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Effects of Intercropping Sunflower with Sugar Beet under Different Plant Densities and Defoliation Levels on Yield and Production Efficiency of Both Crops

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Abstract

Two field trials were carried out in Agriculture Research Station, Giza, Egypt during 2009/2010 and 2010/2011 seasons to study the effect of intercropping sugar beet with different plant densities of sunflower (100%, 80% and 67% sunflower plants from pure stand) and four defoliation levels of sunflower plants (75, 50, 25% and 0% at milk ripe stage) on growth, yield and yield components of sunflower (*Helianthus annus* L.) and sugar beet (*Beta vulgaris* L.).

Sugar beet (c.v. Kawemire), as the main crop, was seeded in hills spaced 20 cm on two sides of wide ridges 120 cm apart, both in intercropping and monoculture patterns to achieve full stand of 35000-plants/ fed. Sunflower (c.v. Giza 102) as a sole crop was seeded in hills spaced 20 cm apart and one plant per hill on both sides of the ridges 120cm to achieve full stand 35,000 plants/fed. Intercropped sunflower was sown at one plant per hill spaced 20, 25 and 30cm on two rows in the top of ridges 120cm width. The experiments included 12 treatments, in addition to monocultures of sunflower and sugar beet as checks. The experiments were designed a Randomized Complete Block Design (RCBD) with three replications.

The obtained results indicated that

1- Intercropping pattern of 100% sugar beet + 67% sunflower of plant density and 75% defoliated leaves gave the highest yield of root and sugar fed.$^{-1}$, while intercropping 100% sugar beet + 100% sunflower of plant density and without defoliated leaves gave the lowest yield of root and sugar per fed., as compared with yield of monoculture sugar beet in two seasons.
2- Intercropping pattern of 100% sugar beet + 100% sunflower of plant density and without defoliated leaves gave the highest seed yield of sunflower fed.$^{-1}$, while intercropping 100% sugar beet + 67% sunflower of plant density and 75% defoliated leaves gave the lowest seed yield of sunflower per fed., as compared with yield of monoculture sunflower in two seasons.
3- Highest value of Land Equivalent Ratio (LER) and Area Time Equivalent ratio (ATER), 1.51 and 1.17 were recorded with 100% sugar beet + 80% sunflower of plant density and 50% defoliating of sunflower leaves over the two seasons . This treatment gave also highest income L.E 8729 fed.$^{-1}$ as average of both seasons.

Key words: *intercropping, sugar beet, sunflower, defoliation, growth, yield, Production efficiency, LER.*

Introduction

Sugar beet is an important sugar crop in the world and ranks next to sugar cane as a source of sugar in Egypt, also sunflower is one of the most important oil crops occupying the fourth place in the world. In Egypt, the area devoted to sunflower in the crop structure is very limited. Therefore, increasing the cropped area of oil seed crops is an important target to reduce the gab between our production and consumption from edible oils. Intercropping can be used, as one of the most effective methods to increase the area of oil crops, intercropping can be considered an effective method.

Toaima *et al* (2001) found that intercropping sugar beet with onion and garlic resulted in greater yield, yield components and improved quality of sugar beet. The highest values of LER were obtained when 16 plants/ m^2 of faba bean were intercropped on sugar beet, but the highest yield of sugar beet was obtained from intercropping five faba bean plants/m^2 (Abd El-All, 2002). Beshay *et al*, (2000) reported that the reduction in sugar beet productivity was due not only to intercropping but also to intercropped density. Also intercropping increased markedly farmer net and profitability per unit capital input (one LE). Mohammed *et al*, (2005) indicated that growth, yield, and yield components of sugar beet were significantly decreased by the intercropping with faba bean as compared with solid sugar beet. Sugar beet yield and its attributes were significantly reduced with increasing plant density of the companion crop. The maximum values of LER, and K were obtained when 100% sugar beet was intercropped with 33% faba bean.

