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Integrated crop managements through optimal planting date and nitrogen fertilizer levels in wheat – sugar beet association on competitive relationships and yield advantages

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Abstract

Two field experiments were carried out in **Sers El – Lian** Research Station **(A.R.C)** Menofyia Governorate, Egypt in 2013/2014 and 2014/2015 seasons to investigate the effect of three sowing dates of wheat with sugar beet, four intercropping patterns and three nitrogen fertilizer levels on competitive relationships, yield advantage and cereal units of wheat with sugar beet. A split – split plot design with three replications was used.

The most import results can be summarized as follows:

The highest value of land equivalent ratio (LER) 1.36 was obtained when sowing wheat with sugar beet at the first irrigation and intercropping patterns (100% sugar beet + 33.3% wheat) in ridges at 120 Kg N/fed (D2 × S3 × N3) in combined analysis of two seasons. The best results for relative crowding coefficient (K) was (15.12) achieved with wheat planting at second irrigation of sugar beet with intercropping pattern (100% + 25%) sugar beet/wheat in ridges (60 cm wide) and fertilized by 100 Kg N/fed (D3 × S1 × N2) in combined analysis of the two seasons. Combined data over two seasons of aggressivity (A) revealed that wheat was the dominant component and sugar beet was dominated in combined analysis. Aggressivity values were increased with wheat planting at first irrigation of sugar beet under combination between different intercropping pattern and nitrogen fertilizer rates the highest values (0.62) was obtained at first irrigation of sugar beet with intercropping pattern (100% sugar beet + 25% wheat) on beds and 80 or 100 Kg N/fed (D2 × S2 × N1 or N2). Whereas, the lowest values (0.17) of A were showed with the second irrigation of sugar beet with two factors (D3 × S3 × N3). The highest values of cereal units (113.80)/fed was obtained when wheat just before the first irrigation of sugar beet and intercropping pattern (100% sugar beet + 33.3% wheat) in ridges and 120 Kg N/fed (D2 × S3 × N3). in combined analysis of two seasons. While the lowest one (97.76) cereal unit/fed was obtained with sugar beet at the same irrigation with intercropping pattern (100% sugar beet + 33.3% wheat) on beds and 80 Kg N/fed (D1 × S4 × N1).

Keyword: wheat – sugar beet – intercropping – competitive relationships – yield advantageous – cereal units

Introduction

Sugar beet **(*beta vulgaris L.*)** is an important crop not only in Egypt, but also all over the world as a source of sugar industry. In Egypt, it is the second sugar crop after sugar cane. Sugar beet successfully grows in the newly reclaimed soils by about 104069 and 131308 fed and about 400293[*] and 423633 fed in old lands in 2013/2014 and 2014/2015 seasons, respectively. Egyptian government imported 1129692 ton of sugar in 2014 to meet the needs of the rapid increase of population.[*] It gives higher yield and growth period is about ½ of sugar cane in season (6-7 months) and it has lower water ¼ requirements of sugar cane. Wheat (***T. aestivum L.***) is one of the most cereal crops in the world as well as in Egypt. The increasing wheat production can achieved by increasing the wheat area (more than 3 million/fed), higher varieties and improving cultural practices.

As an attempt to narrow the gap in sugar and wheat by intercropping wheat with sugar beet successfully, without any change in sugar beet density.

Intercropping wheat with sugar beet ridges or beds is one of the most important practices as a means of maximizing productivity and allow full utilization of the environmental resources with minimum competition, especially for light, water and nitrogen fertilizer levels. In this respect **(Willey 1979)** revealed that a major cause of yield advantage intercropping is the better use of grow resources. **Metwally et al. (1997)** reported that intercropping is one of the most practices as away to increase the productivity per unit area especially in new reclaimed land. **Toaima (2006)** intercropped 4 lines of wheat on back beds (120cm) of fodder beet under different NPK fertilization levels, found that the highest LER was (1.42) and K was (7.90) at the highest level of N.P.K (120, 50 and 72 Kg/fed). Sugar beet was dominant and wheat was dominated in both seasons. **Attia et al. (2007)** revealed that LER was (1.30 and 1.33) and K was (4.43 and 4.97) achieved with three rows of wheat intercropped with sugar beet in the first and second seasons respectively. **Abd EL – Gwad et al. 2008)** indicated that intercropping 50% of wheat with fodder beet increased land usage and proved advantageous by 1.21, 1.07, 1.15 and 1.22% for 70, 90, 110 and 130 Kg N/fed, respectively. **Ibrahim et al. (2008)** showed that

The highest values of LER (1.33 and 1.39) and RCC(K) (6.79 and 8.6) were recorded at 2 rows of wheat with 100% sugar beet. Aggressiviety, sugar beet was dominant and wheat was dominated. **Abd**

[*](Ministry of agriculture and land reclamation. Economic affairs sector. the agriculture statistics. Part (1) winter crops in 2013/2014 and 2014/2015, published in February 2015 and 2016 seasons).

EL – Zaher et al. (2009) observed that the highest values of LER (1.82 and 1.80), RCC (107.60) and aggressivity values of barley was dominated when intercropping system (100% sugar beet + 67% barley) (4 rows) in the first and second seasons, respectively. **Abou – Elela(2012)** mentioned out that the highest values of LER was (1.31 and 1.25), RCC was (12.99 and 5.36) when intercropping 25% wheat on the top of the second bed of sugar beet in both seasons, respectively. **Badr (2013)** found that the highest values of LER were (1.48 and 1.43), cereal units (97.54 and 105.95 fed) and K (10.98 and 9.71) were obtained with (100% sugar beet + 50% wheat) and fertilized with 120 or 140 Kg N/fed in both seasons. Whereas the maximum values of cereal units/fed (102.68) recorded at 100% sugar beet + 50% wheat) with 140 Kg N/fed in the first season and (111.93) cereal units/fed in the second season at (100% sugar beet + 25% wheat) under 120 Kg N/fed. Aggressivity values of wheat were positive (dominant) and sugar beet was negative (dominated) under all intercropping patterns. **Dina EL – sherief (2013)** showed that intercropping sugar beet and wheat increased land usage by 37, 35,31 and 33% over monoculture of both crops at wheat hill spacing 20, 40, 60 and 80 cm as average of two seasons. The greatest values of K (4.72) when intercropping wheat with sugar beet in hills 20 cm in the first season and K(39.73) recorded when intercropping wheat and sugar beet at 80 cm between hills in the second season. **Hala Shehata (2015)** found that the maximum values of LER were (1.23 + 1.25), RCC (3.25 and 4.47) and cereal units (87.12 and 92.61/fed) achieved with intercropping pattern (100% sugar beet + 37.5% wheat) in the first and second seasons, respectively. However aggressivity values of sugar beet were positive (dominant) at 3 intercropping pattern and wheat was positive (dominant) at one in the first season and opposite trend in the second season.

The aim of this research is to investigate the effect of sowing date of wheat with sugar beet, intercropping pattern under nitrogen fertilizer levels of wheat with sugar beet on competitive relationships, yield advantages and cereal units/fed.

Materials and Methods

Two field experiments were conducted at Sers El – Lian Agriculture Research Station, (ARC), Menofyia governorate, during two the successive seasons 2013/2014 and 2014/2015 to study the effect of three sowing dates of wheat (***T. aestivum L***.) CV. Gemmeiza 11 with sugar beet (***Beta Vulgaris L***.) CV. Mezzano, four intercropping patterns and three nitrogen fertilizer levels on competitive relationships, yield advantages and cereal units/fed of sugar beet and wheat crops.

The soil type clay loam in the first and second seasons, respectively. The mechanical and chemical analysis of the experimental sites are recorded in Table (1).

The average of climatic factors during the growth seasons in 2013/2014 and 2014/2015 are presented in table (2). The preceding summer crop was maize in both seasons. A split – split plot design with three replication was used. Each experiment consists of 36 treatments which were the combination of three sowing dates of wheat with sugar beet, allocated to the main plots, four intercropping patterns arranged in the sub plots and three nitrogen fertilizer levels were assigned at random in the Sub – Sub plots; in addition two pure stand of sugar beet and wheat.

