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CROPS MANAGEMENT FOR INTERCROPPING SUGAR BEET WITH SOME ESSENTIAL CROPS TO MAXIMIZE AREA UNIT PRODUCTIVITY

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ABSTRACT

Two Field experiments were conducted at shandaweel Experimental station during 2000/2001 and 2001/2002 seasons to evaluate the effect of intercropping sugar beet with onion, chickpea and faba bean under different ridges width (60, 80 and 120 cm.) on yield and yield components of sugar beet. The experimental design was split plots with four replications.

The most important results could be summarized as follow:

- 1- Yield of sugar beet was significantly reduced by intercropping, and when intercropping with faba bean was more reducing compared with pure stand in both seasons. Yield and yield components of sugar beet grown on wide ridges were higher than that grown on narrow ridges. Sugar beet grown pure stand on wide ridges (120 cm.) had the highest values, while the lowest values were observed when intercropping with faba bean on narrow ridges (60 cm.).
- 2- Chemical characters of sugar beet i.e. T. S. S. %, sucrose % and purity % were affected by ridges width and intercropped crops.
- 3- Onion pure stand or intercropped on ridges 120 cm. gave higher values than ridges 60 and 80 cm. width. Bulb yield t / fed. was significantly decreased by intercropping in both seasons.
- 4- Chickpea seed yield / fed. was significantly decreased by intercropping in both seasons compared with pure stand. The treatment of 120 cm. ridge width gave higher values of seed yield / fed. as solid or intercropped with sugar beet.
- 5- Yield of faba bean grown as solid on narrower ridges (60 cm.) were higher than it grown on wider ridges (120 cm.). While intercropped faba bean grown on wider ridges (120 cm.) was higher than it grow on narrower ridges (60 cm.).
- 6- The highest value for L.E.R. was 1.55 when intercropping sugar beet with onion under wide of ridge 80 cm followed by 1.52 under 120 cm while the lowest values observed when intercropping sugar beet with faba bean were 1.13 , 1.08 under wide of ridge 60 cm in the first and second seasons, respectively.
- 7- Intercropped chickpea with sugar beet in ridges 120 cm. increased gross and benefit and profitability by L.E. 756, 482 and 10.2 % respectively than that of pure stand sugar beet in wide ridges 120 cm..

INTRODUCTION

Agricultural intensification is considered to be one of the important ways of solving or decreasing the large gap between the production and consumption of food products. In such cases intercropping would help farmers getting annual income within the growing season. Some farmers started to plant faba bean in an irregular arrangement in sugar beet fields. Sugar beet yield was not significantly reduced by intercropping with faba bean, and raised the total income. (Nour and Farage 1984, Farrage 1990 and El-Borai and Radi 1993). Amer, *et al* 1997 found that sugar beet quality as

expressed in sucrose %, T.S.S. % and purity % was not affected with intercropping, but reduced significantly beet root and sugar yields / fed.. Intercropping increased significantly no. of branches, pods and seeds / plant as well as seed yield of faba bean plant. Hussein and El-Deeb, 1999, found that the highest seed yield was obtained when intercropped faba bean with 6 or 8 plants / m² and chickepea with 17 plants / m². Intercropped faba bean at 4 plants / m² with sugar beet increased profitability by L.E 12.5 %, than that of solid sugar beet. Toaima, *et al*; 2001. found that the treatment of 60 cm width recorded higher yield, yield components and chemical analysis of sugar beet in solid crop or intercrop than 120 cm width. Higher yield was obtained with the intercropping system of 120 cm width for L.E.R. (1.56, 1.56) 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.

Aggressivity (Agg) for sugar beet was dominant in both intercropping systems, whereas for onion or garlic it was dominated. El-Kafoury *et al*; (1993) and El-Naggar *et al*; (1996) reported that onion as intercropped with cotton on rows 60 cm wide gave lower growth and yield, compared with growing on ridge 120 cm and both systems were lower than solid crop.

The present investigate is aiming to evaluate the effect of intercropping systems onion, chickepea and faba bean under different ridge width on yield, its components and chemical analysis of sugar beet.

MATERIAL AND METHODS

Two field trials were carried out at shandaweel Agriculture Research Station in Sohag governorate during two successive seasons 2000/2001 and 2001/2002 to investigate the effect of intercropping sugar beet (variety sugar 1) with three crops [onion (Giza 6), chickepea (Giza 3) and faba bean (Giza 674)] under different plant densities on yield and its components. The experimental design was split plots with four replications. The main plots were arranged to three ridges width i.e. 0.60, 0.80 and 1.20 m. The sub plots were including intercropping treatments, the treatments are shown in table (1). The plot area was 28.8 m² each plot included 8, 6 or 4 ridges in 0.60, 0.80 and 1.20 m. width.

The preceding crops was maize in the two seasons. Data of sowing and harvesting for the four crops recorded in table (2).

Normal cultural practices were applied for crops under study either in pure stand or intercropped as recommended for each region were applied according to the recommended rate of sugar beet (70 Kg N + 30 Kg P₂O₅ + 24 Kg K₂O / fed.), onion (120 Kg N / fed.), chickepea (15 Kg N / fed.) and faba bean (15 Kg N / fed.). Super phosphate was added during soil preparation. Nitrogen fertilizer was applied in the form of ammonium nitrate 33.5 % N in two equal doses. The first was 45 Kg N / fed. applied after thinning of sugar beet and the second after 75 days from sowing in both seasons Nitrogen fertilizer was applied during planting to chickepea and faba bean in both seasons but nitrogen fertilizer was applied to onion in these equal doses. The first was 30 Kg N / fed. applied during planting, the second

dose 45 Kg N / fed. after one month from planting and third dose 45 Kg N /fed. after one month later.