Nagangoud and Yelshetty (1996) stated that seed yield of sunflower generally decreased by defoliation at 50 days after sowing. Abbaspour *et al*, (2001) indicated that plant height, stem diameter, head diameter, harvest index and grain yield of sunflower were decreased as a result of partial or complete leaf excision of sunflower plant when

compared with the undefoliated control (kept unremoval). Muro *et al,* (2001) stated that sunflower yield loss increased with increasing level of defoliation. Moriondo *et al*, (2002) reported that the yield of sunflower plants defoliated during pre-anthesis caused high yield loss. Sunflower was observed to be fairly tolerant of competition with maize (Olanite *et al*, 2002). Beg *et al*, (2003) found that increasing populations of sunflower, from 80,000 to100,000 plants /ha significantly produced high yields. The seed yield of sunflower was reduced under intercropping system sunflower – peanut (*Arachis hipogaea* L.) (Sahoo *et al*, 2003). Mohammed (2006) found that sunflower yield was maximized with no defoliation and followed by 25% leaf defoliation, while the lowest seed yield was obtained when 75% of leaves were defoliated. The highest values of land equivalent ratio and total income were recorded at 25% defoliation of sunflower leaves at milky ripe stage. El Yamani *et al*, (2010) studied two defoliation levels (50 and 75%) of sunflower intercropped with soybean, and found that the highest sunflower yield was obtained from pure stand with no leaf defoliation, whereas the lowest value was obtained when sunflower was intercropped with soybean with 75% leaf defoliation. In addition LER was increased. Osman and Awed (2010) indicated that the highest plant height was obtained from narrow spacing between plants of sunflower (10cm). The highest stem and head diameter, seed husk, and seed yield per plant of sunflower were recorded at wide spacing (30cm). Intercropping not only helps to solve the problem of pulses and oilseed production but also helps to bring additional income to farmers. Besides to get higher benefits with lower cost of cultivation and helps to utilize the growth resources and the time (duration) very efficiently and numerically the land usage can be intensified (Vishwanatha *et al*, 2011).

Little information is available about intercropping sunflower and sugar beet. Among the agronomic practices, optimum plant population plays a major role. The aim of these experiments was to test sunflower as companion crop in association with sugar beet under different plant densities and some sunflower defoliation treatments for high yields of the two crops.

Materials and Methods

Two field trials was conducted in 2009/2010 and 2010/2011 growing seasons in the experimental Research station of the Agriculture Research Center, Giza, Egypt. The trials were conducted to determine the effect of intercropping sunflower (*Helianthus annus* L.) with sugar beet (*Beta vulgaris* L.). Trials were arranged as Randomized Complete Block Design (RCBD) in three replications. Combinations of Three plant density (100%, 80% and 67%) of sunflower plants from pure stand were used. The ratios of intercropped sunflower differed according to hill spacing as follows, 20 cm between hills (100%), 25cm between hills (80%) and 30cm between hills (67%), and four defoliation levels (75, 50, 25% and 0%) of sunflower plants at milk ripe stage were devoted, after 53and 58 days from planting time in the first and second seasons, respectively. in addition to monocultures of sugar beet and sunflower were sown as checks. Sugar beet, as the main crop, was seeded one plant in hills spaced 20 cm on two sides of wide ridges, 120cm apart, both in intercropping and monoculture patterns to achieve full stand of 35,000-plants/ fed. Sunflower (c.v. Giza 102) as a sole crop, was seeded in hills spaced 20 cm apart and one plant per hill on both sides of the ridge, 120cm to achieve full stand 35,000 plants/fed and on the two rows on the top of bedes in all intercropping patterns Sunflower was sown with three seeds in each hill, and the plots were hand-thinned to one plant per hill spaced 20, 25 and 30cm when the plants were at the 4 to 6-leaf stage on two rows on the top of ridge.