Table 1. Some physical and chemical properties of the experimental soil in 2013/2014 and 2014/2015 seasons.

Seasons	2013/2014	2014/2015
a. Mechanical analysis		
coarse sand%	**1.27**	**1.59**
fine sand %	**27.12**	**32.12**
silt%	**30.90**	**27.89**
clay%	**40.71**	**38.40**
soil texture	**clay loam**	**clay loam**
b. chemical analysis		
PH	**7.80**	**7.48**
E.C. mmohs	**1.92**	**1.57**
soluble cations(mg/L)		
Ca++	**5.80**	**2.10**
Mg++	**2.30**	**1.20**
Na+	**6.25**	**3.70**
K+	**8.81**	**7.25**
soluble anions(mg/L)		
Co3--	**-**	**-**
Hco3-	**3.02**	**3.20**
CL-	**4.91**	**3.80**
So4--	**3.94**	**3.25**
N PPm	**40.00**	**51.00**
P ppm	**21.00**	**67.00**

K ppm	348.00	397.90

Table 2. Meteorlogical records of Minofyia governorate at monthly period from Nov. to May in 2013/2014 and 2014/2015 seasons.

seasons	2013/2014					2014/2015				
Months	T Max	T Min	RH%	rain (mm)	SRAD	T Max	T Min	RH%	rain (mm)	SRAD
Oct.	30.18	15.58	45.2	2.5	15.1	30.65	17.05	43.9	0.1	18.23
Nov.	27.12	14.62	57.7	14.1	13.08	25.38	13.33	55.5	12.9	12.93
Dec.	20.1	8.48	57.8	22.4	10.93	22.74	10.31	53.7	34.7	11.2
Jan.	20.88	8.5	57.6	38.3	12.51	18.88	7.14	55.8	11.9	11.71
Feb.	22.46	8.23	49	12.2	15.38	20.31	7.73	46.2	2.3	13.62
Mar.	25.59	10.41	45.8	1.7	19.37	25.45	10.74	37.3	4.1	15.41
Apr.	30.67	13.56	30.1	5.2	23.16	28.51	11.68	38.9	5	23.03
May.	33.76	17.63	30.7	1.8	25.56	34.07	16.78	32.1	0.1	26.65
Total				98.2					71.1	

(T MAX, C^0) maximum temperature, (T MIN,C^0) minimum temperature, relative humidity (RH%), rain fall (Rain mm), Solar radiation(SRAD, Mi/m^2/day).

Agriculture Research Center.

Soil, Water & Environment Research Institute

Department of Water Requirements and Field Irrigation.

The treatments studied were as follows:

A. Sowing dates of wheat:

D_1. Sowing wheat and sugar beet at the same time.

D_2. Sowing wheat on the 1st irrigation, of sugar beet.

D_3. Sowing wheat on the 2nd irrigation, of sugar beet.

B. intercropping patterns:

S_1. (100% sugar beet + 25% wheat of pure stand) sugar beet was planted on one side of the ridge (60 cm width), 20 cm apart between hills and thinned one plant/hill and wheat was sown on the other side of the second ridge of sugar beet in hills.

S_2. (100% sugar beet + 25% wheat of pure stand) sugar beet was planted on both sides of the bed (120 cm width), 20 cm apart between hills and thinned one plant/hill and wheat was planted on the top of all beds in hills.

S_3. (100% sugar beet + 33.3% wheat of pure stand) sugar beet was planted on one side of the ridge (60 cm width), 20 cm apart between hills and thinned one plant/hill and wheat was sown on the other side of the second ridge of sugar beet in hills.

S_4. (100% sugar beet + 33.3% wheat of pure stand) sugar beet was planted on both sides of the bed (120 cm width), 20 cm apart between hills and thinned one plant/hill and wheat was planted on the top of all beds in hills.

In addition to (100% sugar beet pure stand of sugar beet was planted one side of the ridges(60 cm width) spaced at 20 cm apart between hills to give 35000 plant/fed. and pure stand of wheat 100% Planted on broadcasting 60 kg seed/fed.

C. Nitrogen fertilizer levels:

Three nitrogen fertilizer levels: N1. 80 kg N/fed then N2. 100 kg N/fed at last N3. 120 kg N/fed. Nitrogen fertilizer was applied in the form of ammonium nitrate (33.5% N) at the three equal doses i.e. ⅓ before first irrigation,⅓ before second irrigation and the last one before third irrigation. Phosphorus fertilizer was added during land preparation in the form of calcium superphosphate (15.5% p_2o_5) at the rate of 200 kg/fed. Potassium sulphate fertilizer (50% k_2o + 18% silver) at the rate of 50 kg/fed was applied in two equal

doses 25kg at the first irrigation and the other before third irrigation. Thinning sugar beet took place after 45 days after sowing to one plant/hill. The other agronomic practices of growing wheat with sugar beet were applied as recommendation in Sers El - lain region. The date of agriculture practices in both season are presented in **Table (3)**.

Table 3. Cultural practices of wheat sown and harvest with sugar beet in 2013/2014 and 2014/2015 seasons.

Cultural practices	Seasons	
	2013/2014	2014/2015
Sowing 1st date of wheat with sugar beet	**30.10.2013**	**28.10.2014**
Sowing 2nddate of wheat.	**22.11.2013**	**23.11.2014**
Sowing 3ddate of wheat.	**16.12.2013**	**14.12.2014**
Harvesting 1st date of wheat.	**21.4.2014**	**20.4.2015**
Harvesting 2nd date of wheat.	**28.4.2014**	**25.4.2015**
Harvesting 3d date of wheat	**15.5.2014**	**10.5.2015**
Harvesting sugar beet.	**20.5.2014**	**16.5.2015**

The studied characteristics were:

I. Sugar beet characters:

Top yield/fed (ton), root yield/fed (ton), biological yield/fed (ton) and sugar yield/fed (ton).

II. Wheat characters

Grain yield/fed (ton), straw yield /fed (ton) and biological yield/fed (ton).

III. Competitive relationships and yield advantages:

1. Land equivalent ratio (LER):

Land equivalent ratio (L.E.R) is calculated as the sum of the fraction of the yields of intercrops relative to their sole crop yields. ***(Willey 1979)*.**

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

Where:

Yab= yield of intercropped sugar beet, (in combination with b).

Yaa= yield of pure sugar beet.

Yba= yield of intercropped wheat, (in combination with a).

Ybb= yield of pure wheat.

2. Relative crowding coefficient (K):

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

To determine if there is a yield advantage of mixing, the product of the coefficient is formed by multiplying **Kab × Kba**.

If **K** > 1 there is a yield advantage.

If **K** = 1 there is no difference.

If **K** < 1 there is a yield disadvantage.

Relative crowding coefficient for both crops were determined according to the following formula:

For species (A) in a mixture with species (B) (**De Wit1960)**

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

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

$$K = Kab \times Kba$$

Where:

Yaa= pure stand of species (A).

Ybb= pure stand of species (B).

Yab= mixture yield of species (A) in combination with (B).

Yba= mixture yield of species (B) in combination with (A).

Zab= Sown proportion of species (A) in mixture with (B).

Zba= Sown proportion of species (B) in mixture with (A).

3. Aggressivity (A):

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

It was proposed by **Mc Gillchrist (1965).** It gives a sample measure of how much the relative yield increase in species (A) is greater than of species (B). Aggressivity is determined according to the following formula:

$$Aab = \frac{Mixture\ yield\ of\ A}{Expected\ yield\ of\ A} - \frac{Mixture\ yield\ of\ B}{Expected\ yield\ of\ B}$$

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

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

4. Cereal units and Economic return.

1. Cereal units/fed:

Cereal units were recorded by **Brockhaus (1962).** Cereal units of all agriculture products for each crop were evaluated based on starch value. This measure avoids fluctuation of agricultural products prices which occurred from time. Each 100 Kg of rye, barley, wheat and oat are considered standard having one unit. The products of sugar beet and wheat were evaluated as follows:

- Each 100 Kg of sugar beet roots = 0.25 unit.
- Each 100 Kg of sugar beet tops = 0.10 unit.
- Each 100 Kg of wheat grain = one unit.
- Each 100 Kg of wheat straw = 0.10 unit.
- **Statistical analysis:**

Mean data collected were statistically analyzed in combined analysis according to ***Gomez and Gomez (1984)*.** Treatment means were compared using least significant difference (L.S.D at 5%) test as outlined by **waller and Duncan(1969)**. All statistical analysis performed using analysis of variance technique by **"MSTAT – C" computer soft ware 1990**.