Table (1) Intercropping treatments (sowing methods, plant density/fed. and spacing between hills) of the four crops (sugar beet, onion, chickpea and faba bean) of soled and intercropping.

		Ridge width		
Crops	Intercropping crops	0.60 m	0.80 m	1.20 m
Sugar beet	Solo or intercropped	One row on one side of the ridges and distance between hills 20cm (35.000 plant/fed)	Two rows on both sides of the ridges and distance between hills 30cm (35.000 plant/fed)	Two rows on both sides of the ridges and distance between hills 20cm (35.000 plant/fed)
Onion	Solo	Three rows on both sides and top of the ridges and distance between seedlings 10cm (210.000 plant/fed)	Four rows on both sides and top of the ridges and distance between rows 20 cm and distance between seedlings 10cm (210.000 plant/fed)	Six rows on both sides and top of the ridges and between rows 20 cm and distance between seedlings 10cm (210.000 plant/fed)
	Intercropped	One row on the other side of the ridges and distance between seedlings was 10 cm (70.000 plant/fed)	Two rows on the top of the ridges and between rows 20 cm and distance between seedlings was 15cm (70.000 plant/fed)	On two rows the top of the ridges and between rows 20 cm and distance between seedlings was 10cm (70.000 plant/fed)
Chickpea	Solo	On both sides of the ridges and distance between hills 10 cm (140.000 plant/fed)	Four rows on both sides and top of the ridges and distance between hills 15cm (140.000 plant/fed)	Four rows on both sides and top of the ridges and between rows 20cm and distance between hills 10cm (140.000 plant/fed)
	Intercropped	One row on the other side of the ridges and distance between hills 10cm (70.000 plant/fed)	Two rows on the top of the ridges and distance between hills 15 cm (70.000 plant/fed)	Two rows on the top of the ridges between rows 20 cm and distance between hills 10 cm (70.000 plant/fed)
Faba bean	Solo	Two rows on both sides of the ridges and distance between hills 20cm, two plants /hill (140.000 plant/fed)	Two rows on both sides of the ridges and distance between hills 15 cm, two plants / hill (140.000 plant/fed)	Four rows on both sides and top of the ridges and between rows 20cm and between hills 20 cm, two plants / hill (140.000 plant/fed)
	Intercropped	One row on the other side of the ridges and between hills 20cm, two plants / hill (70.000 plant/fed)	Two rows on the top of the ridges between rows 20 cm and between hills 15cm (70.000 plant/fed)	Two rows on the top of the ridges between rows 20cm and between rows 20cm and hills 20cm, two plants/hill (70.000 plant/fed)

Table (2): Sowing and harvesting dates of sugar beet, onion, chickpea and faba bean.

Season	Sowing date				Harvesting date			
	S. beet	Onion	Chickepea	F. bean	S. beet	Onion	Chickepea	F. bean
2000/2001	Oct. 18	Nov. 8	Nov. 8	Oct. 18	May. 20	Apr. 28	Apr. 26	Apr. 26
2001/2002	Oct. 23	Nov. 12	Nov. 12	Oct. 23	May. 23	May. 3	Apr. 30	Apr. 30

Ten plants from each crop were chosen randomly to determine yield parameters. While the yield / fed. was determined from the whole plot.

Sugar beet:

Top fresh weight, weight of root, root length, root diameter and total yield. Quality attributes: A fresh sample was taken from fresh roots of beet plants representage each treatment to determine the following: total soluble solid percentage (T.S.S. %) was measured by using hand refractometer according to A.O.A.C. (1984); sucrose % by saccharometer according to Le-Docte (1927); and purity % calculated as (% sucrose by T.S.S.) × 100.

Onion : Plant height, bulb diameter, bulb weight, total bulb yield and weight of culls.

Chickepea: Plant height, number of branches, number of pods / plant, weight of 100 seed (g.), seed yield / plant and seed yield ardab/ fed..

Faba bean: Plant height, number of branches and number of pods / plant, weight of 100 seed (g.), seed yield / plant and seed yield ardab/ fed..

Competitive relationships:

Land Equivalent Ratio (LER), Relative Crowding Coefficient (K) and Aggressivity (Agg.) were calculated according to Willey (1979), Dewit (1960) and Mc-Gilchrist (1974), respectively.

$$LER = (y_{so} \text{ or } y_{sc} \text{ or } y_{sf} / y_{ss}) + (y_{os} \text{ or } y_{cs} \text{ or } y_{fs} / y_{oo} \text{ or } y_{cc} \text{ or } y_{ff})$$

Where:

y_{so} or y_{sc} or y_{sf} = yield intercrop of sugar beet with onion or chickepea or faba bean.

y_{os} or y_{cs} or y_{fs} = yield intercrop of onion or chickepea or faba bean with sugar beet.

y_{ss} = yield puree stand of sugar beet.

y_{oo} or y_{cc} or y_{ff} = yield puree stand of onion or chickepea or faba bean.