Sugar beet (C.V. Kawemire) either in pure or intercropped was sown on 20th and 15th of October in 2009 and 2010 seasons, respectively. Sunflower plants were sown on 20th and 15th in November either in pure or intercropped sowing in the first and second seasons, respectively. Weeds in the rows were removed by hand. The preceding crop was maize (*Zea mays* L.). The chemical and mechanical analysis of the experimental soil is presented in Table 1 was done by Water and Soil Research Institute, A.R.C. using the methods described by Jackson (1958) and Chapman and Pratt (1961).

Table 1. Chemical and mechanical analysis of the experimental soil.

Soil depth	Chemical analysis				Mechanical and analysis			
(cm)	EC (Ds m^{-1})	PH	Organic	Total N %	Sand %	Silt %	Clay %	Texture
0-30	0.85	7.47	1.45	1.58	26.51	1.73	71.76	Clay loam

Calcium super phosphate (15% P_2O_5) was added during seedbed preparation at a rate of 150 kg fed^{-1}. Nitrogen fertilizer was added at the rate of 150 kg N fed.$^{-1}$ in two equal doses in form of ammonium nitrate (33% N) was add at 30 and 45 days from sowing date of sugar beet. Potassium fertilizer was added in form of potassium sulphate (48% K_2O) at rate of 150 kg fed.$^{-1}$ after 45 days from sowing. The other cultural practices were applied for both crops, as recommended. The area of plot was 43.2 m^2 consisting of 6 ridges, each of 6.0 m in length and 1.2 m in width.

The following characters were studied: -

1- Sugar beet:

At 180 days after sowing, sugar beet plants grown on the four inner ridges 4 m long and 1.2 m width (19.2 m^2) of each plot were pulled, topped and counted. Fresh weight and yield of root and top per plant and per fed. were calculated. Root length and diameter were recorded on a random sample of 10 roots. Sucrose percentage was polar metrically determined on a lead acetate extract of fresh macerated root according to the method of Le- Docte (1927). Sugar yield fed.$^{-1}$ was calculated by multiplying root yield/fed by root sucrose percentage.

2-Sunflower:

Sunflower was harvested 95days after sowing (55days before sugar beet harvest). Plant height, leaf area, stem diameter, head diameter and weight of seeds /head were studied. These characters were recorded from the average of five guarded plants from each plot. At maturity, head samples for yield were harvested from the central four ridges, 4 m long and 1.2 m width (19.2 m^2) of each plot and converted to yield fed.-1 seed yield was adjusted to a 10.0% moisture basis.

3-Competitive relationships:

Land equivalent ratio (LER):

LER is the ratio of area needed under sole cropping to that of intercropping at the same management level to produce an equivalent yield according to Willey (1979). It was calculated as follows:

$$LER = Yab / Yaa + Yba / Ybb$$

Where: Yaa and Ybb are the sole crop yields of sugar beet (a) and sunflower (b), respectively. Yab is the intercrop yield of sugar beet (a) when combined with sunflower (b) and Yba is the intercrop yield of sunflower (b) when combined with sugar beet yield (a). LER values may be less, equal or more than 1.0 which, indicate the disadvantage, noadvantage and advantage of the intercropping system, respectively.

Area Time Equivalent Ratio (ATER):

Area time equivalent ratio provides a comparison of the yield advantage of intercropping over monocropping in terms of time taken by component crops in the intercropping systems according to (Hiebsch 1980). ATER was calculated by formula Area time equivalent ratio

$$ATER = (LER_{sugar\ beet} \times Dc + LER_{sunflower} \times Dc) / Dt$$

Where LER is land equivalent ratio of crop, Dc is duration (days) taken by crop, Dt is days taken by whole intercropping system from planting to harvest.

4- Economic evaluation

The total return per feddan from each treatment was calculated in Egyptian pound at market price. The average market price was LE 2750 ton^{-1}for sunflower seeds and LE 263 ton^{-1} for fresh sugar beet roots, as an average of the two seasons. The average of sugar beet and sunflower yield price presented by Agricultural Statistics (2010 and 2011) was used.

