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EFFECT OF DIFFERENT INTERCROPPING SYSTEMS OF ONION AND GARLIC ON SUGAR BEET YIELD, YIELD COMPONENTS AND CHEMICAL ANALYSIS

TOAIMA, S.E.A.[1]; K.A. EL-DOUBY[1] AND A.I. NAFEI[2]

1 Intensification Res. Dept., Field Crops Institute

2 Agriculture Treatments Res. Dep., Sugar Crops Institute

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Abstract

Four field trials were conducted through 1998/99 and 1999/2000 seasons, two at Sakha Experimental Station, Kafr El- Sheikh governorate and two at Kom Ousheem Experimental Station, Fayoum governorate to study the effect of two intercropping patterns of onion and/or garlic (60 and 120 cm width) on yield, yield components and chemical analysis of sugar beet. The soil type of Sakha was clay with PH 7.8, while the Kom Ousheem soil was sandy clay loam with PH 8.9. The experimental design was randomized complete block design of four replications. The results indicated that:

Sakha region:

1. The treatment of 60 cm ridge width gave higher yield, yield components and chemical analysis (sucrose %, Total Soluble Sugar % and purity %) of sugar beet as solid crop or when intercropped with onion or garlic ridges 120 cm. wide in both seasons.
2. Higher yields of onion and garlic intercrops were obtained in ridges 120 cm wide.
3. The intercropping pattern of 120 cm width gave higher than 60 cm width. Land Equivalent Ratio (L.E.R) of 1.55, 1.54 for onion and 1.54, 1.46 for garlic and Relative Crowding Coefficient (K) 9.88, 14.62 for onion and 8.54, 9.56 for garlic and total income 4531, 4542 L.E for onion and 5831, 5792 L.E for garlic in the two seasons, respectively. Aggressivity (A) for sugar beet was dominant with both intercropping models (ridges 60 and 120 cm wide), whereas was it dominated with onion and garlic in both seasons.

Kom Ousheem region:

1. The treatment of 60 cm width recorded higher yield, yield components and chemical analyses of sugar beet in solid crop or intercrop than 120 cm width in both seasons.
2. Yields of solid onion or garlic were higher with ridges 60 cm wide, while 120 cm width gave higher yields when intercropped in both seasons.
3. Higher yield was obtained with the intercropping system of 120 cm width for Land Equivalent Ratio (1.56, 1.56) for onion, (1.53, 1.52) for garlic and total income (3174, 3154 LE) for onion and (4103,

4120 LE) for garlic in both seasons, but K was higher with 60 cm width (18.21, 19.20) for onion and (11.16, 12.91) for garlic in both seasons. Aggressivity (A) for sugar beet was dominant in both intercropping systems, whereas for onion or grlic it was dominated.

INTRODUCTION

Since sugar beet takes long time in the field, about six months, which requires farmers to look for suitable crops to grow with sugar beet without reducing its final yield. Choosing different intercropping models of onion or garlic with sugar beet and suitable soil are considered the target to provide farmers with scientific knowledge for achieving more land utilization and net return.

Several investigators studied the effects on final yield and yield components of sugar beet due to type of soil and intercropping pattern. Redk and Hagstrom (1976) stated that soil with capacity to store moisture for long time increased sugar beet yield by 15.2 % due to reduced evaporation. Kass (1978) revealed that nutrient elements such as P, K and Ca when available in greater amounts result in less crop competition under intercropping. Vandermeer (1989) found that different root systems of the combined crops are of advantage to higher final yield crops, use nutrients from different parts of the soil and competition is reduced. Amer *et al.*; (1997) found that planting faba bean at 70 % of its solid population intercropped with 100 % sugar beet gave the highest income value, while 50 % faba bean population and 100 % sugar beet gave the lowest value. Sugar beet quality as expressed in sucrose, T.S.S % and purity % was not affected due to intercropping with faba bean. Abd El-Moneim (2000) found that sugar beet root length, root diameter, top fresh weight, root fresh weight, root yield/ fed., total soluble solid % and sucrose % were higher in clay loam soil than sandy clay loam soil, purity % was higher in sandy clay loam soil than clay loam soil

El- Kafoury *et al.*; (1993) and El- Naggar *et al.*; (1996) repoprted that onion as intercropped with cotton on rows 60 cm wide gave lower growth and yield, compared with growing on ridges 120 cm wide, and both systems were lower than solid crop. Hanna and Abdoh (1997) found that plant height, bulb weight, total bulb weight /fed. and marketable weight /fed. of onion as a solid crop were 62.44 cm., 56.79 g.,13.97 t/fed. and 12.86 t/fed. Zahira (1999) reported that planting four onion rows on the back of ridges 120 cm. wide had the highest value of L.E.R., whereas the lowest value was obtained when onion was grown on one side of the 60 cm wide cotton ridges.

Moursi (1965) reported that growing garlic plants on cotton ridges reduced the growth and dry matter content of the different parts of cotton. Shahien (1987) men-

tioned that growing pea plants on the ridges of garlic did not affect the growth of both garlic and pea plants. On the other hand, growing snap bean plants on the ridges of garlic decreased plant height and dry matter content of garlic, while bulb diameter of garlic and the growth of bean were not affected. El- Moursi (1999) showed that intercropping garlic with snap bean reduced plant height, bulb weight, total yield and clove weight of garlic, whereas bulb diameter, number of circles/ bulb and number of cloves/ bulb did not affect.

The objective of this research is to investigate the possibility of planting onion or garlic with sugar beet under different intercropping patterns and different soil conditions such as clay soil (at Sakha) and sandy clay loam soil (at Kom Ousheem).