$K = K_1 \times K_2$, where:

$$K_1 = [y_{so} \text{ or } y_{sc} \text{ or } y_{sf} \times \% Z_2] / [(y_{ss} - y_{so} \text{ or } y_{sc} \text{ or } y_{sf}) \times \% Z_1]$$

$$K_2 = [y_{os} \text{ or } y_{cs} \text{ or } y_{fs} \times \% Z_1] / [(y_{oo} \text{ or } y_{cc} \text{ or } y_{ff} - y_{os} \text{ or } y_{cs} \text{ or } y_{fs}) \times \% Z_2]$$

and

$\% Z_1$ = Area occupied by sugar beet.

$\% Z_2$ = Area occupied by onion or chickepea or faba bean.

Agg = $A_1 - A_2$ for sugar beet $A_2 - A_1$ for onion or chickepea

$$A_1 (\text{Sugar beet}) = [y_{so} \text{ or } y_{sc} \text{ or } y_{sf} / (y_{ss} \times \% Z_1)] - [y_{os} \text{ or } y_{cs} \text{ or } y_{fs} / (y_{oo} \text{ or } y_{cc} \text{ or } y_{ff} \times \% Z_2)]$$

$$A_2 (\text{onion or chickpea or faba bean}) = [y_{os} \text{ or } y_{cs} \text{ or } y_{fs} / (y_{oo} \text{ or } y_{cc} \text{ or } y_{ff} \times \% Z_2)] - [y_{so} \text{ or } y_{sc} \text{ or } y_{sf} / (y_{ss} \times \% Z_1)]$$

Economical evaluation:

The total income from each treatment was calculated in Egyptian pound (L.E.) / ton in sugar beet and onion and Egyptian pound / ardab in chickepea and faba bean. Average sugar beet price was L.E. 100 per ton, a Average onion price was L.E. 216.5 per ton, average faba bean and chickepea seed

prices were L.E. 195 and 344.4 per ardab respectively and average faba bean and chickepea straw prices L.E. 80 per ton, for each according to ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics.*

Moreover, profitability was calculated for each treatment according to the following formula:

$$\text{Profitability} = [(\text{Net benefit} / \text{Total variable cost}) \times 100]$$

Statistical analysis was applied to data according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

I- Sugar beet :

a- Effect of ridge width on sugar beet:

Data in Table (1) show the effect of ridge width on growth productivity and quality of sugar beet in both seasons. Results revealed that ridge width had significant effects on top fresh weight, weight of root / plant, root length and root diameter in both seasons and root yield/fed. in first season. These characters were higher when sugar beet plants were grown on wider ridges (120 cm) than that grown on narrower ridges (60 and 80 cm). The weight of top fresh, root of plant and root yield / fed. of sugar beet grown on wider ridges (120 cm) were 117, 109 % for top, 130, 108 % for weight of root and 105, 104 % for root yield / fed. over that grown on narrower ridge (60 cm) in both seasons, respectively. These results are in harmony with those obtained by Toaima, *et al.*; (2001). As for chemical characters of sugar beet T.S.S. %, sucrose % and purity % were significantly affected by ridge width in both season.

Sucrose % was higher when sugar beet plants was grown on wider ridges (120 cm) than that at narrower ridges (60 and 80 cm) while purity % was higher when sugar beet grown on 80 cm ridges than that sugar beet grown on 60 or 120 cm ridges in both seasons. These results are in agreement with those obtained by Amer *et. al.*,(1997).

b- Effect of intercropped crops on yield, yield components and chemical analysis of sugar beet:

Data in table (1) demonstrate that yield, yield components and chemical characters of sugar beet were significantly effected by intercropped crops in both seasons. Top fresh weight, root weight/plant, root length, root diameter and root yield / fed. were more affected when intercropped with faba bean as compared with other intercropped crops. The reduction of the characters were 39, 41 % for top fresh weight, 29,28 % for weight of root, 14,15 % for root length and 12,15 % for root diameter of puree stand in both seasons, respectively.

* Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics, Volume 2, March 2002 pp. 113,114.

Root yield/fed. of sugar beet intercropping with onion, chickpea or faba bean were 89.38, 82.03 and 82.38% in the first season and 91.14, 85.26 and 80.42 % in the second season, respectively compared with sugar beet pure stand.

Table (1): Effect of ridge width and intercropping of some field crops on yield, its components and chemical analysis of sugar beet.

Characters Treatments	Top fresh weight (g)	Wieght of root / plant (g)	Root length (cm)	Root diameter (cm)	Root Yield ton / fed.	T.S.S. %	Sucrose %	Purity %
2000/2001								
Ridge width								
60 cm	192.8	624.0	25.23	28.37	25.21	16.01	12.88	82.00
80 cm	233.7	753.9	25.23	28.31	25.26	15.58	12.48	82.25
120 cm	226.1	815.7	26.34	29.55	26.48	16.28	13.28	81.98
L.S.D. (0.05)	7.3	6.3	0.46	0.42	0.40	0.20	0.25	N.S.
2001/2002								
60 cm	209.6	760.5	25.43	28.13	25.62	16.02	12.88	82.03
80 cm	234.8	768.8	25.28	28.06	25.59	15.43	12.47	82.69
120 cm	228.9	827.7	26.62	29.64	26.55	16.23	12.98	81.84
L.S.D. (0.05)	3.1	13.5	0.40	0.69	N.S.	0.24	0.27	0.22
2000/2001								
Intercropped crops								
S. beet pure stand (T ₁)	290.0	898.1	27.10	30.46	29.00	16.39	12.98	81.90
S. beet + onion (T ₂)	214.4	833.3	26.69	29.59	25.92	15.80	12.98	82.03
S. beet +chick pea (T ₃)	189.4	728.9	25.24	28.17	23.79	15.73	12.83	81.77
S. beet + faba bean (T ₄)	176.1	635.7	23.37	26.76	23.89	15.90	12.71	82.61
L.S.D. (0.05)	10.5	5.9	0.19	0.27	0.52	0.23	0.16	0.36
2001/2002								
S. beet pure stand (T ₁)	317.0	905.0	27.47	30.37	29.11	16.22	13.04	82.06
S. beet + onion (T ₂)	201.8	836.3	26.89	29.84	26.53	15.74	12.73	82.58
S. beet +chick pea (T ₃)	192.9	749.9	25.32	28.28	24.82	15.79	12.80	82.03
S. beet + faba bean (T ₄)	186.1	651.3	23.42	25.96	23.41	15.81	12.52	82.09
L.S.D. (0.05)	7.8	7.6	0.27	0.41	0.38	0.21	0.21	0.27