Results and Discussion

III. Competitive relationships and yield advantages:

1. Effect of sowing dates on:

1.1. Land equivalent ratio (LER):

Data in **Table (4)** revealed that when wheat was planted at different sowing dates with sugar beet increased land usage in combined analysis. Results indicated that Ls values of sugar beet were higher than those of wheat Lw over all intercropping patterns. Relative yield of sugar beet increased by delaying wheat sowing date with sugar beet. Sugar beet Ls were 0.86, 0.91 and 0.93, whereas wheat (Lw) were 0.36, 0.39 and 0.33 when wheat was intercropped with sugar beet at the same time, first irrigation and second irrigation respectively, It is evident that sugar beet was the better contributor in all sowing dates. On the other hand, total LER exceeded one under sowing dates. The highest value was (1.30) obtained by planting wheat with sugar beet at the first irrigation followed by planting wheat with sugar beet of the second irrigation (1.25) and the lowest values when wheat was planted with sugar at simultaneously. It could be concluded that intercropping wheat with sugar beet at the first irrigation is recommended for better land usage. **Sanaa Saad(2007)** when intercropping faba bean with sugar beet at different sowing dates (1st Nov., 15th Nov. and 1st Dec.) showed that (L beet) values were increased by delaying sowing date of faba bean, but decreased (L faba) and (LERs) for both crops, the values of LER were 1.40, 1.37 and 1.30 in the first season and 1.30,1.29 and 1.25 in the second season, respectively.

1.2. Relative crowding coefficient (K):

Results in **Table (4)** showed that delaying wheat sowing date with sugar beet achieved yield advantage in combined analysis. The best result was achieved by planting wheat at the second irrigation of sugar beet followed by at the first irrigation and at simultaneously showed the lowest value where K reached 8.77, 6.95 and 3.56, respectively.

It is quite evident from the results that sugar beet coefficient (Ks) exceeded one and increased by delaying wheat sowing date up to the second irrigation. Whereas wheat coefficient (Kw) exceeded one and increased by delaying wheat sowing date to the second irrigation. This result indicated clearly that sugar beet was the better contributor under sowing dates of wheat with sugar beet. **Sanaa Saad(2007)** when intercropping faba bean with sugar beet at different sowing dates (1st Nov., 15th Nov. and 1st Dec.) found that (K beet) were increased by delaying sowing date, but (K faba) were decreased, where K values were 5.20, 5.78 and 6.14 in the first season and 4.14, 4.28 and 3.54 in the second season, respectively.

1.3. Aggressivity(A):

Results in **Table (4)** indicated that aggressivity(A) among sugar beet and wheat increased by delaying wheat sowing date from simultaneously to first irrigation. Whereas, delaying sowing date from first to second irrigation decreased aggressivity between both components. The results indicated that wheat "the over story" intercrop has higher competitive abilities than sugar beet as the "under story" component. So, wheat was the dominant intercrop component and sugar beet was the dominated intercrop under different sowing dates. **Sanaa Saad(2007)** reported that aggressivity values of sugar beet were positive (dominant) with delaying faba bean sowing date up to 1st Dec. whereas, aggressivity values of faba bean were positive (dominant) at earliest sowing date of faba bean with sugar beet.

Table 4. Effect of sowing dates of wheat with sugar beet on LER, K and A, in combined analysis for (2013/2014 and 2014/2015) seasons.

Sowing dates	LER S	LER W	LER	KS	KW	K	As	Aw
D1	0.856	0.355	1.211	1.864	1.904	3.549	-0.478	0.478
D2	0.909	0.389	1.298	3.167	2.195	6.952	-0.555	0.555
D3	0.926	0.325	1.251	5.280	1.661	8.770	-0.251	0.251
L.S.D. 5%	0.003	0.001	0.004	1.008	0.004	1.182	0.008	0.008

D1 Sowing Wheat with Sugar.
D2 Sowing Wheat 1st Irrigation.
D3 Sowing Wheat 2nd Irrigation.

2. Effect of wheat intercropping patterns with sugar beet on:

2.1. Land equivalent ratio (LER):

Results in **Table (5)** revealed that intercropping wheat and sugar beet when both species were planted under different intercropping patterns, increased land usage in combined, Sugar beet (Ls) in ridges exceeded than (Ls) in beds either with wheat 25% or 33.3% plant density of it is pure stand. Wheat (Lw) under intercropping patterns including wheat 33.3% plant density exceeded than intercropping patterns including wheat 25%. In general sugar beet (Ls) produced higher yields than wheat (Lw) in all intercropping patterns. Land usage recorded the highest value with intercropping pattern (100% + 33.3%) sugar beet/ wheat in ridges (1.28) and the lowest value of LER was obtained with (100% + 25%) intercropping pattern in beds (1.23). These results may be due to the increase in wheat seed rate from 25% to 33.3% with sugar beet 100%. These results were coincided with obtained by **Abd EL-Gwad et al.(2008), Badr(2013), Dina EL-Sherief and Hala Shehata (2015)**. While **Abou – Elela(2012)** found that the highest values of LER(1.31 and 1.25) when intercropping 25%wheat on the top of the second bed of sugar beet in both seasons, respectively.

2.2. Relative crowding coefficient (K):

Data in **Table (5)** showed that intercropping sugar beet with wheat under different intercropping patterns exceed relative crowding coefficient (K) and yield advantageous in combined analysis. The highest results was obtained by intercropping pattern which including wheat 25% and 33.3% in ridge width (60 cm) where (K) value reached (9.51) and (6.19) and the lowest values were obtained with treatments included wheat 25% and 33.3% at terraces (120 cm) where (K) value reached (5.33). It is quite evident from data in Table(5) that sugar beet coefficient (Ks) achieved higher values compared with wheat coefficient (Kw), where sugar beet (Ks) values ranged from (2.76) to (4.99) whereas, wheat (Kw) values ranged between (1.91) and (1.94). Therefore, data indicated clearly that sugar beet (Ks) was more contributor compared with wheat Kw in all intercropping patterns. Similar results were reported by **Toaima(2006)**, **Attia et al.(2007)** and **Abd EL-Zaher et al.(2009)**. Whereas **Abou Elela(2012)** showed the highest values of RCC (12.99 and 5.36) when intercropping 25% wheat on the top of the second bed of sugar beet in both seasons, respectively.

2.3. Aggressivity (A):

Data revealed that wheat was the dominant whereas, sugar beet was dominated in all intercropping patterns as shown in combined analysis **Table (5)**. Data revealed that (A) values far from zero, so intercropping wheat with sugar beet under different intercropping patterns increased competitive abilities and leading to be dominant component in all intercropping patterns. Similar results were reported by **Badr(2013),** but **Ibrahim et al.(2008)** found opposite results for aggressivity, they found that sugar beet was dominant component whereas; wheat was dominated component for aggressivity. While, **Hala Shehata (2015)** reported that aggressivity values of sugar beet were positive (dominant) at three intercropping patterns and wheat was positive dominant at one in first season. Simultaneously aggressivity values of sugar beet and wheat behaved opposite trend in the second season.

Table 5. Effect of intercropping patterns of wheat with sugar beet on LER, K and A, in combined analysis for (2013/2014 and 2014/2015) seasons.

Patterns	LER S	LER W	LER	KS	KW	K	As	Aw
S1	**0.92**	**0.32**	**1.25**	**4.99**	**1.91**	**9.51**	**-0.45**	**0.45**
S2	**0.91**	**0.33**	**1.23**	**2.75**	**1.94**	**5.33**	**-0.50**	**0.50**
S3	**0.89**	**0.39**	**1.28**	**3.24**	**1.91**	**6.19**	**-0.37**	**0.37**
S4	**0.87**	**0.39**	**1.26**	**2.76**	**1.93**	**5.33**	**-0.40**	**0.40**
L.S.D. 5%	**0.006**	**0.001**	**0.006**	**0.475**	**0.004**	**0.616**	**0.010**	**0.010**

S1 (100%Sugar + 25% Wheat) ridges.
S2 (100%Sugar + 25% Wheat) beds.
S3 (100%Sugar +33.3% Wheat) ridges.
S4 (100%Sugar + 33.3% Wheat) beds.