MATERIALS AND METHODS

Four field trials were conducted during 1998/ 99 and 1999/ 2000 seasons, two at Sakha Experimental Station, Kafr El-Sheikh governorate (on clay soil) and two at Kom Ousheem Experimental Station, EL Fayoum governorate (on sandy clay loam soil) to study the effect of different intercropping systems for onion or garlic on sugar beet. The treatments used were:

T1: Intercropping onion with sugar beet by planting sugar beet in ridges 60 cm. wide in hills spaced 25 cm. apart on one side of the ridge, (30000 plant/ fed., 100 % of the sole crop) and planting onion on the other side in hills 10 cm. apart to give 70000 plant/ fed (33 % of the sole crop).

T2: Intercropping onion with sugar beet by planting sugar beet in ridges 120 cm. wide spaced 25 cm. apart on both sides of ridges to give 30000 plant/ fed. (100 % of the sole crop) and planting four rows of onion on the top of ridge 20 cm. between each row and 10 cm. between plants to give 140000 plant/ fed. (66% of the sole crop).

T3: Intercropping garlic with sugar beet by planting sugar beet in ridges 60 cm. wide in with 25 cm. apart between plants on one side of ridge, (30000 plant/ fed., 100 % of the sole crop) and planting garlic on the other side 10 cm. apart to give 70000 plant/ fed (33 % of the sole crop).

T4: Intercropping garlic with sugar beet by planting sugar beet in ridges 120 cm. width spaced 25 cm. apart on both sides of ridges to give 30000 plant/ fed. (100 % of the sole crop) and planting four rows of garlic on the back of ridge 20 cm. be-

tween each row and 10 cm. between plants to give 140000 plant/ fed. (66% of the sole crop).

T5: Pure stand of sugar beet was planted in ridges 60 cm.width spaced 25 cm. apart between plants on one side, 30000 plant/ fed.

T6: Pure stand of sugar beet was planted in ridges 120 cm. width. spaced 25 cm. apart on both sides of ridges to give 30000 plant/ fed.

T7: Pure stand of onion was planted on both sides and top of ridges 60 cm wide with plants 10 cm. apart to give 210000 plant /fed.

T8: Pure stand of onion was planted in six rows on the back of ridges 120 cm width with 20 cm. between rows and 10 cm. between plants to give 210000 plant/fed.

T9: Pure stand of garlic was planted on both sides and top of ridges 60 cm wide with plants 10 cm.. apart to give 210000 plant /fed.

T10: Pure stand of garlic was planted in six rows on the back of ridges 120 cm wide and 20 cm. between rows and 10 cm. between plants to give 210000 plant /fed.

Each experiment was carried out in randomized complete block design with four replications. The experimental unit area was 7 m. in length and 6 m in width (42 m2); and consisted of 10 ridges 60 cm wide or 5 ridges 120 cm wide.

The preceding crop was maize in both locations within the two seasons. Normal cultural practices were applied for crops under study, either in pure stand or intercropped as recommended for each region. Super phosphate (15 % P_2O_5) at a rate of 45 kg/ fed and potassium sulphate (48 % K_2O) at a rate of 72 kg/fed. were added during land preparation. Nitrogen fertilizer was applied for all plots at a rate of 120 kg/ fed. ammonium nitrate (33.5 % N.) in three equal doses, the first one was applied at 30 kg N during planting sugar beet and 45 kg N after thinning of sugar beet (at planting onion) and 45 kg N one month later.

Ten plants were choosen randomly to determine yield parameters, while the yield/ fed. was determined on the whole plot.

Sugar beet: Top fresh weight, weight of root, root length, root diameter and total yield.

- **Quality attributes**: A fresh sample of 26 g weight was taken from fresh roots

of beet plants representing each treatment to determine the following: Percentage of Total Soluble Solid (T.S.S) was measured by using refractometer according to A.O.A.C. (1984); sucrose % by Saccharameter according to Le-Docte (1927); and purity % calculated as (% sucrose by T.S.S) X 100

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

Garlic: Plant height, bulb diameter, bulb weight, and total yield.

Table 1. Sowing and harvesting dates of sugar beet, onion and garlic.

Location	season	Sowing date			Harvesting date		
		Beet	Onion	Garlic	Beet	Onion	Garlic
Sakha	1998/ 1999	Oct.5 th	Nov. 5 th	Sep. 15 th	May 12 th	Apr. 15 th	Mar. 5 th
	1999/ 2000	Oct. 9 th	Nov. 10 th	Sep. 18 th	May 15 th	Apr. 18 th	Mar. 7 th
Kom Ousheem	1998/ 1999	Oct. 8 th	Nov. 9 th	Sep. 17 th	May 3 rd	Apr. 24 th	Mar. 8 th
	1999/ 2000	Oct.12 th	Nov. 13 th	Sep. 23 th	May 8 th	Apr. 26 th	Mar. 12 th

Competitive relationships:

Land Equivalent Ratio (LER), Relative Crowding Coefficent (K) and Aggressivity (A) were respectively calculated according to Willey (1965), Dewit (1960) and McGilchrist (1974).

$$LER = \frac{Yso \text{ or } Ysg}{Yss} + \frac{Yos \text{ or} Ygs}{Yoo \text{ or } Ygg}$$

Where:

Yso or Ysg = Yield intercrop of sugar beet with onion or garlic.

Yos or Ygs = Yields intercrop of onion or garlic with sugar beet.

Yss = Yield pure of sugar beet.

Yoo or Ygg = Yield pure of onion or garlic.

K = K1 x K2, where:

$$K1 = \frac{\text{Yso or Ysg x \% Z 2}}{\text{(Yss -Yso or Ysg) X \% Z1}} \qquad K2 = \frac{\text{Yos or Ygs x \% Z1}}{\text{(Yoo or Ygg - Yos or Ygs) X \% Z2}}$$

and:

% Z1 = Area occupied by sugar beet.