Regarding to chemical characters of T.S.S %, sucrose % and purity % were significantly affected by intercropped onion, chickpea or faba bean in both seasons. Intercropping onion, chickpea or faba bean significantly decreased T.S.S % and sucrose % compared with puree stand sugar beet in the two seasons. While purity % behaved the opposite in both seasons.

These results are in agreement with those obtained by Amer *et. al.*, (1997) and Toaima *et. al.*, (2001).

C- Effect of interaction on sugar beet:

The interaction between ridges width and intercropped crops had significant effects on all studies characters except root length and root yield / fed. in the first season and purity % in the second season.(Table 2).

Table (2): Effect interaction of intercropped crops × Ridge width on yield and its components of sugar beet.

Characters		Top fresh weight (g)	Weight of root/ plant (g)	Root length (cm)	Root diameter (cm)	Yield ton/ fed	Purity %
Treatments	Ridge width						
2000/2001							
60 cm	S. beet pure stand (T ₁)	233.3	885.0	26.80	29.90	28.50	82.03
	S. beet + onion (T ₂)	191.7	780.0	26.17	28.93	25.63	81.63
	S. beet +chick pea (T ₃)	178.3	720.7	24.87	28.30	23.27	81.43
	S. beet + faba bean (T ₄)	167.7	624.0	23.07	26.33	23.43	82.90
80 cm	S. beet pure stand (T ₁)	308.3	847.7	26.77	29.80	28.33	81.87
	S. beet + onion (T ₂)	240.0	853.3	26.50	29.03	25.03	82.67
	S. beet +chick pea (T ₃)	201.7	705.0	24.83	27.67	23.60	82.03
	S. beet + faba bean (T ₄)	184.0	609.7	22.83	26.73	24.07	82.43
120 cm	S. beet pure stand (T ₁)	328.3	961.7	27.73	31.67	30.17	81.80
	S. beet + onion (T ₂)	211.7	866.7	27.40	30.80	27.10	81.80
	S. beet +chick pea (T ₃)	188.3	761.0	26.03	28.53	24.50	81.83
	S. beet + faba bean (T ₄)	176.0	673.3	24.20	27.20	24.17	82.50
L.S.D. (0.05)		18.3	10.19	N.S.	0.46	N.S.	0.62
2001/2002							
60 cm	S. beet pure stand (T ₁)	296.7	901.7	27.43	29.77	28.57	81.90
	S. beet + onion (T ₂)	182.0	773.0	26.47	29.40	26.27	82.33
	S. beet +chick pea (T ₃)	186.0	733.3	24.80	28.23	24.50	81.90
	S. beet + faba bean (T ₄)	173.7	634.0	23.03	25.13	23.17	82.00
80 cm	S. beet pure stand (T ₁)	324.3	851.7	26.93	29.43	28.47	82.50
	S. beet + onion (T ₂)	209.0	860.0	26.13	29.03	26.13	83.07
	S. beet +chick pea (T ₃)	205.0	728.3	24.96	27.67	24.20	82.53
	S. beet + faba bean (T ₄)	201.0	635.0	23.07	26.10	23.57	82.67
120 cm	S. beet pure stand (T ₁)	330.0	961.7	28.03	31.90	30.30	81.77
	S. beet + onion (T ₂)	214.3	876.0	28.07	31.10	27.20	82.33
	S. beet +chick pea (T ₃)	187.7	788.0	26.20	28.93	25.20	81.67
	S. beet + faba bean (T ₄)	183.7	685.0	24.17	26.63	23.50	81.60
L.S.D. (0.05)		13.5	13.2	0.47	0.71	0.66	N.S.

The highest values of these characters were observed when sugar beet grown pure stand on wider ridges (120 cm). The lowest values were observed when sugar beet intercropped with faba bean on narrower ridges (60 cm) in both seasons. Sugar beet intercropped with onion had the highest values especial that grown on width ridges (120 cm), compared with the intercropping treatments. While sugar beet intercropped with faba bean had the lowest values compared the other intercropping treatments. Similar results was obtained by Toaima *et. al.*,(2001).

II-Effect of the intercropping on intercropped crops:

1- Onion:

Data in Table (3) show effect of ridge width and intercropping on yield and yield components of onion. Plant height, bulb diameter, bulb weight, bulb yield ton/fed. and marketable yield (ton/fed.) were increased with increasing ridge width in both seasons.

Table (3): Effect of ridge width and intercropping onion with sugar beet on yield and its components of onion.