3. Effect of nitrogen fertilizer levels on:

3.1. Land equivalent ratio (LER):

Data in **Table (6)** revealed that land equivalent ratio (LER) values increased land usage by adding N fertilization in combined analysis. The increases of land usage were 24, 27 and 26% by increasing nitrogen fertilizer level from 80 to 100 and 120 Kg N/fed. Data showed that (Ls) was more contributor for land usage compared with (Lw). Land usage of sugar beet (Ls) was 70.96, 71.65 and 71.42 % of sugar beet pure stand, whereas land usage of wheat (Lw) were 29.03, 28.34 and 28.57% of wheat pure stand by adding 80, 100 and 120 Kg N/fed, respectively. Data revealed that the highest value of LER (1.27) was obtained by adding 100 Kg N/fed followed by 120 Kg N/fed (1.26) and the lowest value was (1.24) showed with 80 Kg N/fed. It could be concluded that no differences between 100 and 120 Kg N/fed to obtained the best land usage with intercropping wheat by 25 or 33.3% plant density of its pure stand. Similar results were also reported by **Abd EL-Gwad et al.(2008) , Ibrahim et al.(2008) and Badr(2013.**

3.2. Relative crowding coefficient (K):

Data presented in **Table (6)** clearly indicated that increasing nitrogen rates from 80 to 100 up to 120 Kg N/fed. improved yield advantageous of sugar beet (Ks) and wheat (Kw) in combined analysis. Relative crowding coefficient (K) was more than one and maximum value achieved (8.69) at 100 Kg N/fed followed by 120 Kg N/fed (6.35) whereas the minimum value (4.79) was obtained at 80 Kg N/fed Relative crowding coefficient of sugar beet (Ks) was more contributor for yield advantageous than of wheat (Kw). Sugar beet yield advantageous (Ks) were 2.52, 4.50 and 3.29, whereas (Kw) 1.9, 1.93 and 1.93at 80,100 and 120 Kg N/fed, respectively. It is evident that adding 100 Kg N/fed. gave the highest values (4.50 and 1.93) for crowding coefficient of sugar beet (Ks) and wheat (Kw), respectively. **Attia et al.(2007)**, **Abd EL-Zaher et al.(2009)** and **Badr(2013)**. They found that the best values of (K) was ranged from 4.43 to 10.98 with cropping 3 rows of wheat with sugar beet.

3.3. Aggressivity (A):

Results in **Table (6)** showed that wheat was the dominant component in all treatments, whereas sugar beet was the dominated in combined. Aggressivity

values were increased where sugar beet and wheat fertilized at a rate of 80 Kg N/fed and there is no different in aggressivity values where both component crops at a rate of 100 or 120 Kg N/fed. The present results indicated that wheat could be considered as a component with higher competitive abilities when both crops fertilized by N. fertilization and increased N fertilizer level up to 120 Kg N/fed., lead to increase in growth and yield components of wheat. Similar results were reported by **Badr (2013). Whereas, Attia et al.(2007). Abd EL-Zaher et al.(2009)** showed opposite results they reported that sugar beet was the dominant component and wheat or barley was the dominated components.

Table 6. Effect of N. levels of wheat with sugar beet on LER, K and A, in combined analysis for (2013/2014 and 2014/2015) seasons.

N.levels	LER S	LER W	LER	KS	KW	K	As	Aw
N1	0.88	0.36	1.24	2.52	1.90	4.79	-0.44	0.44
N2	0.91	0.36	1.27	4.50	1.93	8.69	-0.42	0.42
N3	0.90	0.36	1.26	3.29	1.93	6.35	-0.42	0.42
L.S.D. 5%	0.006	0.001	0.006	0.524	0.006	0.632	0.009	0.009

N1 80 Kg N/fed.
N2 100 Kg N/fed .
N3 120 Kg N/fed .

4. Effect of the interaction between sowing date and wheat intercropping patterns (D×S):

4.1. Land equivalent ratio:

Data presented in **Table (7)** revealed that land equivalent ratio achieved positive results by the interaction between wheat sowing dates with sugar beet and intercropping patterns in combined analysis. The highest value (1.34) of land usage was obtained by intercropping wheat 33.3% in ridges with the first irrigation of sugar beet (D2 × S3) where, land usage increased by 34%. Whereas, the lowest value (1.20) for land usage was showed with wheat and sugar beet at simultaneously and (100% + 25%) sugar beet/wheat at terraces (D1 × S2).

4.2. Relative crowding coefficient (K):

Data in **Table (7)** indicated that the interaction between sowing dates and intercropping patterns (D × S) of wheat with sugar beet was advantageous in all treatments in combined analysis. The highest result 15.26 was achieved by planting wheat with sugar beet at the second irrigation of sugar beet and wheat 25% of its pure stand in ridges 60 cm wide (D2 × S3) whereas, the lowest value (2.93) was obtained when wheat was planted and sugar beet with sowing irrigation of sugar beet (D1 × S4) **Table (7)** revealed that values of sugar beet coefficient (Ks) were ranged between 1.57 and 9.16, whereas values of wheat coefficient (Kw) were ranged between 1.63 and 2.26. It is evident clearly that sugar beet was the better contributor to achieve yield advantageous than wheat.

Table 7. Interaction effect between sowing dates and intercropping patterns of wheat with sugar beet on LER, K and A in combined analysis for (2013/2014 and 2014/2015 seasons).

Sowing dates	Intercropping patterns	LER S	LER W	LER	KS	KW	K	As	Aw
D1	S1	0.90	0.32	1.23	2.42	1.93	4.66	-0.50	0.50
	S2	0.87	0.33	1.20	1.74	1.95	3.40	-0.55	0.55
	S3	0.83	0.38	1.22	1.73	1.87	3.23	-0.42	0.42
	S4	0.82	0.39	1.20	1.57	1.87	2.93	-0.45	0.45
D2	S1	0.93	0.35	1.28	3.40	2.12	7.21	-0.57	0.57
	S2	0.91	0.35	1.26	2.64	2.16	5.70	-0.62	0.62
	S3	0.92	0.43	1.34	3.89	2.23	8.68	-0.48	0.48
	S4	0.88	0.43	1.31	2.74	2.26	6.21	-0.55	0.55
D3	S1	0.94	0.29	1.24	9.16	1.67	15.26	-0.29	0.29
	S2	0.93	0.30	1.23	3.87	1.69	6.56	-0.32	0.32
	S3	0.91	0.35	1.27	4.11	1.63	6.70	-0.19	0.19
	S4	0.91	0.36	1.27	3.98	1.65	6.58	-0.20	0.20
L.S.D 5%		0.012	0.002	0.010	0.823	0.008	1.068	0.018	0.018

D1 Sowing Wheat with Sugar.
D2 Sowing Wheat 1st Irrigation.
D3 Sowing Wheat 2nd Irrigation.

S1 (100%Sugar + 25% Wheat) ridges.
S2 (100%Sugar + 25% Wheat) beds.
S3 (100%Sugar +33.3% Wheat) ridges.
S4 (100%Sugar + 33.3% Wheat) beds.

4.3. Aggresivity(A):

Results in **Table (7)** showed that wheat was the dominant intercrop component and sugar beet was the dominated in all treatments in combined analysis. The present results indicated clearly that wheat intercropping patterns with sugar beet just before the first irrigation of sugar beet increased competitive ability of wheat followed by intercropping patterns at planting irrigation of sugar beet and simultaneously (D1 × S2) competitive abilities of wheat was reduced at different intercropping patterns when wheat was planted just before the second irrigation of sugar beet (D3 × S3).