% Z2 = Area occupied by onion or garlic.

A = A1 – A2 for sugar beet. **A2 – A1** for onion or garlic.

$$\textbf{A 1} \text{ (sugar beet)} = \frac{\text{Yso or Ysg}}{\text{Yss X \% Z1}} - \frac{\text{Yos or Ygs}}{\text{Yoo or Ygg X \% Z2}}$$

$$\textbf{A 2} \text{ (onion or garlic)} = \frac{\text{Yos or Ygs}}{\text{Yoo or Ygg X \% Lc2}} - \frac{\text{Yso or Ysg}}{\text{Yss X \% Z1}}$$

Economic evaluation:

The total income from each treatment was calculated in Egyptian pound/ ton at market prices of L.E. 100/ ton of sugar beet, 200/ ton of onion and 400/ ton of garlic according to farm price.

Data were statistically analysed according to the procedure out- lined by Roger (1985).

Table 2. Physical and chemical analysis of the experimental site at Sakha and Kom Ousheem research farm (according to methods outlined by Black 1965).

A:Physical analysis						
Region	Coarse sand %	Fine sand %	Silt %	Clay %	Textural class	
Sakha	2.1	22.7	23.5	51.7	Clay	
Kom Ousheem	19.8	31.9	21	27.3	Sandy clay loam	
B:Chemical analysis (available nutrients)						
	N (ppm)	P (ppm)	K (ppm)	$Caco_3$ %	Na (meq./L)	PH
Sakha	20.2	10.1	575	2.71	5.02	7.8
Kom Ousheem	11.8	4.3	350	20.6	15.11	8.9

RESULTS AND DISCUSSION

In this study, two experiments were carried out at each of Sakha and Kom Ousheem locations. Experiments at each location will be presented and discussed separately.

1. The Sakha experiments station:

1.1. Effect of intercropping onion with sugar beet on yield, yield components and chemical analysis of sugar beet.

Data presented in Table (3) show that yield, yield components and chemical characters of sugar beet were significantly decreased by intercropping patterns, compared with pure stand sugar beet in both seasons. The results revealed that yield components characters i.e. top fresh weight, weight of root/ plant, root length and root diameter recorded the highest values in 60 cm ridges, compared to 120 cm ridges in 1998/99 and 1999/2000 seasons. Values recorded with pure stand sugar beet in 60 cm ridges were higher than in 120 cm ridges in both seasons. The increase in results with 60 cm ridges may be due to differences in root depth among crops (Vandermeer 1989) and or available moisture (Redk and Hagstrom 1976).

Yield/ fed.of sugar beet intercropped with onion in ridges 60 cm wide was greater than from120 cm ridges in both seasons. The yields of sugar beet intercropped with onion at 60 cm width (T1) and intercropped at 120 cm width (T2) Were 92.28, 89.97 % in the first season, and 90.02, 88.18 % in the second season, respectively, compared with sugar beet pure stand in ridges 60 (T5) and 120 cm width (T6) in both seasons. The increase in sugar beet yield grown on ridges 60 cm width was due to an increase in growth characters.

Regarding chemical characters of T.S.S %, sucrose % and purity %, the results showed that previous characters increased in intercropped 60 cm. width than in ridges 120 cm. wide in both seasons. These results are in harmony with those obtained by Amer *et al.*; (1997).

1.2. Effect of intercropping garlic with sugar beet on yield, yield components and chemical characters of sugar beet.

The results in Table (3) show that top fresh weight, root weight/ plant, root length and root diameter were significantly reduced by intercropping patterns, compared with pure stand sugar beet. The highest values were recorded with pure stand sugar beet, whereas intercropping sugar beet with garlic in ridges 120 cm wide gave

the lowest values in both seasons. These results may be due to higher plant population and intra and inter competition in ridges 120 cm wide.

Concerning sugar beet yield / fed., the data showed the same trend shown by growth characters in both seasons as shown in Table (3). The highest value was recorded with pure stand sugar beet in ridges 60 cm width and the lowest value was obtained with intercropping sugar beet with garlic in 120 cm ridges in both seasons. The yield of T3 and T4 intercropping patterns were 88.00, 87.33 % and 87.58, 86.57 % of their pure stand of T5 and T6 in the first and second season, ordinally. These results are in concordance with Vandermeer (1989) and Redk and Hagstrom (1976).

As for Chemical characters of sugar beet i.e. T.S.S %, sucrose % and purity % were significantly affected by intercropping patterns in both seasons. Intercropping patterns increased T.S.S % and sucrose %, compared with pure stand sugar beet in the first and second season. Purity % behaved the opposite to T.S.S % and sucrose % in both seasons. These results are in harmony with those obtained by Amer *et al.*; (1997).

1.3 Effect of intercropping onion with sugar beet on yield and yield components of onion.

The data in Table (4) show that yield and yield components of onion were significantly affected by intercropping patterns in both seasons. Plant height, bulb diameter and bulb weight were significantly decreased by both intercropping systems in both seasons, compared with their pure stand. The highest values were obtained with pure stand treatment of onion in ridges 60 cm wide, whereas the lowest values were recorded with intercropping onion with sugar beet in ridges 120 cm wide in both seasons. That may be due to higher competition between onion and sugar beet in ridges 120 cm and reduction in soil moisture in ridges spaced 60 cm apart.