Characters Treatments	Plant height (cm.)	Bulb diameter (mm)	Bulb weight (g)	Bulb yield ton /fed.	Culls ton / fed.	Marketable yield ton / fed	T.S.S. %
Ridge width							
2000/2001 season							
60 cm	46.15	46.95	93.47	6.89	1.033	5.858	16.28
80cm	47.03	48.12	93.67	7.44	0.937	6.673	16.27
120 cm	48.07	49.43	96.85	7.73	1.038	6.688	15.65
L.S.D (0.05)	0.30	1.09	1.17	0.37	0.049	0.105	N.S.
2001/2002 season							
60 cm	46.08	47.13	91.97	6.87	1.040	5.828	16.53
80cm	46.97	48.40	92.38	7.68	1.040	6.723	16.18
120 cm	47.85	49.53	94.93	7.85	1.117	6.732	15.65
L.S.D (0.05)	0.81	0.22	0.42	0.26	N.S.	0.286	0.27
intercropping onion							
2000/2001 season							
Onion pure stand	47.38	48.73	92.34	9.25	1.110	8.024	15.96
Onion with S. beet	46.79	47.60	96.98	5.46	0.896	4.789	16.17
L.S.D (0.05)	0.44	0.94	0.56	0.22	0.068	0.283	0.29
2001/2002 season							
Onion pure stand	47.12	48.87	91.72	9.38	1.227	8.169	16.15
Onion with S. beet	46.81	47.84	94.47	5.55	0.904	4.687	16.08
L.S.D (0.05)	N.S.	0.38	0.32	0.22	0.050	0.219	N.S.,

The highest values of these characters were observed when onion grown on wider ridges (120 cm), whereas, the lowest observed when onion was grown on narrower ridges (60 cm) in both seasons. Similar results were obtained by Toaima, *et. al.*, (2001). T.S.S% was decreased with increasing width from 60 to 120 cm. These results were in harmony with those obtained by Amer, *et. al.*, (1997).

Data show, also, that yield, yield components and chemical characters of onion were decreased by intercropping except bulb weight compared with pure stand in both seasons. Bulb yield of intercropped was equal 41% of pure stand while bulb weight of intercropping onion was heavier than pure stand in the both seasons.

The interaction between the intercropping and ridge width had significant effects on bulb weight, bulb yield ton / fed., culls ton / fed. and marketable yield ton / fed. in both seasons (table 4). Bulb weight of intercropping onion was higher than that grown pure stand, while bulb yield / fed. was equal half of pure stand in both seasons. The highest value of bulb weight was obtained in intercropping onion grown on wider ridges (120 cm), whereas the lowest value was obtained in pure stand and grown on narrower ridges (60 cm) in both seasons. Onion of pure stand or intercropping grown on wider ridge (120 cm) had higher than narrower ridges (60 or 80 cm). These results are in agreement with those obtained by El-Kafoury *et. al.*, (1993) and El-Naggar *et. al.*, (1996).

Table (4): Effect of intercropped onion × Ridge width on bulb weight, bulb yield ton / fed., culls ton / fed., marketable yield ton / fed.

Characters		Bulb weight (g)		Bulb yield ton / fed.		Culls ton / fed.		Marketable yield ton / fed.	
Treatments									
Ridge width	Intercropping crops								
		2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02
60 cm	Onion pure stand	90.47	90.60	9.00	9.00	1.157	1.133	7.847	7.867
	Onion with S. beet	93.17	96.20	4.73	4.78	0.923	0.933	3.810	3.850
80 cm	Onion pure stand	90.77	90.73	9.10	8.78	1.157	0.993	7.977	7.457
	Onion with S. beet	94.30	96.73	5.65	5.50	0.867	0.873	4.780	4.627
120 cm	Onion pure stand	93.93	95.70	10.05	9.95	1.367	1.203	8.683	8.750
	Onion with S. beet	95.93	98.00	6.27	6.10	0.923	0.880	5.470	5.890
L.S.D. (0.05)		0.56	0.97	0.39	0.36	0.080	0.118	0.380	0.490

2- Chickpea:

Data in table (5) show the highest values of all studies characters of chickpea were obtained when grown on wider ridge (120 cm) while, the lowest value were observed on narrower ridge (60 cm) in both seasons. The seed yield of chickpea grown on 60 and 80 cm were 91.34 and 92.2 % in first season and 90.5 and 92.3 % in second seasons of that grown on wider ridges (120 cm). These results were in harmony with those obtained by El-Kafoury *et. al.*, (1993) and El-Naggar *et. al.*, (1996) who found higher yield and yield components.

Data in table (5) show also that all characters studied of chickpea were significantly affected by intercropping in both seasons. Plant height,

number branches / plant, number pods / plant, weight / 100 seed, seed yield / plant and seed yield / fed. were significantly decreased by intercropping compared with pure stand.

Table (5): Effect of ridge width and intercropping chickpea with sugar beet on yield and its components of chickpea.