5. Effect of the interaction between wheat sowing dates and N levels:

5.1. Land equivalent ratio (LER):

Results in **Table(8)** showed that wheat sowing date with sugar beet when both species were fertilized by 80 to 100 up to 120 Kg N/fed increased land usage in all treatments in combined analysis. Data revealed that land usage of sugar beet (Ls) was better contributor in land equivalent ratio (LER) than land usage of wheat (Lw). The highest value of land usage (1.31) was obtained when wheat was planted with the first irrigation of sugar beet and 100 or 120 Kg N/fed (D2 × N2 or N3). On the other hand the lowest value of land usage (1.19) was obtained when wheat planted with sowing sugar beet and 80 Kg N fertilizer level (D1 × N1). In general, the second sowing date of wheat under different N. fertilizer rate gave the highest values compared with other sowing dates and different N., fertilization levels.

5.2. Relative crowding coefficient (K):

Results in **Table (8)** showed that the interaction between wheat sowing dates with sugar beet and nitrogen fertilizer level achieved yield advantageous in all treatments. The best yield advantage was achieved with wheat planting date at the second irrigation of sugar beet and a rate of 100 Kg N/fed (K) was 13.22, simultaneously (D3 × N2**)** the lowest value 2.92 of (K) was showed when wheat was planted with sugar beet at the sowing irrigation of sugar beet and a rate of 80 Kg N/fed (D1 × N1). It is quite evident from the results that sugar beet coefficient (Ks) or wheat coefficient (Kw) exceeded one in all treatments.

5.3. Aggressivity(A):

Data presented in **Table (8)** showed that wheat was the dominant component crop and sugar beet was the dominated component crop in all treatments due to the interaction between wheat sowing dates and N. fertilizer levels in combined analysis. Nitrogen fertilizer levels (80,100 and 120 Kg N/fed.) decreased aggressivity values the highest values (0.56) when wheat was planted with sugar beet at the first irrigation of sugar beet (D2 × N1) followed by nitrogen fertilizer levels with planting wheat and sugar beet at the first irrigation of sugar beet, (D2 × N2 or N3) and simultaneously the lowest values of competitive abilities between sugar beet and wheat with the same of nitrogen levels when wheat was planted just before the second irrigation of sugar beet (D3 × N2 orN3). Results indicated clearly that wheat could be considered as the component with higher competitive abilities when wheat and sugar beet fertilized at a rate of 100 or 120 Kg N/fed. under different sowing dates of wheat with sugar beet.

Table 8. Interaction effect between sowing dates and N. levels of wheat with sugar beet on LER, K and A in combined analysis for (2013/2014 and 2014/2015 seasons).

Sowing dates	N.levels	LER S	LER W	LER	KS	KW	K	As	Aw
D1	N1	0.84	0.35	1.19	1.55	1.89	2.92	0.50	-0.50
	N2	0.87	0.36	1.23	2.18	1.92	4.17	0.46	-0.46
	N3	0.86	0.36	1.22	1.87	1.91	3.56	0.48	-0.48
D2	N1	0.89	0.39	1.28	2.66	2.17	5.77	0.56	-0.56
	N2	0.92	0.39	1.31	3.39	2.21	7.51	0.55	-0.55
	N3	0.92	0.39	1.31	3.45	2.20	7.59	0.55	-0.55
D3	N1	0.91	0.32	1.24	3.35	1.65	5.51	0.26	-0.26
	N2	0.93	0.33	1.26	7.93	1.67	13.22	0.25	-0.25
	N3	0.93	0.33	1.26	4.56	1.67	7.62	0.25	-0.25
L.S.D	5%	0.010	N.S	N.S	0.907	N.S	1.095	0.016	0.016

D1 Sowing Wheat with Sugar. N1 80 Kg N/fed.
D2 Sowing Wheat 1st Irrigation. N2 100 Kg N/fed.
D3 Sowing Wheat 2nd Irrigation. N3 120 Kg N/fed.

6. Effect of the interaction between intercropping patterns and N. levels on (S × N):

6.1. Land equivalent ratio (LER):

Results in **Table (9)** revealed that land equivalent ratio (LER) were exceeded one in all treatments due to the interaction between the intercropping patterns

in ridges and N., fertilizer levels in combined analysis. Land usage value achieved the highest value (1.29) when intercropping pattern (100%+ 33.3%) sugar beet/wheat in ridges at a rate of 100 or 120Kg N/fed (S3 × N2 or N3) where, LER value increased by 29% followed by intercropping patterns (100%+33.3%) sugar beet/wheat at terraces and fertilized by 100Kg N/fed which increased LER by 28%. Whereas, the lowest value (1.22) was obtained with intercropping pattern (100% + 25%) sugar beet/wheat at terraces and fertilized by 80 Kg N/fed (S2 × N1) where LER value increased by 22%. Sugar beet was a better contributor in LER and produced higher values in all treatments than wheat. There is no significant differences between intercropping patterns (100%+ 33.3%) sugar beet/wheat at ridges or terraces and fertilized by 100Kg N/fed. Similar results were reported by **Ibrahim et al.(2008);** on the other hand **Badr(2013)** reported that LERs were ranged between 1.48 and 1.92 obtained when intercropping (100% + 50%) sugar beet/wheat with no significant between 120 and 140 Kg N/fed.

6.2. Relative crowding coefficient (K):

Data in **Table (9)** indicated that the interaction between intercropping patterns and N. fertilizer levels achieved yield advantage in combined analysis. The best result was obtained by intercropping wheat with sugar beet (100% + 25 %) at terraces and fertilization by a rate of 100Kg N/fed (S2 × N2) where (K) value reached 4.21 and the lowest value (3.98) was showed by intercropping pattern (sugar beet 100%+wheat 33.3%) at terraces and fertilized by 80 Kg N/fed (S4 × N1), Results indicates clearly that sugar beet has more competitive abilities than wheat in all cases. These results may be due to plant density of sugar beet was 100% whereas, wheat plant density was ranged between 25 and 33.3% of its pure stand. Results reported by **Attia et al. (2007), Abd EL-Gwad et al. (2008), Ibrahim et al. (2008) and Badr (2013)** showed that RCC resulting from intercropping of both species with different nitrogen levels excepted one indicating yield advantages.

6.3. Aggressivity (A):

Data in **Table (9)** indicated that wheat gave positive values of (A), whereas, sugar beet gave negative values of (A) in all treatments because of the interaction between intercropping patterns and N, levels (S × N) in combined. So, wheat is considered dominant component crop and sugar beet was dominated component crop in all interaction treatments. It is quite evident that all the combination between intercropping patterns and nitrogen levels under study increased competitive abilities between wheat and sugar beet. Similar the results were recorded by **Badr (2013)**, but **Toaima (2006), Attia et al. (2007) and Abd EL-Gwad et al. (2008)** revealed that sugar beet was dominant crop and wheat was dominated in both seasosns.

Table 9. Interaction effect between intercropping patterns and N. levels of wheat with sugar beet on (LER, K and A), in combined analysis for (2013/2014 and 2014/2015 seasons).

Intercropping	N levels	LER S	LER w	LER	KS	Kw	K	AGG S	AGG W
	N1	0.91	0.319	1.23	2.14	1.88	4.03	-0.46	0.46
S1	N2	0.93	0.323	1.26	2.19	1.92	4.19	-0.45	0.45
	N3	0.93	0.322	1.25	2.18	1.92	4.18	-0.45	0.45
	N1	0.90	0.323	1.22	2.12	1.91	4.05	-0.49	0.49
S2	N2	0.91	0.327	1.24	2.15	1.95	4.21	-0.49	0.49
	N3	0.91	0.326	1.23	2.14	1.94	4.15	-0.50	0.50
	N1	0.87	0.387	1.25	2.12	1.89	4.01	-0.39	0.39
S3	N2	0.90	0.389	1.29	2.18	1.92	4.19	-0.36	0.36
	N3	0.90	0.388	1.29	2.19	1.91	4.18	-0.35	0.35
	N1	0.85	0.389	1.24	2.08	1.91	3.98	-0.42	0.42
S4	N2	0.89	0.391	1.28	2.17	1.94	4.20	-0.38	0.38
	N3	0.88	0.391	1.27	2.15	1.94	4.17	-0.39	0.39
L.S.D 5%		0.021	N.S	0.012	1.048	N.S	1.395	0.018	0.018

S1 (100%Sugar + 25% Wheat) ridges. **N1 80 Kg N/fed.**
S2 (100%Sugar + 25% Wheat) beds. **N2 100 Kg N/fed.**
S3 (100%Sugar +33.3% Wheat) ridges. **N3 120 Kg N/fed .**
S4 (100%Sugar + 33.3% Wheat) beds.