Data in Table (4) indicate that intercropping patterns significantly decreased bulb yield/ fed., compared with onion pure stand in both seasons. Onion pure stand in ridges 120 cm wide gave higher values than ridges 60 cm wide. As well, intercropping onion in ridges 120 cm width gave the highest values than 60 cm width in both seasons. The treatments produced 35.55, 66.53 % in the first season and 34.70, 66.23 % in the second season for T1 and T2, respectivelly compared with pure stand in ridges 60 and 120 cm width. The reduction in intercropped onion yield is mainly due to the reduction in plant density which is practically 66 % or 33 % of the pure stand density when planted onion with sugar beet in ridges 120 cm or 60 cm width.

Culls/ fed. and marketable yield/ fed. of onion behaved the same as bulb yield/ fed. in both seasons. These results are in agreement with those obtained by El Kafoury *et al.*, (1993) and El Naggar *et al.* (1996) who found higher yield and yield components of onion when grown in 120 cm.width, compared with 60 cm. wide.

Table 3. Effect of intercropping onion or garlic with sugar beet on yield, yield components and chemical analysis of sugar beet (Sakha location).

Characters Treatments	Top fresh weight (g)	Weight of root/ plant (g)	Root length (cm)	Root diameter (cm)	Yield ton/ fed.	T.S.S %	Succrose %	Purity %
1998/ 99 season								
S.beet + onion (T1)	161.18	810.11	27.35	36.40	24.14	23.60	18.00	76.27
S.beet + onion (T2)	151.76	740.16	25.80	35.50	22.09	22.60	16.58	73.36
S.beet + garlic (T3)	170.80	770.14	30.90	35.40	23.02	26.25	18.80	71.62
S.beet + garlic (T4)	140.64	720.12	27.70	34.90	21.51	25.60	18.00	70.31
S.beet pure stand (T5)	212.06	875.10	31.75	37.30	26.16	22.55	17.70	78.49
S.beet pure stand (T6)	170.14	830.12	28.40	37.54	24.63	21.90	16.60	75.80
L.S.D (0.05)	8.11	12.08	1.41	0.66	1.12	0.51	0.62	1.06
1999/ 2000 season								
S.beet + onion (T1)	159.22	805.12	29.25	37.66	24.00	23.20	17.60	75.86
S.beet + onion (T2)	153.70	738.16	26.20	36.40	22.00	23.40	16.38	70.00
S.beet + garlic (T3)	172.66	480.08	30.76	36.76	23.35	25.75	18.60	72.23
S.beet + garlic (T4)	138.70	725.04	28.30	36.60	21.60	25.40	18.20	71.65
S.beet pure stand (T5)	208.22	890.10	31.25	39.10	26.66	22.45	17.78	79.20
S.beet pure stand (T6)	166.20	835.06	27.60	38.00	24.95	21.70	16.00	73.73
L.S.D (0.05)	7.51	10.41	1.81	1.59	1.03	0.46	0.40	2.05

T (1) = Sugar beet + onion (on ridges 60 cm.) T (2) = Sugar beet + onion (on ridges 120 cm.).

T (3) = Sugar beet + garlic (on ridges 60 cm.) T (4) = Sugar beet + garlic (on ridges 120 cm.).

T (5) = Sugar beet pure stand (on ridges 60 cm.) T (6) = Sugar beet pure stand (on ridges 120 cm.).

Table 4. Yield and yield components of onion as affected by intercropping with sugar beet (Sakha location).

Characters / Treatments	Plant height (cm)	Bulb diameter (mm)	Bulb weight (g)	Bulb yield/ fed (ton)	Culls/ fed (ton)	Marketable yield/ fed (ton)
1998/ 1999 season						
S.beet – onion (T1)	49.00	59.28	96.00	6.51	0.95	5.56
S.beet – onion (T2)	46.00	58.30	90.56	11.61	1.34	10.27
Onion pure stand (T7)	51.06	62.70	98.40	18.31	1.75	16.56
Onion pure stand (T8)	50.02	59.02	95.58	17.45	1.30	16.15
L.S.D (0.05)	2.03	0.60	1.03	1.51	0.46	0.83
1999/ 2000 season						
S.beet – onion (T1)	47.36	59.08	94.34	6.43	0.67	5.76
S.beet – onion (T2)	42.30	56.90	90.00	11.71	1.00	10.71
Onion pure stand (T7)	49.60	60.90	98.06	18.53	1.35	17.18
Onion pure stand (T8)	48.30	58.60	95.04	17.68	1.08	16.60
L.S.D (0.05)	1.02	1.03	1.33	0.91	0.31	0.73

1.4 Effect of intercropping garlic with sugar beet on yield and yield components of garlic.

Data in Table (5) show that growth and yield components of garlic, i.e. plant height, bulb diameter and bulb weight gave the highest values with the treatment of pure stand in ridges 120 cm wide, whereas garlic intercropped with sugar beet in ridges 60 cm wide gave the lowest values in both seasons. Similar results were obtained by Moursi (1965) and Shahien (1987)

Total bulb/fed. behaved similar to growth and yield components in both seasons. The reduction in total bulb yield/ fed. caused by intercropping patterns reached 28.98, 60.85 % in the first season and 28.29, 28.29, 59.66 % in the second season for (100 % sugar beet + 33 % garlic) and (100 % sugar beet + 66 % garlic) treatments, respectively compared with solid garlic in ridges 60 and 120 cm width. These results are in agreement with those obtained by El- Moursi, (1999).

1.5. Competitive relationships and yield advantage of intercropping:

1.5.1. Land Equivalent Ratio (L.E.R):

Results in Table (6) indicate that intercropping sugar beet with onion or garlic in both intercropping patterns through the first and second season. Intercropping 100 % sugar beet + 66 % onion or garlic recorded the highest values for "LER" which were 1.55, 1.54 for intercropping sugar beet with onion and were 1.54, 1.46 for sugar beet with garlic in the first and second seasons, respectively. Sugar beet was more contributor with "Ls" values than onion or garlic. Similar results were obtained by Zahira (1999), who found that LER values were greater with ridges 120 than 60 cm wide.