Characters Treatments	Plant height (cm.)	Number branches / plant	Number of pods / plant	Weight of 100 - seed (g)	Seed yield / plant (g.)	Seed yield ardab / fed.
Ridge width						
2000/2001 season						
60 cm	84.35	5.80	27.25	14.46	24.6	4.22
80cm	90.20	6.64	29.00	15.08	26.3	4.26
120 cm	92.02	7.13	34.75	16.69	35.0	4.62
L.S.D (0.05)	1.16	0.39	0.35	0.49	0.08	0.18
2001/2002 season						
60 cm	84.68	5.81	28.02	15.04	24.7	4.38
80cm	89.10	6.62	30.05	16.03	26.5	4.47
120 cm	89.75	7.43	36.35	17.96	35.9	4.84
L.S.D (0.05)	0.93	0.20	0.23	0.74	0.08	0.11
intercropping chickpea						
2000/2001 season						
chikpea pure stand (T.)	91.62	6.91	34.52	16.23	29.4	5.55
chickpea with S. beet	86.09	6.14	29.50	14.59	27.8	3.17
L.S.D (0.05)	1.03	0.22	0.24	0.51	0.09	0.12
2001/2002 season						
chikpea pure stand (T.)	89.10	7.13	35.93	16.57	30.1	5.77
chickpea with S. beet	86.59	6.10	30.39	16.12	28.0	3.38
L.S.D (0.05)	0.22	0.08	0.17	0.34	0.12	0.14

The interaction between intercropping and ridge width had significant effect on all studies characters (table 6). The highest values were observed with pure stand grown on wider ridges (120 cm) and the lowest values were observed in intercropping chickpea grown narrower ridge (60 cm) in both seasons. Seed yield of chickpea intercropping with sugar beet and grown on 60, 80 and 120 cm were 54.68, 55.29 and 61.1 % in first season and 55.32,

55.75 and 63.07 % second season of pure stand, respectively. These results are in agreement with those obtained by El-Kafoury *et. al.* , (1993) and El-Naggar *et. al.*, (1996).

Table (6): Effect of interaction of intercropped chickpea × Ridge width on plant height, number branches / plant, number pods / plant and seed yield ardab / fed.

Characters		Plant height (cm)		Number branches / plant		Number pods / plant		Seed yield ardab / fed.	
Ridge width	intercropping crops	2000 / 2001	2001 / 2002	2000 / 2001	2001 / 2002	2000 / 2001	2001 / 2002	2000 / 2001	2001 / 2002
60 cm	chickpea pure stand	87.50	86.20	6.13	6.27	29.7	30.6	5.45	5.64
	chickpea with S. beet	81.20	83.17	5.47	5.35	24.8	25.4	2.98	3.12
80 cm	chickpea pure stand	92.17	90.40	7.00	7.02	28.1	29.2	5.48	5.74
	chickpea with S. beet	88.23	87.80	6.28	6.22	29.9	30.9	3.03	3.20
120 cm	chickpea pure stand	95.20	90.70	7.60	8.12	35.8	37.8	5.73	5.93
	chickpea with S. beet	88.83	88.80	6.67	6.73	33.7	34.8	3.50	3.74
L.S.D. (0.05)		1.79	0.38	N.S.	0.13	0.4	0.3	0.21	0.23

3- Faba bean:

Data in Table (7) show that number branches/plant, number pods/plant, weight 100 seed and seed yield/plant were significantly increased by increasing ridge width from 60 to 120 cm ,while the reduction of plant height and seed yield/fed. was not significantly in both seasons.

Data show also that all studied characters were decreased by intercropping. The yield of intercropping faba bean was 38,36.5% of pure stand in first and second season, respectively.

Data in Table (8) show effect of interaction between intercropping and ridges width on faba bean . Faba bean grown pure stand on ridges 60 cm width had the highest values for number of pods / plant, seed yield / plant and seed yield/fed. The lowest values were observed when grown intercropping on narrower ridges (60 cm). Intercropped faba bean and grown on 120 cm width was higher than grown on both 60 and 80 cm in the two seasons. These results are in agreement with those obtained by Amer *et. al.*, (1997).

This serious reduction in intercropped onion, chickpea and faba bean yield because of lower intercropping density compared with onion, chickpea and faba bean pure stand, also a result of the increase in intra- as well as inter specific competition among plants.

Table (7): Effect of ridge width and intercropping faba bean with sugar beet on yield and its components of faba bean.

Characters Treatments	Plant height (cm.)	Number branches / plant	Number pods / plant	Weight 100 seed (g)	Seed yield / plant (g)	Seed yield ardab / fed.
Ridge width						
2000/2001 season						
60 cm	153.2	3.19	14.26	56.37	18.79	6.44
80cm	153.4	3.43	14.83	55.74	18.19	6.61
120 cm	147.9	3.76	16.53	59.21	20.36	6.73
L.S.D (0.05)	N.S.	0.07	0.48	55.74	1.03	N.S.
2001/2002 season						
60 cm	146.6	3.33	14.47	56.83	18.63	6.71
80cm	149.9	3.44	14.40	56.30	18.25	6.69
120 cm	149.6	3.79	15.08	58.72	20.88	6.91
L.S.D (0.05)	N.S.	0.09	0.88	0.59	0.45	N.S.
intercropping faba bean						
2000/2001 season						
faba bean pure stand (T ₁)	154.3	3.79	17.94	57.25	21.21	9.56
fabe bean with S. beet (T ₂)	148.6	3.13	11.14	56.96	17.01	3.63
L.S.D (0.05)	N.S.	0.11	0.41	0.11	0.68	0.16
2001/2002 season						
faba bean pure stand (T ₁)	149.5	3.86	17.89	57.37	21.28	9.91
fabe bean with S. beet (T ₂)	147.9	3.17	11.41	57.20	17.23	3.62
L.S.D (0.05)	N.S.	0.12	0.45	N.S.	0.34	0.25

Table (8): Effect interaction of intercropped faba bean × Ridge width on number of pods / plant, 100 seed weight, seed yield / plant, seed yield ardab / fed.

