Farghaly *et al.* (2003) reported that yield of sugar beet has been reduced by intercropping with onion, or faba bean, compared to sole sugar beet. However, sugar beet intercropped with onion or with coriander gave a better performance to get interim benefit from the same piece of land (Azad and Alam, 2004). In addition, the highest values for land equivalent ratio were obtained when sugar beet was intercropped with onion (Farghaly *et al.*, 2003).

It has been indicated that some intercropping systems improve soil conditions. Li *et al.* (1999) showed that intercropping can improve soil quality and ecological microclimate, and enhances crop productivity. Xiao *et al.* (2012) reported that intercropping between cucumber and garlic has stimulated population of bacteria and actinomycetes, and inhibited fungi, which suggests that this intercropping system can improve soil biology.

In plant protection programs, it has become necessary to use non-chemical methods for controlling insect pests. In such concern, intercropping of two crops which do not act as hosts for the same pest can contribute in reducing insect pest populations. Thus, adoption of intercropping is to create more favorable conditions for beneficial insect species and inhibit pest development. Wnuk and Zytko (2007) have shown that Tancy phacelia, *Phacelia tanacetifolia* Benth is a good source of pollen and nectar for the bees and other beneficial insects. When Tancy phacelia was intercropped with faba bean, the population of *Aphis fabae* Scopoli was reduced because of the synergistic effect of Tancy phacelia pollens and nectars to the predatory surphids that feed upon aphids.

In addition to insect control, intercropping was found to reduce disease infection in sugar beet. Banaszak *et al.* (1998) found that using new varieties of oil radish and white mustard as intercrops have reduced the infection of the disease, *Hheterodera schachtii* Schm. to sugar beet plants by 20-40%.

From the economic point of view, intercropping sugar beet with lentil gave the highest monetary benefits compared to the sole sugar beet, or other intercropping systems. Also, Farghaly *et al.* (2003) reported that the highest values of land equivalent ratio were observed when sugar beet was intercropped with onion, while the least were found when sugar beet was intercropped with faba bean.

The current investigation aimed to study the effect of intercropping sugar beet with onion or garlic on the yield and yield quality of sugar beet. Also, the effects of intercropping on the population densities of major sugar beet insect pests were considered. The economic benefits of such intercropping system were investigated.

MATERIALS AND METHODS

The current investigation was carried out at El-Riad District, Kafr El-Sheikh Governorate during two sugar beet seasons; 2012/13 and 2013/14. It aimed at studying the effect of intercropping between sugar beet and each of onion and garlic on sugar beet yield and quality. Also, the effect of intercropping on population densities of major sugar beet insect pests, and economic return were considered.

A split plot design with three replications was used. The main plots were assigned to the intercropping pattern and the sub-plot was allocated to the plant spacing of the second crop.

The experimental area was divided into 42 plots, each of 84 m^2. Twenty one plots were assigned to the early date of sowing; 20th of August to monitor the insect infestation of cotton leafworm; *Spodoptera littoralis* Boisd. The other 21 plots were devoted to the second date of sowing; 20th of September to Monitor other insect pests; beet fly, *Pegomyia mixta* Vill., beet moth, *Scrobipalpa ocellatella* Boyd., and tortoise beetle, *Cassida vittata* Vill. The sugar beet yield and yield quality were studied in the plots of the second sowing date.

The land of the experimental field was prepared as recommended. Calcium super phosphate (15.5% P_2O_5) was incorporated into the soil with the last tillage at rate of 150 kg/fed. Also, potassium sulphate (50% P_2SO_4) was added into the soil at a rate of 50 kg/fed.

Sugar beet seeds, onion seedlings and garlic lobes were sown or transplanted on the same day. For intercropping, the onion seedlings or garlic lobes were planted on a ridge of the row, and sugar beet seeds (Kawamira cultivar) were sown on the other ridge. The intercropping patterns were as follows:

- Sole sugar beet, one ridge.
- Sugar beet on a ridge, onion seedling at 25 cm spacing on the other ridge.
- Sugar beet on a ridge, onion seedlings at 50 cm spacing on the other ridge.
- Sugar beet on a ridge, onion seedlings at 75 cm spacing on the other ridge.
- Sugar beet on a ridge, garlic lubes at 25 cm spacing on the other ridge.
- Sugar beet on a ridge, garlic lubes at 50 cm spacing on the other ridge.
- Sugar beet on a ridge, garlic lubes at 75 cm spacing on the other ridge.