1.5.2. Relative Crowding Coefficient (K):

Plant density of intercropping onion and garlic with sugar beet (K) is shown in Table (6). The best values were achieved by intercropping pattern of sugar beet with onion or garlic in ridges 120 cm wide in both seasons, where K values reached 9.88, 14.62 for intercropping sugar beet with onion and 8.54, 9.56 for intercropping sugar beet with garlic in both seasons, respectively. Onion or garlic was greater contributer due to its increased plant population in the system of 120 cm wide.

1.5.3. Aggressivity (A):

The data in Table (6) show that sugar beet was the dominant intercrop component in intercropping patterns (100 % sugar beet + 66 % or 33 % onion or garlic) in both seasons. But, onion or garlic was the dominated intercrop component in both intercropping patterns during the two seasons.

Table 5. Yield and yield components of garlic as affected by intercropping with sugar beet (Sakha location).

Characters / Treatments	Plant height (cm)	Bulb diameter (mm)	Bulb weight (g)	Total bulb/ ton (fed.)
1998/ 1999				
S.beet + garlic (T3)	91.00	4.02	59.00	4.11
S.beet + garlic (T4)	92.41	4.25	67.00	9.20
Garlic pure stand (T9)	93.90	4.50	68.32	14.18
Garlic pure stand (T10)	94.80	4.60	72.56	15.12
L.S.D (0.05)	1.21	0.15	3.81	0.66
1999/ 2000				
S.beet + garlic (T3)	89.80	4.00	57.24	4.02
S.beet + garlic (T4)	92.21	4.05	65.36	9.08
Garlic pure stand (T9)	93.30	4.40	68.12	14.21
Garlic pure stand (T10)	94.20	4.62	72.16	15.22
L.S.D (0.05)	1.35	0.19	3.16	0.86

Table 6. Land Equivalent Ratio (L.E.R.) and total income of sugar beet as advantages of Intercropping (Sakha location).

Characters / Treatments	Land Equivalent Ratio (L.E.R)			Relative Crowiding Coefficient (K)			Aggressivity (A)		Total income
	Ls	Lo & Lg	LE.R	Ks	Ko & Kg	K	As	Ao & Ag	
1998/ 99 season									
Sugar beet + onion (T1)	0.92	0.35	1.27	7.89	0.83	6.55	+0.76	-0.76	3716
Sugar beet + onion (T2)	0.89	0.66	1.55	11.48	1.51	9.88	+0.78	-0.78	4531
Sugar beet + garlic (T3)	0.88	0.33	1.21	4.84	0.62	4.67	+0.88	-0.88	3946
Sugar beet + garlic (T4)	0.87	0.67	1.54	9.10	2.05	8.54	+0.83	-0.83	5831
Sugar beet pure stand (T5)									2616
Sugar beet pure stand (T6)									2463
1999/ 2000 season									
Sugar beet + onion (T1)	0.90	0.35	1.25	5.95	0.80	4.76	+0.75	-0.75	3686
Sugar beet + onion (T2)	0.88	0.66	1.54	9.88	1.88	14.62	+0.76	-0.76	4542
Sugar beet + garlic (T3)	0.87	0.28	1.15	4.67	0.60	2.80	+0.89	-0.89	3943
Sugar beet + garlic (T4)	0.86	0.60	1.46	8.54	1.12	9.56	+0.83	-0.83	5792
Sugar beet pure stand (T5)									2666
Sugar beet pure stand (T6)									2495

Total income was calculated as farm price/ton.

Sugar beet = 100 L.E

Onion = 200 L.E

Garlic = 400 L.E

Economic Evaluation:

The data in Table (6) show that the advantage of intercropping onion or garlic with sugar beet as economic evaluation. The highest values of the total income (L.E/ fed.) could be achieved by treatment of 120 cm width; 4531, 4542 L.E for intercropping onion with sugar beet and 5831, 5792 L.E for intercropping garlic with sugar beet in both seasons, respectively.

In general, the treatment of 60 cm width produced higher yield and yield components of sugar beet as intercropping with onion or garlic or as pure stand. But, higher yield and yield components of onion or garlic was collected with intercropping system of 120 cm width. Higher L.E.R, K and total income were collected from intercropping 100 % sugar beet + 66 % onion or garlic.

The second experiment (at Kom Ousheem location):

2.1. Effect of intercropping onion with sugar beet on yield, yield components and chemical characters of sugar beet.

Data present in Table (7) show that yield, yield components and chemical characters of intercropping sugar beet were significantly affected by intercropping patterns in both seasons. Top fresh weight, weight of root/ plant, root length and root diameter of sugar beet recorded the highest values with 60 cm ridges, compared with planting in 120 cm ridges in both seasons. This result may be due to higher $CaCO_3$ in that type of soil (Table 2), where ridges 120 cm wide do not maintain soil moisture for long period and gave lower yield (Redk and Hagstrom, 1976).

With respct to yield/ fed. data indicate that pure stand of sugar beet in ridges 60 or 120 cm width was higher than intercropped systems in both seasons. The intercropping patterns of 100 % sugar beet + 66 % onion produced lower values than 100 % sugar beet + 33 % onion. The values were 92.19, 90.49 % in the first season and 92.54, 91.05 % in the second season of their pure stand in ridges 60 or 120 cm width, respectively. The present results are mainly due to increased growth characters and maintain moisture in ridges 60 cm wide longer. Similar results were reported by Redk and Hagstrom (1976) who showed that increasing sugar beet yield by 15.2 % was due to reduced evaporation.