Characters Treatments		Number of pods / plant		100 seed wieight (g.)		Seed yield / plant (g.)		Seed yield ardab / fed.	
Ridge width	intercropping crops	2000 / 2001	2001/ 2002	2000 / 2001	2001/ 2002	2000 / 2001	2001/ 2002	2000 / 2001	2001/ 2002
60 cm	faba bean pure stand	18.67	18.12	56.67	56.87	22.23	22.20	9.85	10.58
	faba bean with S. beet	9.85	10.83	56.07	56.80	15.34	15.06	3.03	2.83
80 cm	faba bean pure stand	18.63	18.07	59.72	59.05	20.73	20.83	9.39	9.57
	faba bean with S. beet	11.03	10.73	56.12	56.42	15.64	15.67	3.78	3.79
120 cm	faba bean pure stand	18.53	17.47	55.37	56.18	20.65	20.80	9.43	9.58
	faba bean with S. beet	14.53	12.68	58.70	58.38	20.07	20.97	4.07	4.24
L.S.D. (0.05)		0.72	0.77	0.19	0.45	1.18	0.59	0.24	0.38

III- Competitive relationships and yield advantage of intercropping:

1- Land Equivalent Ratio (LER):

Results in table (9) show that intercropping sugar beet with onion, chickpea and faba bean as well as ridges 60, 80 and 120 cm width through the first and second season. The highest value for L.E.R. was 1.55 when intercropping sugar beet with onion under ridge 80 cm wide followed by 1.52 under ridge 120 cm while the lowest values observed when intercropping sugar beet with faba bean were 1.13 , 1.08 under ridge 60 cm wide in the first and second seasons, respectively. These yield advantages could be attributed to the relative yield of sugar beet which was relatively high than that of onion, chickpea and faba bean. Similar results were obtained by Toaima *et. al.*, (2001) who found that LER values were higher with ridges 120 cm than 60 cm wide.

2- Relative crowding coefficient (K):

Data are shown in table (9) intercropping sugar beet with onion, chickpea and faba bean in ridges 60, 80 and 120 cm width in both seasons. The highest values was observed when intercropping with onion on 80 cm wide and the lowest values was observed when intercropping with faba bean on 60 cm wide in the second season.

3- Aggressivity (A):

Results show also, that the values of Aggressivity for sugar beet were positive and for onion, chickpea and faba bean were negative. It means that the sugar beet was the dominant, whereas onion, chickpea and faba bean were the dominated intercrop component in both seasons.

IV- Economical evaluation:

For economic analysis profitability was used as a measure of the efficiency of intercropping some crops with sugar beet.

Data in table (10) indicate that, sugar beet with onion, chickpea and faba bean on ridges 120 cm wide recorded the highest gross and net benefit (L.E. 3945 and 2009, respectively) and profitability (103.8 %) for intercropping sugar beet with onion, were (L.E. 3780 and 2083, respectively) and profitability (122.7 %) for intercropping sugar beet with chickpea and were (L.E. 3257 and 1583, respectively) and profitability (94.6 %) for intercropping sugar beet with faba bean compared with other intercropping systems on ridges 60 and 80 cm width. This mean that, one Egyptian pound invested in intercropped chickpea with sugar beet in ridges 120 cm wide condition gain 1.23 Egyptian pound whereas, one Egyptian pound invested under solid sugar beet in ridges 120cm wide condition gain 1.13 Egyptian pound.

Table (9) Effect of interaction crops and ridge width on competitive relationship and advantage.

Ridge width	Intercropped crops	2000/2001 Season						2001/2002 Season					
		Land Equivalent Ratio			Aggressivity (Agg)			Land Equivalent Ratio			Relative crowding coefficient		
		Ls.beet	L crop	Tot.	S.beet	Crops	R.C.C. K	Ls.beet	L crop	Tot.	S.beet	Crops	R.C.C. K
60 cm.	Onion	0.90	0.53	1.43	+ 0.37	- 0.37	9.91	0.92	0.53	1.46	+ 0.39	- 0.39	12.90
	Chickpea	0.82	0.55	1.37	+ 0.27	- 0.27	5.44	0.86	0.55	1.41	+ 0.31	- 0.31	7.46
	Faba bean	0.82	0.31	1.13	+ 0.51	- 0.51	1.69	0.81	0.27	1.08	+ 0.54	- 0.54	1.59
80 cm.	Onion	0.88	0.63	1.51	+ 0.25	- 0.25	12.73	0.92	0.63	1.55	+ 0.29	- 0.29	18.77
	Chickpea	0.83	0.55	1.38	+ 0.28	- 0.28	6.19	0.83	0.56	1.39	+ 0.27	- 0.27	7.14
	Faba bean	0.85	0.40	1.25	+ 0.45	- 0.45	3.79	0.83	0.40	1.23	+ 0.43	- 0.43	3.17
120 cm.	Onion	0.90	0.62	1.52	+ 0.28	- 0.28	14.66	0.90	0.61	1.55	+ 0.29	- 0.29	13.86
	Chickpea	0.81	0.61	1.42	+ 0.20	- 0.20	6.78	0.83	0.63	1.46	+ 0.20	- 0.20	8.45
	Faba bean	0.80	0.43	1.23	+ 0.37	- 0.37	3.06	0.78	0.44	1.22	+ 0.27	- 0.27	2.73

Table (10): Mean intercropping systems profitability of food legume crops with sugar beet during 2000/2001 and 2001/2002 seasons.