Sugar beet seedlings were thinned to one plant per hill 25 days after planting. Nitrogen fertilizer was added at a level of 100 kg N/fed. in the form of urea (46.5% N) as divided into two equal doses; the first one was applied after thinning, and the second dose was applied 21 days later.

Yield and yield attributes:

At harvest, foliage and roots were separately weighed per plot, and adjusted to one feddan. Depending on sugar percentage in the roots of each treatment, total sugar production per feddan was calculated. At laboratories

of Delta Sugar Company, the quality parameters; juice quality, sodium, alpha amino-nitrogen and potassium were assessed.

Yields of onion and garlic were estimated. Gross return under different patterns of intercropping was calculated by summation the value of sugar beet yield and value of onion or garlic.

Insect infestation examination:

In the early plantation (20th of August), cotton leafworm infestation was assessed as number of larvae per 20 sugar beet plants. In the second sowing date, (20th of September), *Pegomyia mixta* larvae, *Scrobipalpa ocellatella* larvae and *Cassida vittata* larvae and adults per 20 sugar beet plants were counted.

Economic evaluation:

Gross return (L.E. fed^{-1}): Gross return from each treatment was calculated in Egyptian pounds (L.E.)/ton of sugar beet and (L.E.)/ton of onion and garlic in both seasons as follows:

[Ton of sugar beet = 400 L.E, Ton of onion = 1000 L.E and Ton of Garlic = 3000 L.E for both seasons].

[Price of sugar beet was obtained by Egyptian Sugar and Integrated Industries Company and price of onion and garlic was obtained by market search.]

Statistical analysis:

The obtained data were subjected to analysis of variance according to Gomez and Gomez (1984). Treatment means were compared by Duncan's Multiple Range Test (Duncan, 1955). All statistical analysis was performed using analysis of variance technique by means of "MSTATC" computer software package.

RESULTS AND DISCUSSION

Data in Table (1) show the infestation levels of sugar beet plants by major insects as influenced by intercropping system, during 2012/13 season.

Cotton leaf worm:

The highest infestation by the cotton leafworm (815.33 larvae/20 sugar beet plants) was detected in sole sugar beet. The second rank was that in sugar beet plants intercropped with garlic (av. 529.33 larvae), while the sugar beet plants intercropped with onion suffered the least insect infestation (av. 456.00 larvae/20 plants).

On the other hand, the narrow spacing of both onion and garlic exhibited less cotton leaf worm infestation compared to wider spaces. These values were 430.00 & 502.67 larvae/20 beet plants at 25 cm spacing, and increased to 477.33 & 544.00 larvae at 75 cm spacing in sugar beet intercropped with onion and garlic, respectively. Statistical analysis revealed significant differences among different intercropping patterns (Table 1).

Data of the second season, 2013/14 (table 2) took the same trend; 728.00 larvae/20 plants in the sole sugar beet, 430.22 larvae in the intercropping with garlic and 347.0 larvae in the intercropping with onion.

Pegomyia mixta:

In the first season (Table 1), sole sugar beet was infested by 215.67 larvae/20 plants, followed by sugar beet intercropped with onion (170.33) and that intercropped with garlic (168.78).

Data of the second season (Table 2) took a similar trend, but sugar beet intercropped with garlic occupied the second rank (167.33 larvae/20 sugar beet plants) and intercropping with onion occupied the third rank (146. 89 larvae). Differences among different treatments were significant.

Table (1): Effect of intercropping between sugar beet and each of onion and garlic on the population density of major sugar beet insect pests, At El-Riad District, Kafr El-Sheikh Governorate, 2012/13 season.