As for chemical characters, T.S.S %, and purity % were significantly affected by intercropping patterns, while succrose % was not affected by intercropping patterns in both seasons. The intercropping system of 100 % sugar beet + 66 % onion, recorded higher values for T.S.S %, whereas purity % showed lower values, compared with the other system in both seasons. These results are in harmony with those obtained by Abd El- Moneim (2000).

2.2. Effect of intercropping garlic with sugar beet on yield, yield components and chemical characters of sugar beet

The results in (Table 7) stated that all sugar beet characters were significantly affected by intercropping patterns, except sucrose % in both seasons. Top fresh weight, weight of root/ plant, root length and root diameter were recorded the highest values with sugar beet pure stand in ridges 60 cm width, while the lowest values were obtained with intercropping pattern (100 % sugar beet + 66 % garlic) in both seasons. The present result is mainly due to increase in inter as well as intra specific competition

due to increase plant population at unit area in ridges 120 cm width, Vandermeer (1989).

Table 7. Effect of intercropping onion and garlic with sugar beet on yield, Yield components and chemical analysis of sugar beet (Kom Ousheem location).

Characters / Treatments	Top fresh weight (g)	Weight of root/ plant (g)	Root length (cm)	Root diameter (cm)	Yield ton/ fed.	T.S.S %	Succrose %	Purity %
1998/ 99 season								
S.beet + onion (T1)	133.16	640.14	20.30	35.00	18.90	25.30	18.50	73.12
S.beet + onion (T2)	127.30	600.12	16.00	27.00	17.52	27.50	18.30	66.54
S.beet + garlic (T3)	109.00	610.10	20.00	32.50	17.65	25.40	17.40	68.50
S.beet + garlic (T4)	93.20	550.20	15.25	26.00	16.38	26.50	17.46	65.89
S.beet pure stand (T5)	135.34	690.18	20.93	37.00	20.50	25.00	18.80	75.20
S.beet pure stand (T6)	130.44	650.16	19.80	29.50	19.36	25.50	18.20	71.37
L.S.D (0.05)	6.18	13.00	2.03	1.05	1.06	0.86	N.S	1.16
1999/ 2000 season								
S.beet + onion (T1)	131.50	630.18	20.00	34.00	18.60	24.20	18.00	74.38
S.beet + onion (T2)	127.70	580.14	14.55	25.50	17.30	26.50	17.00	64.15
S.beet + garlic (T3)	105.34	590.08	19.60	30.50	17.40	24.35	17.00	69.81
S.beet + garlic (T4)	91.80	550.12	14.30	24.50	16.45	26.40	17.00	64.39
S.beet pure stand (T5)	133.00	675.04	20.73	36.50	20.10	24.00	18.78	78.25
S.beet pure stand (T6)	129.90	640.02	18.50	29.00	19.00	25.50	17.20	67.45
L.S.D (0.05)	3.01	11.30	2.11	2.13	1.14	0.81	N.S	2.16

T (1) = Sugar beet + onion (on ridges 60 cm.) T (2) = Sugar beet + onion (on ridges 120 cm.).

T (3) = Sugar beet + garlic (on ridges 60 cm.) T (4) = Sugar beet + garlic (on ridges 120 cm.).

T (5) = Sugar beet pure stand (on ridges 60 cm.) T (6) = Sugar beet pure stand (on ridges 120m.).

Concerning sugar beet yield / fed., the data gave the same trend of sugar beet yield components in both seasons (Table 7). It is evident that the highest sugar beet yield was obtained with pure stand in ridges 60 cm width and the lowest was that of the intercropping pattern including 100 % sugar beet + 66 % garlic. The data were 86.10, 84.61 % and 86.57, 86.58 % of the pure stand yield in ridges 60 and 120 cm width in the first and second seasons, ordinally. The results may due to the adverse effects of dense garlic with sugar beet population on some other yield component characters such as root weight/ plant, root length and diameter, Redk and Hagstrom (1976).

Table 8. Yield and yield components of onion as affected by intercropping with sugar beet (Kom Ousheem location).

Characters / Treatments	Plant height (cm)	Bulb diameter (mm)	Bulb weight (g)	Bulb yield/ fed (ton)	Culls/ fed (ton)	Marketable yield/ fed (ton)
1998/ 1999						
S.beet + onion (T1)	41.00	55.16	85.34	5.90	1.31	4.59
S.beet + onion (T2)	40.00	53.40	51.13	7.11	1.60	5.51
Onion pure stand (T7)	47.06	56.30	86.12	18.02	2.71	15.31
Onion pure stand (T8)	43.04	54.28	52.14	10.82	3.50	7.32
L.S.D (0.05)	1.61	0.96	0.98	1.61	0.38	0.47
1999/ 2000						
S.beet + onion (T1)	39.32	55.00	85.00	5.89	1.11	4.78
S.beet + onion (T2)	38.22	53.02	51.40	7.12	1.62	5.50
Onion pure stand (T7)	45.30	56.04	86.20	18.04	2.31	15.73
Onion pure stand (T8)	41.60	54.00	52.24	10.90	3.36	7.54
L.S.D (0.05)	1.53	1.03	1.07	1.41	0.29	0.83

T (7) = Onion pure stand (on ridges 60 cm width)

T (8) = Onion pure stand (on ridges 120 cm width)

With respect to chemical characters, i.e. T.S.S %, sucrose % and purity %, the results significantly affected by intercropping patterns in both seasons, except sucrose %. Intercropping patterns increased T.S.S % compared with sugar beet pure stand in 60 or 120 cm width through the first and second season. Whereas, purity % behaved the inverse trend of T.S.S % in both seasons. These results are in harmony with those obtained by Amer *et al.*; (1997).