Statistical analysis of the collected data was done using MSTATC (1980) software with means comparison by least significant difference test (LSD) using 5% probability levels according to Snedecor and Cochran (1988).

Results and Discussion

A- Growth and yield of sugar beet:

Results presented in Table (2) indicated that all characters of intercropped sugar beet were significantly decreased by intercropping sunflower at different plant densities and defoliation as compared with sugar beet monoculture except sucrose%, in both seasons. In comparison among the intercropping treatments, it was found that intercropping sunflower at 67% of its plant density and at 75% defoliation of its leaves with sugar beet gave the highest values of length, diameter, fresh weight, top fresh weight, yield of roots and sugar ton fed.$^{-1}$, while the lowest values were recorded by intercropping sunflower at 100% of its plant density without leaf defoliation except of sucrose% not significant, in both seasons.

Such results are mainly due to the effect of both intra and inter competition between sugar beet and sunflower plants. Sugar beet plants were shaded by sunflower especially at high sunflower density and low defoliation level, which decreased sugar beet growth traits compared with solid culture. In this concern, Abd El-All, (2002) and Mohammed *et al*, (2005) reported similar results in the intercropping of sugar beet with faba bean.

Table 2: Effects of intercropping sugar beet with sunflower at different plant densities and defoliation levels on growth, yield and yield components and sucrose% of sugar beet during 2009 /2010 and 2010 /2011seasons.

Intercropping system	Sunflower defoliation levels	Root plant $^{-1}$			Top fresh weight	Yield fed.$^{-1}$ ton		Sucrose %
		Length (cm)	Diameter	Fresh weight		Roots	Sugar	
		2009/2010 season						
Sugar beet 100% + 100% Sunflow	0%	18.30	9.23	493.3	215.3	12.53	2.12	16.94
	25%	20.33	9.50	537.7	283.0	15.50	2.61	16.84
	50%	23.00	10.27	599.0	283.7	21.10	3.51	16.63
	75%	23.33	11.27	615.0	310.7	23.33	3.88	16.63
Sugar beet 100% + 80% Sunflower	0%	20.00	9.33	495.0	225.0	14.50	2.43	16.73
	25%	21.00	9.27	568.3	290.0	17.10	2.83	16.53
	50%	22.33	10.77	589.0	315.3	24.07	3.95	16.43
	75%	23.33	11.27	615.0	353.3	23.97	3.92	16.30
Sugar beet 100% + 67% Sunflower	0%	23.67	9.57	553.7	241.3	15.47	2.57	16.63
	25%	24.33	10.20	593.3	270.3	18.43	3.02	16.40
	50%	24.33	11.00	643.7	322.7	23.37	3.76	16.07
	75%	25.00	12.50	761.0	371.7	25.00	3.93	15.73
Sugar beet 100% alone		25.33	12.87	783.7	374.4	30.45	4.90	16.1
LSD at $_{0.05}$		2.67	2.41	78.0	33.7	2.44	0.55	NS
		2010/2011 season						
Sugar beet 100% + 100% Sunflow	0%	17.03	8.43	473.3	206.3	12.59	2.05	16.30
	25%	19.67	9.83	424.1	217.3	15.64	2.53	16.20
	50%	23.03	10.33	544.4	258.0	21.41	3.43	16.00
	75%	24.00	12.67	568.5	286.7	22.75	3.63	15.97
Sugar beet 100% + 80% Sunflower	0%	17.97	9.40	456.7	213.3	14.63	2.35	16.10
	25%	20.73	9.33	425.3	229.0	18.69	2.95	15.80
	50%	23.00	11.00	505.3	270.3	22.12	3.47	15.70
	75%	24.00	11.33	529.7	304.0	23.04	3.59	15.60
Sugar beet 100% + 67% Sunflower	0%	19.73	9.40	466.7	203.0	14.97	2.40	16.03
	25%	22.00	10.60	589.3	268.7	19.36	3.06	15.82
	50%	23.33	11.33	549.3	275.3	24.06	3.71	15.40
	75%	24.67	12.67	616.7	304.3	25.40	3.86	15.20
Sugar beet 100% alone		23.53	13.60	679.0	352.2	29.70	4.72	15.90
LSD at $_{0.05}$		2.58	2.26	75.2	25.2	2.54	0.56	NS