Treatment	Spacing of secondary crop (cm)	Av. No. of insects/20 sugar beet plants			
		S. littoralis (larvae)	*P. mixta* (larvae)	*S. ocellatella* (larvae)	*C. vittata* (larvae + adults)
Sole sugar beet	-	815.33 a	215.67 a	121.00 a	220.67 a
Sugar beet	onion 25cm	430.00 e	161.33 d	51.33 d	164.33 d
	onion 50cm	460.67 d	169.67 d	66.00 c	171.33 c
	onion 75cm	477.33 d	180.00 bcd	70.33 bc	173.67 c
Sugar beet	garlic 25cm	502.67 c	166.00 d	62.33 cd	167.00 c
	garlic 50cm	541.33 b	174.67 cd	79.67 b	183.33 bc
	garlic 75cm	544.00 b	170.67 d	80.00 b	184.00 bc

In a column, means followed by the same letter are not significantly different at the 5% level of probability according to Duncan multiple range test.

Table (2): Effect of intercropping between sugar beet and each of onion and garlic on the population density of major sugar beet insect pests, At El-Riad District, Kafr El-Sheikh Governorate, 2013/14 season.

Treatment	Spacing of secondary crop (cm)	Av. No. of insects/20 sugar beet plants			
		S. littoralis (larvae)	*P. mixta* (larvae)	*S. ocellatella* (larvae)	*C. vittata* (larvae + adults)
Sole sugar beet	-	728.00 a	179.67 a	67.33 a	69.33 a
Sugar beet	onion 25cm	325.00 e	148.00 c	40.33 b	49.33 d
	onion 50cm	360.67 d	145.67 c	42.67 b	51.00 cd
	onion 75cm	355.33 d	152.00 c	50.00 b	55.67 bc
Sugar beet	garlic 25cm	418.67 c	160.33 bc	43.33 b	51.00 cd
	garlic 50cm	422.00 c	170.67 ab	45.67 b	51.67 cd
	garlic 75cm	450.00 b	171.00 ab	44.00 b	60.33 b

In a column, means followed by the same letter are not significantly different at the 5% level of probability according to Duncan multiple range test.

Scrobipalpa ocellatella:

In both seasons, sole sugar beet harbored the highest population of *S. ocellatella*; 121.00 larvae in 2012/13 season and 67.33 larvae/20 plants in 2013/14 season. These infestations decreased to 62.55 & 44.33 larvae/20

plants in 2012/13 and 2013/14 seasons, respectively in case of sugar beet – onion intercropping system. When sugar beet was intercropped with garlic, the infestation by *S. ocellatella* decreased to 74.00 larvae in the first season and to 44.33 larvae/20 plants in the second season.

Cassida vittata:

Similar to the previous insects, sole sugar beet plants suffered the highest insect infestation; 220.67 larvae + adults in the first season (Table 1) and 69.33 in the second season (Table 2). In case of intercropping of onion, the infestation level was reduced to 169.78 and 52.00 larvae + adults, in the first and second seasons, respectively. As for sugar beet-garlic intercropping, the infestation was intermediate; with 178.11 larvae and adults in the first season and with 54.00 larvae and adults in the second season. Differences in infestation levels were significant in both seasons.

Multiple cropping could be a powerful component of cultural pest control, as well as it satisfies the socio-economic objectives of the growers (Perrin, 1987). Risch (1984) and Baliddawa (1985) reported that population of several insect pests have been depressed under conditions of plant species diversity, indicating that intercropping could be used for the control of some insect pests. Reductions were recorded in cotton infestations with major insects when intercropped with cowpea, as compared with infestations in sole cotton (Omar *et al*., 1994).

Wnuk and Zytko (2007) pointed out that intercropping of two crop plants which are not shared hosts for pests is considered to be a method for pest control without usage of chemicals. El-Fakharany *et al.* (2012) reported that the rate of infestations by *Pegomyia mixta* and *Cassida vittata* were lower in sugar beet plants intercropped with faba bean, maize or cabbage as compared with their numbers in sole sugar beet. In addition, the sugar beet intercropped with maize had higher population densities of the insect predators; *Chrysoperla carnea, Paederus alfierii* and *Scymnus* spp. On the other hand, Oso and Falde (2010) indicated that intercropping may not necessarily reduce pest load in any given situation.