2.3. Effect of intercropping onion with sugar beet on yield and yield components of onion.

Data in table (8) reveal that all characters studied of onion were significantly affected by intercropping patterns in both seasons. Plant height, bulb diameter and bulb weight recorded the highest values with 100 % sugar beet in ridges 60 cm width, while the lowest values were showed with T2 treatment.

As for bulb yield/ fed. the data indicated that the highest values were obtained with pure stand onion in ridges 60 or 120 cm width compared with intercropping pat-

terns which were 32.74, 65..71 % in the first season and 32.65, 65.32 % in the second season, respectively. This serious reduction in intercropped onion yield because of lower intercropping density compared with onion pure stand, also a result of the increase in intra- as well as inter specific competition among plants. Data in Table (8) showed that lower values for 120 cm ridges pure stand than 60 cm width in spite of equal plant population, that may be due to higher Ca CO_3 and Na element (Table 2).

Culls/ fed. and marketable/ fed. of onion behaved the same trend of bulb yield in the first and second seasons (Table 8). These results are in agreement with those obtained by El Kafoury *et al.*, (1993) and El Naggar *et al.* (1996) who found that higher yield and yield components of onion when grown in 120 cm.ridges, compared with 60 cm. width.

2.4. Effect of intercropping garlic with sugar beet on yield and yield components of garlic.

The results in Table (9) reveale that the highest values of plant height, bulb diameter and bulb weight were obtained with garlic pure stand in ridges 60 cm wide, while the lowest values resulted with intercropping 100 % sugar beet + 33 % garlic in both seasons. This reduction is mainly due to the decrease in plant population per unit area and as a result of the increase in inter and intra specific competition. Similar results were reported by Moursi (1965) and Shahien (1987).

Significant differences were found between treatments for total bulb/ fed. in both seasons (Table 9). The highest bulb yield/fed. of intercropping garlic was produced at 100 % sugar beet + 66 % garlic in both seasons. The data were 32.63, 67.03 % in the first season and 31.20, 66.58 % in the second season of the garlic pure stand garlic in ridges 60 or 120 cm wide, respectively. Similar results were obtained by El-Moursi (1999). It is shown that lower values in ridges 120 cm pure stand than 60 cm width in spite of equal plant population may be atributed higher Ca CO_3 and Na element (Table 2).

2.5. Competitive relationships and yield advantage of intercropping:

2.5.1. Land Equivalent Ratio (L.E.R):

Results in Table (10) show that intercropping sugar beet with onion or garlic increased land usage in both intercropping patterns in both seasons. Treatments 1 and 2 proved advantageous by 25 and 56 % in the first season and 25, 56 % in the second season, respectively. Also, treatments 3 and 4 increased land usage of garlic inter-

cropped with sugar beet by 19, 53 % in the first season and 17, 52 % in the second season.

2.5.2 Relative Crowding Coefficient (K):

Two intercropping patterns were advantageous for sugar beet + onion or garlic in both seasons (Table 10). The best results were achieved by intercropping sugar beet + onion or garlic at 100 % sugar beet + 66 % onion or garlic. Sugar beet (ks) was higher contributer component in both intercropping patterns in both seasons. These results are due to increasing plant population of onion or garlic in this pattern.

2.5.3 Aggressivity (A):

The data in Table (10) show that sugar beet was the dominant in both intercropping patterns, whereas onion or garlic was the dominated intercrop component in both seasons. The present results clearly indicated that onion or garlic could be considered as the component with lower competitive abilities when planted with sugar beet.

Economic Evaluation:

The data in Table (10) show that the advantage of intercropping onion or garlic with sugar beet as economic evaluation. The highest values of the total income (L.E/ fed.) could be achieved by treatment of 120 cm width; 3174 and 3154 L.E for intercropping onion with sugar beet and were 4103, 4120 L.E for intercropping garlic with sugar beet in both seasons, respectively.

In general, the data of Kom Ousheem location showed higher yield and yield growth of sugar beet in ridges 60 cm wide, but higher yield and yield components of onion or garlic with the other intercropping systems due to increased plant population.. Higher L.E.R, K and total income were collected from intercropping 100 % sugar beet + 66 % onion or garlic.

Conclusion:

Intercropping 100 % sugar beet + 66 % onion or garlic at Sakha location was the best treatment that results in higher yield of sugar beet, onion and garlic,.as well as, higher total income. At Kom Ousheem location intercropping sugar beet 100 % + 33 % onion or garlic gave higher yield of sugar beet, but the other treatment gave higher yield of onion, garlic and higher income.

Table 9. Yield and yield components of garlic as affected by intercropping with sugar beet (Kom Ousheem location).

Characters / Treatments	Plant height (cm)	Bulb diameter (mm)	Bulb weight (g)	Total bulb/ ton (fed.)
1998/ 1999				
S.beet + garlic (T3)	87.00	3.02	45.12	3.08
S.beet + garlic (T4)	84.06	2.80	35.20	4.88
Garlic - pure stand (T9)	91.06	3.65	46.10	9.44
Garlic – pure stand (T10)	89.04	3.20	35.26	7.28
L.S.D (0.05)	1.36	0.20	1.71	1.58
1999/ 2000				
S.beet + garlic (T3)	85.22	3.00	44.80	3.02
S.beet + garlic (T4)	82.30	2.66	35.30	4.90
Garlic - pure stand (T9)	89.40	3.57	46.32	9.68
Garlic – pure stand (T10)	87.60	3.02	35.38	7.36
L.S.D (0.05)	1.41	0.28	1.53	1.88

T (9) = Garlic pure stand (on ridges 60 cm width)

T (10) = Garlic pure stand (on ridges 120 cm width)

Table 10. Land Equivalent Ratio (L.E.R.) and total income of sugar beet as advantages of Intercropping (Kom Ousheem location).