2- Growth and yield of sunflower: -

Results presented in Table (3) indicated that all characters studied of intercropped sunflower, were significantly decreased by intercropping sunflower at different plant densities and leaf defoliation compared with sunflower monoculture except plant height, in both seasons. In comparison among the intercropping treatments, it was found that intercropping sunflower at 67% of its plant density with sugar beet without leaf defoliation gave the highest values of stem diameter, plant leaf area, head diameter and seed/ head, while the lowest values of these traits were recorded by intercropping sunflower at 100% of its plant density and 75% defoliation of its leaves in both seasons.

The response of seed yield fed.$^{-1}$ of intercropped sunflower to plant densities and defoliation levels was different. The yield of seeds of sunflower was increased with increasing sunflower density up to 100% (20cm between plants) without defoliation and the reduction in yield of sunflower was parallel to the decrease of sunflower plant density up to 75% with increasing level of defoliation. This trend may be due to increase of sunflower plants per unit area. Similar results in the intercropping sunflower – peanut (*Arachis hipogaea* L.) were recorded by Sahoo *et al*. (2003).

Maximum leaf area development is necessary for full interception and conversion of solar radiation to efficient photosynthetic activity and carbohydrate accumulation in order to support maximum reproductive development and seed formation. In this concern, Abbaspour *et al*, 2001; Muro *et al*., 2001; Mohammed, 2006 and El-Yamni *et al*, 2010 reported similar conclusion.

Table 3: Effect of intercropping sugar beet with sunflower at different plant densities and defoliation levels on growth, yield and yield components of sunflower plants during 2009/2010 and 2010/2011seasons.

Intercropping system	Sunflower defoliation levels	Plant height (cm)	Stem diameter (cm)	Leave area plant (cm^2)	Head diameter (cm)	Seeds yield $head^{-1}$ (g)	Seed yield fed. (kg^{-1})
		2009/2010 season					
Sugar beet + 100%Sunflower	0%	132.7	2.66	333.0	18.27	57.63	1103.0
	25%	129.0	2.59	319.7	17.20	53.33	1021.3
	50%	125.7	2.57	314.3	17.00	48.27	947.7
	75%	125.0	2.32	300.3	16.03	47.60	853.7
Sugar beet + 80% Sunflower	0%	135.7	2.95	371.3	18.40	63.10	901.7
	25%	134.3	2.91	343.3	17.43	54.67	865.7
	50%	131.3	2.60	334.7	16.67	50.47	853.3
	75%	127.7	2.55	339.0	16.47	48.17	753.0
Sugar beet + 67% Sunflower	0%	143.0	3.14	406.7	19.27	68.00	853.3
	25%	142.3	3.10	392.3	18.70	64.10	794.0
	50%	138.3	2.88	384.3	17.70	61.10	779.3
	75%	133.7	2.59	363.3	17.73	59.80	739.3
Sunflower 100% alone		139.1	3.24	391.2	20.90	63.77	1195.3
LSD at 0.05		NS	0.53	53.8	1.84	10.75	193.4
		2010/2011 season					
Sugar beet + 100%Sunflower	0%	132.7	2.40	334.7	17.70	58.70	1155.0
	25%	130.7	2.39	328.4	17.13	53.80	1079.7
	50%	129.0	2.36	314.3	16.47	53.00	983.0
	75%	127.3	2.22	306.3	15.70	50.10	893.3
Sugar beet + 80% Sunflower	0%	136.0	2.82	362.0	18.37	63.10	964.7
	25%	136.7	2.74	351.0	18.30	56.23	931.3
	50%	137.7	2.68	350.3	17.27	56.00	894.0
	75%	135.3	2.66	342.7	16.80	53.90	832.0
Sugar beet + 67% Sunflower	0%	144.7	2.97	398.7	19.27	67.37	890.3
	25%	146.0	2.95	390.7	18.43	63.57	845.0
	50%	142.7	2.67	373.7	18.27	61.90	845.7
	75%	141.0	2.54	372.7	17.67	59.97	783.3
Sunflower 100% alone		145.3	2.93	392.7	21.43	64.43	1236.7
LSD at 0.05		NS	0.43	39.4	2.59	10.30	192.0