7. Effect of the interaction between sowing dates, intercropping patterns and N. fertilizer levels on (D × S × N):

7.1. Land equivalent ratio (LER):

Data presented in **Table (10)** revealed that land equivalent ratio (LERs) were positively increased by the interaction between three factors under study in combined analysis. Data indicated that land usage exceeded one in all interaction treatments. The best value (1.36) was obtained with wheat sowing date with sugar beet at the first irrigation of sugar beet and intercropping patterns (sugar beet 100% + wheat 33.3 %) in ridges at a rate of 120 Kg N./fed (D2 × S3 × N3) and the lowest value (1.18) was obtained by wheat

planting with sugar beet at sowing irrigation of sugar beet and intercropping patterns (sugar beet 100% + wheat 33.3%) either in ridges or terraces and with adding 80 Kg N/fed (D1 × S3 or S4 × N1) in combined. Sugar beet was a better contributor in LER and produced higher values (Ls) were ranged between 66.94 and 76% of LERs as average of all treatments whereas, Lw of wheat ranged between 26.44 and 43.33% of LERs. Similar results was obtained by **Sanaa Saad(2007)** found that the highest values of LER (1.51 and 1.45) were produced from intercropping faba bean plant on mid Nov. at the highest plant density (105 thousand/fed) and highest N fertilizer level (100 Kg /fed) in the first and second seasons, respectively when intercropping faba bean with sugar beet.

Table (10): Interaction effect between sowing dates, intercropping patterns and N. fertilizer levels of wheat on (LER, K and A), in combined analysis for (2013/2014 and 2014/2015 seasons).

Sowing dates	Intercropping patterns	N. Levels	LER S	LER W	LER	KS	KW	K	AS	AW
D1	S1	N1	0.88	0.32	1.21	1.92	1.91	3.66	-0.51	0.51
		N2	0.92	0.33	1.25	2.94	1.95	5.71	-0.49	0.49
		N3	0.91	0.32	1.23	2.40	1.93	4.61	-0.49	0.49
	S2	N1	0.86	0.33	1.19	1.64	1.93	3.17	-0.55	0.55
		N2	0.87	0.33	1.20	1.71	1.97	3.37	-0.56	0.56
		N3	0.88	0.33	1.21	1.87	1.96	3.66	-0.54	0.54
	S3	N1	0.80	0.38	1.18	1.35	1.85	2.49	-0.46	0.46
		N2	0.86	0.39	1.25	2.18	1.88	4.09	-0.39	0.39
		N3	0.83	0.38	1.22	1.67	1.87	3.13	-0.43	0.43
	S4	N1	0.79	0.38	1.18	1.29	1.86	2.40	-0.47	0.47
		N2	0.85	0.39	1.23	1.88	1.88	3.52	-0.41	0.41
		N3	0.82	0.39	1.21	1.53	1.88	2.88	-0.45	0.45
D2	S1	N1	0.92	0.34	1.26	2.99	2.09	6.25	-0.57	0.57
		N2	0.93	0.35	1.28	3.50	2.13	7.46	-0.58	0.58
		N3	0.94	0.35	1.29	3.71	2.14	7.94	-0.58	0.58
	S2	N1	0.90	0.35	1.24	2.22	2.13	4.72	-0.62	0.62
		N2	0.92	0.35	1.27	2.85	2.20	6.25	-0.62	0.62
		N3	0.92	0.35	1.27	2.84	2.16	6.15	-0.61	0.61
	S3	N1	0.90	0.43	1.33	3.29	2.20	7.25	-0.49	0.49
		N2	0.92	0.43	1.35	3.86	2.25	8.69	-0.49	0.49
		N3	0.93	0.43	1.36	4.52	2.24	10.12	-0.47	0.47
	S4	N1	0.86	0.43	1.29	2.16	2.24	4.83	-0.57	0.57
		N2	0.90	0.43	1.33	3.36	2.28	7.64	-0.53	0.53
		N3	0.89	0.43	1.32	2.71	2.27	6.17	-0.55	0.55
D3	S1	N1	0.93	0.29	1.22	3.42	1.66	5.66	-0.30	0.30
		N2	0.95	0.30	1.25	9.04	1.67	15.10	-0.28	0.28
		N3	0.95	0.29	1.24	5.01	1.68	8.41	-0.29	0.29
	S2	N1	0.93	0.30	1.23	3.77	1.68	6.31	-0.31	0.31
		N2	0.95	0.30	1.25	4.94	1.70	8.39	-0.30	0.30
		N3	0.92	0.30	1.21	2.91	1.71	4.97	-0.35	0.35
	S3	N1	0.90	0.35	1.25	3.31	1.62	5.36	-0.21	0.21
		N2	0.91	0.35	1.26	3.60	1.64	5.89	-0.20	0.20
		N3	0.94	0.35	1.29	5.42	1.64	8.87	-0.17	0.17
	S4	N1	0.89	0.36	1.24	2.91	1.63	4.75	-0.22	0.22
		N2	0.92	0.36	1.27	4.14	1.67	6.90	-0.21	0.21
		N3	0.94	0.36	1.29	4.90	1.66	8.12	-0.18	0.18
L.S.D	**5%**		**0.021**	N.S	**0.022**	**1.815**	N.S	**2.198**	**0.032**	**0.032**

D1 Sowing Wheat with Sugar. S1 (100%Sugar + 25% Wheat) ridges. N1 80 Kg N/fed.
D2 Sowing Wheat 1st Irrigation. S2 (100%Sugar + 25% Wheat) beds. N2 100 Kg N/fed.
D3 Sowing Wheat 2nd Irrigation. S3 (100%Sugar +33.3% Wheat) ridges. N3 120 Kg N/fed.
S4 (100%Sugar + 33.3% Wheat) beds.

7.2. Relative crowding coefficient (K):

Data presented in **Table (10)** indicated that sugar beet and wheat under different combination between three factors under study was advantageous in all interaction treatments in combined analysis. The best result was achieved with wheat planting before the second irrigation of sugar beet and intercropping pattern (100% + 25%) sugar beet/wheat in ridges (60

cm wide) and fertilized by 100 Kg N/fed (D3 × S1 × N2), which was (15.10). On the other hand, the lowest value 2.40 was showed with wheat planting with sugar beet at sowing irrigation and intercropping pattern (sugar beet 100 % + wheat 33.3%) at terraces and N1 80Kg N/fed (D1 S4 N1) in combined analysis, sugar beet was the best component in all cases with higher (Ks) values. This result that sugar beet has more competitive abilities than wheat and led to a great increase in K under all combination between three factors under study in combined. **Sanaa Saad(2007)** revealed that the maximum values for K were 9.51 and 6.94, obtained from intercropping faba bean and sugar beet at sowing date 1st Nov. at the highest plant density (105 thousand/fed) and 80 Kg N/fed in the first season, whereas in the second season K value was 6.94 achieved from intercropping faba bean with sugar beet at mid Nov. at the highest plant density (105.000/fed) and 100 Kg N/fed when intercropping faba bean with sugar beet.

7.3. Aggressivity (A):

Data presented in **Table (10)** revealed that wheat was the dominant component in all cases and sugar beet was the dominated component in combined analysis. In general, aggressivity values were increased with wheat planting at first irrigation of sugar beet under combination between different intercropping pattern and nitrogen fertilizer rates 0.62 (D2 × S2 × N1or N2). Whereas, the best values 0.17 of (A) were obtained at interaction treatment (D3 × S3 × N3). **Sanaa Saad(2007)** showed that aggressivity values of sugar beet were positive (dominant) and faba bean were negative dominated with delaying faba bean sowing date up the 1st Dec. under any plant density and N fertilizer level in both seasons. whereas, aggressivity were negative for sugar beet and positive for faba bean at earliest sowing date of Faba bean with the moderate and highest plant density under different N. fertilizer levels in both seasons when intercropping faba bean with sugar beet.