Yield and yield attributes:

Data sited in table (3) show that sole sugar beet gave the highest numerical values of foliage (t/fed.) for both seasons of study followed by sugar beet intercropped with onion at 25 cm spacing rate and that intercropped with garlic, with no significant differences between other spacing rates for both sugar beet + onion and sugar beet + garlic. Root yield (ton/fed) took a similar trend with no significant differences among different treatments in both seasons of study. On the other hand, % sugar revealed no significant differences among different treatments and spacing rates. Total sugar (ton/fed.) was not significant for both seasons with no significant differences among different spacing rates. Abdel Motagally and Metwally,(2014) found that the effects of the associated cropping patterns of onion with sugar beet on yield and its components of onion crop were significantly reduced by intercropping. Nevertheless the yield of sole sugar beet was slightly higher than obtained from any intercropped combination under study. Root yield of sugar beet was not significantly reduced by intercropping with onion

comparing with pure stand. These results may be due to the competition between sugar beet and onion plants for nutrient, water and solar radiation.

Besheit *et al*. (2002) revealed that intercropping onion at various densities on both ridge widths (50 and 100 cm) had insignificant effect on most quality and productivity traits in both seasons except pol% (in the first season), extractable sugar, extractability % and sugar yield ton fed^{-1}. The highest sugar beet quality and productivity were obtained from beet planted on 100 cm ridge width and intercropped with two onion rows, while intercropping onion on the other side of beet ridge 50 cm width was high and negatively affected beet quality and productivity. Abou Khadra *et al*. (2013) found a significant difference among intercropping systems in top, root and sugar yields and their attributes as well as root quality in the two seasons. Root and sugar yields fed^{-1} produced by sole sugar beet plants and its intercropped with wheat at hills 80 cm apart were practically the same and significantly surpassed those intercropped with wheat at hills of 20 cm apart in both seasons. Similar results were recorded by Farghaly *et al*. (2003), El-Shaikh and Bekheet (2004), Gadallah *et al*. (2006) and Hussein and Yousrya (2012).

Table (3): Yield of sugar beet as affected by effect of intercropping between sugar beet and each of onion and garlic on the yield of sugar beet at 2012/13 and 2013/14 seasons.

Treatment	Spacing of secondary crop (cm)	Foliage (t/fed.)		Root yield (t/fed.)		% sugar (av.)	Total sugar (t/fed.) av.
		2012/13	2013/14	2012/13	2013/14		
Sugar beet	onion 25cm	7.95 b	7.74 b	23.64 b	25.76 b	18.25	4.51
	onion 50cm	6.46 c	7.20 b	23.36 b	25.84 b	18.20	4.48
	onion 75cm	6.54 c	6.55 b	23.20 b	25.84 b	18.13	4.45
Sugar beet	garlic 25cm	6.01 c	7.19 b	21.70 b	22.88 b	17.20	3.83
	garlic 50cm	6.40 c	6.96 b	20.80 b	22.56 b	18.00	3.90
	garlic 75cm	6.39 c	6.36 b	20.80 b	22.40 b	17.89	3.86
Sole sugar beet	-	9.45 a	9.54 a	30.03 a	32.74 a	19.05	5.98
F. test		**	*	**	**	NS	NS

In a column, means followed by the same letter are not significantly different at the 5% level of probability according to Duncan multiple range test.

Table (4): Yield characteristics of sugar beet as influenced by intercropping with onion and garlic at 2012/13 and 2013/14 seasons.