C- Competitive relationships: -

1- Land equivalent ratio (LER)

Results in Table (4) showed that the land equivalent ratio revealed the merits and demerits of intercropping system. All intercropping treatments of sunflower at plant density and different defoliation % with sugar beet recorded higher land equivalent ratio over sole cropping. Higher land equivalent ratio (1.51) averages of two seasons was obtained when sugar beet was intercropped with sunflower plant at 80% of the recommended plant density (25cm apart) and 50% defoliation of sunflower leaves. Similar results were recorded by Sahoo *et al,* (2003), Mohammed (2006) and El Yamani et al, (2010).

2- Area time equivalent ratio (ATER)

Higher area time equivalent ratio (1.17) was obtained when sunflower was intercropped with sugar beet at 80% of the recommended plant density and 50% defoliation leaves of sunflower plants as averages of two seasons. These values indicated that intercropping system was highly efficient in utilizing the growth resources than sole cropping of both crops, (Table 4). Whereas, intercropping sunflower with sugar beet, at 67% of the recommended plant density (25cm apart) without defoliation leaves of sunflower, recorded the lowest values of ATER (0.88) as an average of the two successive seasons. Similar results of higher LER and ATER were reported by several workers by Nagangound *et al* (1996), Olanite *et al* (2002) and Verma *et al,* (2005).

D – Total economic:

The data in Table (4) indicated that the highest value of total income (8729 L.E.) was recorded when sugar beet was intercropped with sunflower at 80% of the recommended plant density (25cm apart) and

at 50% of sunflower leaves defoliated, over the two seasons. However, the lowest value of total income (6397 and 6399 L.E.) were recorded when sugar beet was intercropped with sunflower at 80% or 67% of the recommended plant density (25cm and 30cm apart) and without leaves defoliation of sunflower plants over both seasons. In the respect high return was reported when sunflower was intercropped with groundnut (over sole cropping) as reported by Patil *et al*. (2007).

Table 4. Productivity, land equivalent ratio (LER), area time equivalent ratio (ATER) and total economic of intercropped sugar beet and sunflower as influenced by some defoliation treatments and different plant density of sunflower plants (average of 2010 and 2011 seasons).

Intercropping system	Defoliation level	Land equivalent ratio (LER)			ATER	Total economic		
		L_a	L_b	LER		Sugar beet	Sunflower	Total
Sugar beet + 100%Sunflower	Zero	0.42	0.93	1.36	0.91	3303.0	3104.8	6407.8
	25	0.52	0.86	1.38	0.97	4094.7	2888.9	6983.6
	50	0.71	0.79	1.50	1.13	5590.2	2654.7	8244.9
	75	0.77	0.72	1.48	1.15	6060.4	2402.1	8462.5
Sugar beet + 80% Sunflower	Zero	0.48	0.77	1.25	0.89	3830.8	2566.2	6397.0
	25	0.60	0.74	1.33	0.99	4706.7	2470.9	7177.6
	50	0.79	0.72	1.51	1.17	6326.8	2402.6	8729.4
	75	0.82	0.65	1.47	1.16	6443.8	2179.4	8623.2
Sugar beet + 67% Sunflower	Zero	0.51	0.72	1.22	0.88	4002.1	2397.5	6399.6
	25	0.63	0.67	1.30	0.98	4970.3	2253.6	7223.9
	50	0.79	0.67	1.46	1.14	6236.9	2234.4	8471.3
	75	0.84	0.63	1.48	1.16	6627.6	2093.7	8721.3
Solid sugar beet		1	---	1	1	7911.0	---	7911.0
Solid sunflower		---	1	1	1	---	3344.0	3344.0