II- Cereal units:

1. Effect of wheat sowing dates with sugar beet:

Data presented in **Table (11) revealed** that cereal units/fed were significantly affected by wheat sowing dates with sugar beet in combined analysis. Wheat planting just before second irrigation of sugar beet gave the highest value, where cereal units was 110.62/fed as a total of both crops (main and by products), followed by wheat sowing date with the first irrigation (110.05) cereal units/fed and simultaneously wheat planted with sowing irrigation of sugar beet gave the lowest value (102.90) cereal units/fed which was the least than sugar beet alone (105.84) cereal units/fed.

Table (11): Effect of sowing dates of wheat with sugar beet on total cereal units (root, top, grain, and straw yields/fed.) in combined analysis for (2013/2014 and 2014/2015) seasons.

	Cereal units				
	Main products		By products		Total cereal units/fed.
Sowing dates	Root yield of sugar beet	wheat grain yield	Top yield of sugar beet	Straw yield of wheat	
D1	76.41	11.54	13.36	1.60	102.90
D2	81.14	12.62	14.64	1.66	110.05
D3	82.63	10.55	15.96	1.48	110.62
L.S.D. 5%	0.40	0.03	0.28	0.00	0.48
pure stand of sugar beet	89.24	-	16.60	-	105.84

D1 Sowing Wheat with Sugar.
D2 Sowing Wheat 1st Irrigation.
D3 Sowing Wheat 2nd Irrigation.

2. Effect of wheat intercropping patterns with sugar beet on cereal units.

Results in **Table (12)** indicated that the effect of intercropping patterns of wheat with sugar beet on cereal units were significantly in combined analysis. The differences were light compared with sugar beet pure stand. Intercropping pattern including 100% + 25 % sugar beet/wheat in ridges 60 (cm) wide (S1) achieved the highest value for cereal units/fed (109.67 unit), intercropping pattern 100% + 33.3% ridges S3 occupied the second ranked for both crop products of cereal units (108.02), followed by intercropping pattern including (100 % +25%) at terraces S2 107.54 cereal units/fed and the lowest value of total cereal unit was showed when wheat intercropped by 33.3% of its pure stand with sugar beet at terraces (106.20unit) S4. Results revealed that the intercropping patterns in ridges resulted cereal units more intercropping patterns at terraces. Total cereal units/fed were 103.62, 101.61, 102.05 and 100.35% of sugar beet pure stand(105.84). **Badr (2013)** mentioned that the highest values of cereal units/fed recorded at cropping system (100%+25) sugar beet /wheat in both seasons and **Hala Shehata** (2015) found that (100% sugar beet + 37.5% wheat) gave the highest value than other intercropping patterns.

Table (12): Effect of Intercropping patterns of wheat with sugar beet on total cereal units (root, top, grain, and straw yields/fed.) in combined analysis for (2013/2014 and 2014/2015) seasons.

	Cereal units				
	Main products		By products		Total cereal units/fed.
Patterns	Root yield of sugar beet	wheat grain yield	Top yield of sugar beet	Straw yield of wheat	
S1	82.46	10.46	15.39	1.37	109.67
S2	80.79	10.57	14.77	1.41	107.54
S3	79.22	12.58	14.48	1.75	108.02
S4	77.78	12.66	13.98	1.79	106.21
L.S.D. 5%	0.60	0.02	0.40	0.00	0.76
pure stand of sugar beet	89.24	-	16.60	-	105.84

S1 (100%Sugar + 25% Wheat) ridges.
S2 (100%Sugar + 25% Wheat) beds.
S3 (100%Sugar +33.3% Wheat) ridges.
S4 (100%Sugar + 33.3% Wheat) beds.

3. Effect of nitrogen levels on cereal units:

Cereal units/fed was significantly affected by increasing nitrogen fertilizer levels from 80 to 100 up to 120 Kg N/fed as shown in **Table (13)**. Results revealed that sugar beet pure stand gave the lowest value (105.84) compared with nitrogen fertilizer levels of 100 and 120 Kg N/fed for total cereal units/fed which were 109.13 and 108.90 cereal units/fed, respectively. Whereas, N. fertilizer level of 80 Kg N/fed showed the lowest value (102.9 unit) for cereal units/fed compared with nitrogen fertilizer levels of 100 or 120 Kg N/fed or sugar beet pure stand. The increases of total cereal units/fed for nitrogen fertilizer levels of 100 and 120 Kg N/fed were 3.10 and 2.89% respectively than cereal units/fed of sugar beet alone at 80 Kg N/fed **Mahrous et al. (1998)** found that cereal units/fed had yield advantages by intercropping pattern (100% wheat + 100% lentil) under all rates of N. fertilizer from 20 to 80 Kg N/fed in both seasons.

Table (13): Effect of N. levels of wheat with sugar beet on total cereal units (root, top, grain, and straw yields/fed.) in combined analysis for (2013/2014 and 2014/2015) seasons.

	Cereal units				
	Main products		By products		Total cereal units/fed.
N.levels	Root yield of sugar beet	wheat grain yield	Top yield of sugar beet	Straw yield of wheat	
N1	78.58	11.49	13.90	1.57	105.55
N2	80.96	11.61	14.97	1.58	109.13
N3	80.64	11.60	15.09	1.59	108.90
L.S.D. 5%	0.55	0.03	0.31	0.00	0.62
pure stand of sugar beet	89.24	-	16.60	-	105.84

N1 80 Kg N/fed.
N2 100 Kg N/fed.
N3 120 Kg N/fed.

4. Effect of the interaction between sowing dates and intercropping patterns (D × S) on total cereal units /fed.

The interaction between sowing dates and intercropping patterns was significantly affected on total cereal units in combined analysis as shown in **Table (14)**. Wheat planting with sugar beet at the first irrigation of sugar beet and growing wheat by 33.3 % of its pure stand with sugar beet on ridges (D2 × S3**)** produced the highest value (112.39) for total cereal units/fed whereas, wheat planting with sugar beet at sowing irrigation of sugar beet and growing wheat 33.3% in beds showed the lowest value (100.50) (D1 × S4) for total cereal units/fed.

5. The interaction between sowing dates and nitrogen fertilizer levels on total cereal units/fed (D × N).

Data presented in **Table (15)** indicated that total cereal units/fed were significantly influenced by the interaction between sowing dates and nitrogen fertilizer levels in combined analysis. Data revealed that wheat planting before the second irrigation and fertilizer by 120 Kg N/fed gave the highest values (111.97) for cereal units (D3 × N3). Whereas, wheat

planting with sugar beet at sugar beet sowing irrigation showed the lowest value (100.3) of cereal units/fed (D1 × N1). On the other hand, wheat planting at sugar beet sowing irrigation and fertilizer by 80,100 and 120Kg N/fed gave lower values compared with sugar beet pure stand. These values were(100.3, 104.72, and 103.70) cereal units for these treatments, respectively. So, wheat planting with sugar beet at sowing irrigation of sugar beet under different nitrogen levels to obtain cereal units could not be recommended.

Table 14. Interaction effect between sowing dates and intercropping patterns of wheat with sugar beet on total cereal units (root, top, grain, and straw yields/fed.) in combined analysis for (2013/2014 and 2014/2015) seasons.

Sowing dates	Intercropping	Cereal units				
		Main products		By products		Total cereal units/fed.
		Root yield of sugar beet	wheat grain yield	Top yield of sugar beet	Straw yield of wheat	
D1	S1	80.43	10.55	14.34	1.39	106.70
	S2	77.84	10.65	12.85	1.43	102.77
	S3	74.26	12.45	13.16	1.77	101.64
	S4	73.10	12.48	13.11	1.81	100.50
D2	S1	82.83	11.26	15.84	1.43	111.36
	S2	81.25	11.40	14.14	1.47	108.27
	S3	81.77	13.84	14.94	1.84	112.39
	S4	78.72	13.96	13.63	1.88	108.19
D3	S1	84.11	9.56	15.99	1.29	110.95
	S2	83.27	9.67	17.31	1.32	111.57
	S3	81.62	11.45	15.34	1.62	110.02
	S4	81.51	11.53	15.21	1.70	109.94
L.S.D 5%		1.04	0.04	0.69	0.01	1.32
pure stand of sugar beet		89.24	-	16.60	-	105.87

D1 Sowing Wheat with Sugar.
D2 Sowing Wheat 1st Irrigation.
D3 Sowing Wheat 2nd Irrigation.
S1 (100%Sugar + 25% Wheat) ridges.
S2 (100%Sugar + 25% Wheat) beds.
S3 (100%Sugar +33.3% Wheat) ridges.
S4 (100%Sugar + 33.3% Wheat) beds.