Treatment	Incropped			Solid crops			Intercropped legume crops						
	Crops			S. beet			Onion		Chickepea				
	Ridge width	60 cm.	80 cm.	120 cm.	60 cm.	80 cm.	120 cm.	60 cm.	80 cm.	120 cm.	60 cm.	80 cm.	120 cm.
Costs and benefits													
Total variable cost L.E./ fed		1423	1423	1423	1936	1936	1936	1936	1697	1697	1697	1697	1697
Yield													
Sugar beet (ton/fed)		28.54	28.40	30.24	25.95	25.58	27.15	23.89	23.90	24.85			
Onion (bulb yield ton/fed)					3.83	4.70	5.68						
legume seed (ardab/fed)											3.05	3.12	3.62
legume straw (ton/fed)											0.600	0.620	0.600
Revenues (L.E./fed)													
From sugar beet root		2854	2840	3024	2595	2558	2715	2389	2390	2485			
From bulb yield (ton/fed)					829	1018	1230						
From legume seed											1050	1075	1247
From legume straw											48	50	48
Gross benefit		2854	2840	3024	3424	3576	3945	3487	3515	3780			
Net benefit		1431	1417	1601	1488	1640	2009	1790	1818	2083			
Profitability		100.6	99.6	112.5	76.9	84.7	103.8	105.5	107.1	122.7			

Average sugar beet price was L.E. 100 per ton. / Average onion price was L.E. 216.5 per ton. / Average faba bean and chickepea seed prices were L.E. 195.0 and 344.4 per ardab respectively / Average faba bean and chickepea straw prices were L.E. 80 per ton. For each.

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إدارة المحاصيل لتحميل بنجر السكر مع بعض المحاصيل الهامة لتعظيم إنتاجية وحدة المساحة

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أجريت تجربتان حقليةتان في محطة البحوث الزراعية بشندويل خلال موسمي الزراعة ٢٠٠١/٢٠٠٠ و ٢٠٠٢/٢٠٠١ لتقييم تأثير تحميل بنجر السكر مع البصل والحمص والفول البلدي تحت معدلات مختلفة من التخطيط (٦٠، ٨٠، ١٢٠ سم) على المحصول ومكوناته والتحليل الكيماوي لبنجر السكر وحساب العائد الاقتصادي. وقد أستخدم تصميم القطع المنشقة مرة واحدة في أربع مكررات. ويمكن تلخيص النتائج فيما يلي:-

- ١- لوحظ من النتائج أن التحميل أدى إلى انخفاض محصول بنجر السكر وخاصة عند التحميل مع الفول البلدي مقارنة بالزراعة المنفردة خلال الموسمين. زيادة المحصول ومكوناته بزيادة المسافة بين الخطوط ، بنجر السكر المنفرد أعطى أعلى محصول عند الزراعة على خطوط عرض ١٢٠ سم بينما الزراعة على الخطوط الضيقة عرض ٦٠ سم والمحملة بالفول البلدي أعطت أقل قيمة محصوليه.
- ٢- صفات الجودة لبنجر السكر معبرا عنها كنسبة مئوية لكلا من المواد الصلبة الذائبة الكلية ، و السكروز ، والنقاوة تأثرت معنويا بزيادة المسافة بين الخطوط وبالتحميل أيضا.
- ٣- تفوق محصول البصل المنفرد أو المحمل على مصاطب عرض ١٢٠ سم مقارنة بالزراعة على خطوط عرض ٦٠ سم أو ٨٠ سم خلال الموسمين. وانخفض محصول البصل بالتحميل خلال الموسمين.
- ٤- أوضحت النتائج أن محصول الحمص انخفض معنويا بالتحميل خلال الموسمين. وتفوقت الزراعة على المصاطب عرض ١٢٠ سم وأعطت أعلى محصول من الحمص سواء منفرد أو محمل مع بنجر السكر خلال الموسمين.
- ٥- تفوقت الزراعة على خطوط ضيقة (عرض ٦٠ سم) وأعطت أعلى قيم من المحصول للفول البلدي المنفرد مقارنة بالزراعة على خطوط عرض ١٢٠ سم لكلا الموسمين بينما أعطت الزراعة على خطوط عرض ١٢٠ سم أعلى قيم من المحصول ومكوناته للفول البلدي المحمل مع بنجر السكر مقارنة بالزراعة على خطوط ضيقة ٦٠ سم.
- ٦- سجل معدل استغلال الأرض أعلى إنتاجية عند الزراعة على خطوط عرض ٨٠ ، ١٢٠ سم مقارنة بالزراعة على خطوط ضيقة عرض ٦٠ سم. وكانت أعلى القيم المتحصل عليها لمعدل استغلال الأرض هي ١,٥٢ ، ١,٥٥ للبصل عند الزراعة على خطوط عرض ١٢٠ ، ٨٠ سم على التوالي بينما أقل القيم المتحصل عليها ١,١٣ ، ١,٠٨ للفول البلدي على خطوط عرض ٦٠ سم خلال الموسمين على التوالي.
- ٧- وقد أظهرت النتائج أن تحميل الحمص مع بنجر السكر والزراعة على خطوط عرض ١٢٠ سم أدى إلى زيادة صافي العائد الاقتصادي بمقدار ٤٨٢ جنيها مصريا مقارنة بمحصول بنجر السكر المنفرد والمنزوع على خطوط عرض ١٢٠ سم.