L.E 263 ton^{-1} of fresh sugar beet roots and, L.E 2750 ton^{-1} of sunflower, (Feddan = 4200 m^2).

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تأثير تحميل زهرة الشمس مع بنجر السكر تحت معاملات كثافات نباتية وتوريق مختلفة على المحصول وكفاءة الانتاج الكلى للمحصولين

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أجريت تجربتان حقليتان خلال الموسمين الشتويين 2010/2009 و2011/2010 في محطة البحوث والتجارب الزراعية – مركز البحوث الزراعية – جيزة لدراسة تأثير الشمس مع بنجر السكر تحت ثلاث مختلفة من زهرة الشمس 100%, 80%,67% من الكثافة النباتية الموصى بها (35 ألف نبات/ فدان) وأربعة مستويات من التوريق لنبات لزهرة الشمس عند مرحلة الطور اللبني (75، 50، 25 % وبدون توريق) وذلك على النمو والمحصول لكلا المحصولين وعلى النسبة الئوية للسكروز لبنجر السكر. هذا وقد تم زراعة بنجر السكر (صنف Kawemire) أولا على جانبى الخط (عرض 120 سم) ثم بعد شهر من زراعة بنجر السكر تم زراعة زهرة الشمس (صنف جيزة 102) فى سطرين على ظهر الخط. واشتملت كل تجربة 12 معاملة بالإضافة الى زراعة كل من بنجر السكر و زهرة الشمس كزراعة منفرده للمقارنة. وتم استخدام تصميم القطاعات الكاملة العشوائية فى ثلاث مكررات1.

ويمكن ايجاز اهم النتائج المتحصل عليها كالتالي: –

1– أعطى نظام التحميل 100% بنجر السكر + 67% زهرة الشمس ومعدل التوريق 75% أعلى قيمة لمحصول الفدان من الجذور والسكر لبنجر السكر في الموسمين في حين أعطي تحميل 100% بنجر السكر + 100% زهرة الشمس بدون توريق أقل قيمة وذلك مقارنة بمحصول بنجر السكر المنفرد لموسمي الزراعة.

2– أظهرت النتائج المتحصل عليها أن نظام التحميل 100% بنجر السكر + 100% زهرة الشمس بدون توريق أعطى أعلى قيمة لمحصول البذور للفدان من زهرة الشمس في الموسمين في حين أعطي تحميل 100% بنجر السكر + 67% زهرة الشمس ومعدل التوريق 75% أقل محصول مقارنة بمحصول زهرة الشمس المنفرد خلال موسمي الزراعة.

3– أعطى تحميل100% بنجر السكر مع زهرة الشمس بكثافة نباتية 80% من الكثافة الموصى بها و معدل التوريق 50% لزهرة الشمس أعلا قيم لمعامل كفاءة استغلال الأرض (1.51 كمتوسط للموسمين) مقارنة بمعاملات التحميل الاخرى والزراعة المنفردة لكلا المحصولين وكذلك أعطى أعلا القيم لمعدل الدخل الكلى (8729.4 جنيه كمتوسط للفدان للموسمين) وذلك مقارنة لمعدل الدخل للزراعات المنفردة لكلى المحصولين(7911 جنيه كمتوسط لفدان بنجر السكر, 3344 جنيه كمتوسط لفدان زهرة الشمس).