Treatment	Spacing of secondary crop (cm)	Juice quality QZ		Sodium Na		Alpha amino-nitrogen α-N		Potassium K	
		2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Sugar beet	onion 25cm	79.07 ab	81.13 ab	1.79 bc	1.83 b	4.95 b	4.89 b	6.83	6.15
	onion 50cm	84.69 a	82.22 ab	1.52 cd	1.66 b	4.65 b	4.88 b	7.35	7.22
	onion 75cm	86.78 a	88.39 a	1.33 d	1.51 b	4.15 b	4.11 b	8.15	8.11
Sugar beet	garlic 25cm	71.47 b	79.60 b	2.00 ab	1.90 b	5.00 b	5.01 b	6.66	6.40
	garlic 50cm	73.80 b	80.22 ab	2.01 ab	1.98 b	5.11 b	4.90 b	7.32	6.96
	garlic 75cm	85.23 a	85.23 ab	1.89 ab	1.64 b	4.95 b	4.33 b	8.25	7.13
Sole sugar beet		71.66 b	71.19 c	2.15 a	3.83 a	7.90 a	6.98 a	8.36	8.25
F. test		**	*	**	**	**	*	NS	NS

In a column, means followed by the same letter are not significantly different at the 5% level of probability according to Duncan multiple range test.

Juice quality, potassium, sodium and α-amino nitrogen in the roots are regarded as impurities because they interfere with sugar extraction. Means of these impurities and juice quality as affected by intercropping system between sugar beet with onion and garlic in 2012/13 and 2013/14 seasons are presented in Table (4).

Data in table (4) reveled that juice quality was significant in both seasons, sugar beet intercropped with onion gave the highest values of juice quality at 75 cm and 50 cm spacing in the two seasons of study followed by sole sugar beet intercropped with garlic at 50 cm and 25 cm spacing with no significant differences between different spacing rates among both treatments. The sole sugar beet gave the lowest juice quality values in the second season. Differences among different treatments were significant. Sole sugar beet recorded the highest values of sodium (Na) followed by sugar beet intercropped with garlic and that intercropped with onion with no significant differences between different spacing rates. Sole sugar beet gave the highest values of Alpha amino-nitrogen (α-N) followed by both sole sugar beet intercropped with garlic and that intercropped with onion with no significant differences among them in the two seasons of study. Potassium (K) revealed no significant differences among different treatments and spacing rates in both seasons. Last and Draycott (1977) pointed to the highly negative and significant correlation between the loss of sugar or molasses and nonsugar (K, Na, α-amino-n). Similar results were also reported by Hilde *et al.* (1983) and Van Geijn *et al.* (1993). Farghaly *et al.*(2003) revealed that ridge width had significant effect on sucrose% which were higher when sugar beet plants were grown on wider ridges (120cm) than that grown on narrow ridges (60 and 80cm). Abou Khadra *et al*. (2013) found that the sole beets and intercropped with wheat at 80cm hill space were statistically at par in

white sugar yield and most juice quality in both seasons, The sole beets produced the greatest concentration of total sugar and the lowest concentration of impurities (K, Na, α-amino-N and K+Na) compared to those intercropped with wheat at 20cm hills in both seasons. The increase in white sugar yield may be due to the considerable increase in root yield and extractable white sugar and in turn increased white sugar yield. These results are in agreement with these obtained by Amer *et al.* (1997),Toaima *et al*.(2001) and Farghaly *el al*. (2003).

Economic evaluation:

Gross return (L.E. fed^{-1}):

Results presented in Table (5) indicated that sugar beet intercropped with onion at 25 cm spacing recorded the highest gross return (14890 LE) followed by sugar beet intercropped with onion at 50 cm spacing (14110 LE). While, sugar beet intercropped with garlic at 75 cm spacing gave the lowest values (11520 LE). Toaima *et al*. (2001) recorded that higher yield was observed when intercropping system was 120 cm width ridges, with higher Land Equivalent Ratio (LER) were (1.56, 1.51) for onion, (1.53, 1.52) for garlic and total income (3174, 3154 L.E) for onion and (4103, 4120 L.E) for garlic in both seasons, respectively. These results are in accordance with those obtained by Besheit *et al*. (2002) who reported that all intercropping treatments increased markedly farmer net return and profitability per unit capital input (one Egyptian pound), but intercropping two or three rows of onion on a wide ridge of beet maximized those traits. Economically sugar beet intercropped with onion gave highest net return and better performance to get interim benefit compared with sole sugar beet.