Characters / Treatments	Land Equivalent Ratio (L.E.R)			Relative Crowiding Coefficient (K)			Aggressivity (A)		Total income
	Ls	Lo & Lg	L.E.R	Ks	Ko & Kg	K	As	Ao& Ag	
1998/ 99									
Sugar beet + onion (T1)	0.92	0.33	1.25	7.80	0.74	5.77	+0.75	-0.75	3070
Sugar beet + onion (T2)	0.90	0.66	1.56	12.56	1.45	18.21	+0.82	-0.82	3174
Sugar beet + garlic (T3)	0.86	0.33	1.19	4.08	0.73	2.98	+0.73	-0.73	3534
Sugar beet + garlic (T4)	0.85	0.67	1.53	7.25	1.54	11.16	+0.67	-0.67	4103
Sugar beet pure stand (T5)									2050
Sugar beet pure stand (T6)									1936
1999/2000									
Sugar beet + onion (T1)	0.92	0.33	1.25	8.18	0.73	5.97	+0.86	-0.86	3038
Sugar beet + onion (T2)	0.91	0.65	1.56	13.43	1.43	19.20	+0.83	-0.83	3154
Sugar beet + garlic (T3)	0.86	0.31	1.17	4.25	0.69	2.93	+0.78	-0.78	3563
Sugar beet + garlic (T4)	0.86	0.66	1.52	8.55	1.51	12.91	+0.72	-0.72	4120
Sugar beet pure stand (T5)									2010
Sugar beet pure stand (T6)									1900

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تأثير نظم التحميل المختلفه للبصل والثوم على انتاجيه وجودة محصول بنجر السكر ومكوناته

صلاح السيد عطيه طعيمه[1] ، كامل على الدوبى[1] ، عبدالله ابراهيم نافع[2]

١ معهد بحوث *المحاصيل الحقليه*
٢ معهد بحوث *المحاصيل السكريه*

أجريت أربع تجارب حقليه موسمى ١٩٩٨/٩٩ و ٢٠٠٠/٩٩، تجربتان بمحطه البحوث الزراعيه بسخا محافظه كفر الشيخ وتجربتان بمحطه البحوث الزراعيه بكوم أوشيم محافظه الفيوم لدراسه تأثير نظامى لتحميل البصل والثوم مع البنجر (تحميل البصل أو الثوم مع بنجر السكر على خطوط بعرض ٦٠ سم وعلى مصاطب بعرض ١٢٠ سم) على النمو وانتاج المحصول وعلي بعض الصفات الكيميائيه للبنجر. وكانت نوع التربه المنزرعه بسخا طينيه ودرجه الحموضه ٧,٨ بينما كانت تربه كوم أوشيم رمليه طينيه طميه ودرجة الحموضه ٨,٩ وأستخدم تصميم القطاعات الكاملة العشوائيه وكانت النتائج المتحصل عليها كالتالى:

موقع سخا

١- تفوقت الزراعه على خطوط ضيقه (عرض ٦٠ سم) وأعطت محصول من بنجر السكر ومكوناته والصفات الكيميائيه (المكونات الصلبه الكليه والسكروز و درجه النقاوه) مقارنه بالزراعه على خطوط بعرض ١٢٠ سم ونفس الاتجاه لوحظ مع البنجر المفرد لكلا الموسمين.

٢- تفوق محصول البصل والثوم المحمل على مصاطب بعرض ١٢٠ سم مقارنة بالزراعه على صفوف بعرض ٦٠ سم فى الموسمين.

٣- سجل معدل إستغلال الأرض و معدل التزاحم للنباتات وكذلك معدل الدخل الكلى أعلى انتاجيه عند الزراعه على مصاطب بعرض ١٢٠ سم. وكانت القيم المتحصل عليها لمعدل استغلال الأرض هى ١,٥٩ و١,٥٦ للبصل و ١,٥١ و١,٤٩ للثوم فى كلا الموسمين على التوالى. وسجل معدل الدخل ٤٥٣١ و ٤٥٤٢ جنيها للبصل و ٥٨٣١ و ٥٧٩٢ جنيها للثوم لكلا الموسمين. كان البنجر سائدا مع نظامى التحميل بينما كان البصل والثوم مسود فى كلا الموسمين.

موقع كوم أوشيم

١- سجلت الزراعه على خطوط ضيقه (عرض ٦٠ سم) اعلا انتاجيه لمحصول بنجر السكر ومكوناته والصفات الكيميائيه (المكونات الصلبه الكليه والسكروز و درجه النقاوه) مقارنة بالزراعه على خطوط بعرض ١٢٠ سم ونفس الاتجاه لوحظ مع البنجر المفرد لكلا الموسمين.

٢- تفوق محصول البصل والثوم المحمل على مصاطب بعرض ١٢٠ سم مقارنة بالزراعه على صفوف بعرض ٦٠ سم بينما سجلت الزراعه المنفرده أعلا انتاجيه على خطوط بعرض ٦٠ سم فى كلا الموسمين.

٣- سجل معدل إستغلال الأرض و معدل التزاحم للنباتات وكذلك معدل الدخل الكلى أعلى انتاجيه

عند الزراعه على مصاطب بعرض ١٢٠ سم. وكانت القيم المتحصل عليها لمعدل استغلال الأرض هى ١,٥٦ و١,٥٦ للبصل و١,٥٣ و ١,٥٢ للثوم فى كلا الموسمين على التوالى . وسجل معدل الدخل ٣١٧٤ و ٣١٥٤ جنيها للبصل و ٤١٠٣ و ٤٢١٠ جنيها للثوم لكلا الموسمين. كان البنجر سائدا مع نظامى التحميل بينما كان البصل والثوم مسود فى كلا الموسمين.