Table (5): Effects of intercropping sugar beet with onion on gross return (L.E. fed^{-1}) in 2012-2013 and 2013-2014 seasons.

Intercropping system	Sugar beet		Onion/garlic		Gross Return (L.E. fed^{-1})
	Yield (t/fed.)	Value L.E	Yield (t/fed.)	Value L.E	
Sole sugar beet	31.39	12556	-	-	12556
Sugar beet + onion 25 cm	24.70	9880	5.01	5010	14890
Sugar beet + onion 50 cm	24.60	9840	4.27	4270	14110
Sugar beet + onion 75 cm	24.52	9808	2.10	2100	11908
Sugar beet + garlic 25 cm	22.29	9816	1.58	4740	13656
Sugar beet + garlic 50 cm	21.68	8672	1.50	450	13172
Sugar beet + garlic 75 cm	21.60	8640	0.96	2880	11520

Prices per ton:
Sugar beet = 400 LE
Onion = 1000 LE
Garlic = 3000 LE

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تأثيرنظم تحميل بنجر السكر مع البصل والثوم على الاصابة بالحشرات ،المحصول و العائد الاقتصادى

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تسهم نظم التحميل المحصولى فى تكثيف انتاجية المحاصيل واتاحة الفرصة للاستغلال الامثل للموارد المتاحة، و ذلك مقارنة بنظم الزراعة المنفردة.

أجرى البحث بمركز الرياض (محافظة كفر الشيخ) خلال موسمى ٢٠١٣/٢٠١٢، ٢٠١٤/٢٠١٣ . استهدف البحث دراسة تأثير نظم تحميل بنجر السكرمع كل من البصل والثوم على الاصابة بالحشرات الرئيسية، و كذا تأثير التحميل على محصول البنجر و مكوناته وصفات الجودة. كما تناولت الدراسة ايضا تأثير التحميل على اقتصاديات هذة النظم من التحميل.

كانت الاصابة بحشرات البنجر الرئيسية (دودة ورق القطن، ذبابة البنجر، الخنفساء السلحفائية و فراشة البنجر) أقل ما يمكن فى البنج المحمل مع البصل ، وكانت اعلى ما يمكن فى القطع المنزرعة بالبنجر منفردا. كما كانت النباتات المنزرعة على مسافات ضيقة (٢٥سم) من البصل أو الثوم أقل اصابة بالحشرات السابقة مقارنة بالاصابة فى القطع المحتوية على مسافات واسعة (٧٥ سم) من البصل أو الثوم.

أوضحت نتائج تحليل صفات الجودة ، ان نظم التحميل سواء من حيث المحصول الثانوى او مسافات زراعته لم يكن لها تأثير معنوى على نسب كل من البوتاسيوم ونسبة السكر فى عصير بنجر السكر.بينما كان لها تأثير معنوى على محصول الجذور والعرش وكذا نسبة كل من الصوديوم ،ألفا نيتروجين و جودة العصير.

و من الناحية الاقتصادية، كانت المعاملة المحتوية على بنجر وبصل على مسافات ٢٥ سم هى الأكثر ربحية (١٤٨٩٠ جنيها للفدان)، تلتها المعاملة المحتوية على بنجر و بصل على مسافات ٥٠ سم (١٤١١٠ جنيها للفدان). و كان العئد من البنجر منفردا ١٢٥٥٦ جنيها / فدان. و كانت أقل المعاملات ربحية هى البنجر المحمل مع بصل أو ثوم على مسافات ٧٥ سم، والتى أعطت ١١٩٠٨، ١١٥٢٠ جنيها للفدان على التوالى.

يتضح من نتائج البحث الحالى ان تحميل بنجر السكر مع البصل (٢٥ سم) يعمل على تعظيم انتاجية البنجر والحصول على أعلى عائد من وحدة المساحة المنزرعة بالبنجر.