Table(15): Interaction effect between sowing dates and N. levels of wheat with sugar beet on total cereal units (root, top, grain, and straw yields/fed.) in combined analysis for (2013/2014 and 2014/2015) seasons.

Sowing dates	N.levels	Cereal units				
		Main products		By products		Total cereal units/fed.
		Root yield of sugar beet	wheat grain yield	Top yield of sugar beet	Straw yield of wheat	
D1	N1	74.50	11.47	12.74	1.59	100.30
	N2	77.99	11.58	13.55	1.60	104.72
	N3	76.74	11.553	13.81	1.60	103.70
D2	N1	79.76	12.517	14.04	1.64	107.96
	N2	81.83	12.686	14.98	1.66	111.16
	N3	81.84	12.648	14.90	1.66	111.05
D3	N1	81.49	10.49	14.94	1.47	108.39
	N2	83.07	10.577	16.38	1.49	111.52
	N3	83.33	10.59	16.56	1.49	111.97
L.S.D	5%	0.95	N.S	N.S	N.S	1.08
pure stand of sugar beet		89.24	-	16.60	-	105.87

D1 Sowing Wheat with Sugar.
D2 Sowing Wheat 1st Irrigation.
D3 Sowing Wheat 2nd Irrigation.
N1 80 Kg N/fed.
N2 100 Kg N/fed.
N3 120 Kg N/fed.

6. Effect of the interaction between intercropping patterns and N. fertilizer levels on (S × N) on total cereal units/fed.

Cereal units/fed of both sugar beet and wheat were significantly affected by the interaction between intercropping patterns and N. fertilizer level (S × N**)** in combined analysis as shown in **Table (16).** Results indicated that wheat intercropped by 25% of its pure stand in ridges (60 cm) width with sugar beet and fertilized at a rate of 100 and 120 Kg N/fed (S1 × N2 or N3) produced the highest value 110.50 and 110.99, respectively without significant differences between them for cereal units/fed; simultaneously intercropping pattern including (sugar beet 100% + wheat 33.3%) at terraces 120 cm wide at fertilizer by 80 Kg N/fed (S4 × N1) showed the lowest values (103.31) for cereal units/fed. for both crops. Similar results were obtained by **Attia et al. (2007) and Badr(2013).**

Table 16. Interaction effect between intercropping patterns and N. levels of wheat with sugar beet on total cereal units (root, top, grain, and straw yields/fed.) in combined analysis for (2013/2014 and 2014/2015) seasons.

Intercropping patterns	N.levels	Cereal units				
		Main products		By products		Total cereal units/fed.
		Root yield of sugar beet	wheat grain yield	Top yield of sugar beet	Straw yield of wheat	
S1	N1	81.28	10.38	14.52	1.36	107.54
	N2	83.16	10.49	15.48	1.37	110.50
	N3	82.94	10.50	16.17	1.38	110.99
S2	N1	80.13	10.49	14.03	1.40	106.05
	N2	81.46	10.64	15.15	1.42	108.67
	N3	80.78	10.60	15.12	1.41	107.91
S3	N1	77.38	12.51	13.66	1.73	105.28
	N2	79.99	12.63	14.98	1.75	109.35
	N3	80.29	12.60	14.79	1.75	109.43
S4	N1	75.55	12.58	13.40	1.78	103.31
	N2	79.24	12.70	14.27	1.80	108.01
	N3	78.54	12.70	14.28	1.80	107.32
L.S.D 5%		1.09	N.S	N.S	N.S	1.25
pure stand of sugar beet		89.24	-	16.60	-	105.87

S1 (100%Sugar + 25% Wheat) ridges. N1 80 Kg N/fed.
S2 (100%Sugar + 25% Wheat) beds. N2 100 Kg N/fed.
S3 (100%Sugar +33.3% Wheat) ridges. N3 120 Kg N/fed.
S4 (100%Sugar + 33.3% Wheat) beds.

7. Effect of the interaction between wheat sowing dates, intercropping patterns and N. fertilizer levels (D × S × N) on total cereal units in combined.

Results presented in **Table (17)** illustrated that the interaction between three factors under study had a significant effect on cereal units/fed in combined analysis. The highest values of cereal units/fed (113.80) was obtained when wheat planting just before the first irrigation of sugar beet and intercropping patterns sugar beet 100% +wheat 33.3% (in ridges) and 120 Kg N/fed (D2 × S3 × N3) whereas, the lowest value of cereal units/fed (97.76) was showed when wheat planting at sowing irrigation of sugar beet and (sugar beet 100 % + 33% wheat) at terraces intercropping pattern and 80 Kg N/fed (D1 × S4 × N1) **Sanaa Saad (2007)** found the highest values were (116.00 and 109.88 cereal units) recorded from intercropping faba bean with sugar beet in 1st Dec. and faba bean density 70 000 plant/fed and the highest fertilizer level (100 Kg) compared to sugar beet pure stand (113.66 and 108 cereal units) in the first and second season, respectively when intercropping faba bean with sugar beet.

Table 17. Interaction effect between wheat sowing dates, intercropping patterns and N. fertilizer levels of wheat with sugar beet on total cereal units (root, top, grain, and straw yields/fed.) in combined analysis for (2013/2014 and 2014/2015) seasons.

			Cereal units				
			Main products		By products		
Sowing dates	Intercropping patterns	N. Levels	Root yield of sugar beet	wheat grain yield	Top yield of sugar beet	Straw yield of wheat	Total cereal units/fed.
D1	S1	N1	78.80	10.49	13.41	1.38	104.08
		N2	81.75	10.62	14.01	1.39	107.77
		N3	80.72	10.53	15.60	1.39	108.24
	S2	N1	77.09	10.58	12.06	1.42	101.15
		N2	77.76	10.70	13.56	1.44	103.46
		N3	78.69	10.67	12.92	1.44	103.72
	S3	N1	71.43	12.39	12.62	1.76	98.20
		N2	77.03	12.50	13.42	1.78	104.73
		N3	74.34	12.46	13.44	1.78	102.02
	S4	N1	70.68	12.42	12.86	1.80	97.76
		N2	75.42	12.50	13.19	1.81	102.93
		N3	73.20	12.53	13.28	1.82	100.83
D2	S1	N1	82.06	11.15	15.35	1.42	109.99
		N2	82.98	11.30	15.55	1.43	111.26
		N3	83.46	11.33	16.62	1.44	112.85
	S2	N1	79.89	11.29	13.74	1.46	106.39
		N2	81.95	11.52	14.27	1.49	109.23
		N3	81.91	11.39	14.42	1.48	109.20
	S3	N1	80.53	13.74	14.01	1.83	110.11
		N2	81.86	13.92	15.65	1.85	113.28
		N3	82.93	13.87	15.15	1.85	113.80
	S4	N1	76.56	13.88	13.07	1.87	105.38
		N2	80.53	14.01	14.44	1.88	110.86
		N3	79.06	14.00	13.39	1.89	108.34
D3	S1	N1	82.97	9.51	14.79	1.28	108.56
		N2	84.74	9.56	16.88	1.29	112.47
		N3	84.64	9.61	16.28	1.30	111.83
	S2	N1	83.42	9.60	16.30	1.31	110.63
		N2	84.67	9.69	17.61	1.32	113.29
		N3	81.73	9.73	18.02	1.32	110.80
	S3	N1	80.18	11.40	14.37	1.61	107.56
		N2	81.09	11.47	15.88	1.62	110.06
		N3	83.60	11.47	15.77	1.63	112.47
	S4	N1	79.40	11.45	14.29	1.68	106.82
		N2	81.77	11.58	15.17	1.70	110.22
		N3	83.36	11.56	16.17	1.70	112.79
L.S.D	5%	-	1.90	-	-	-	2.16
pure stand of sugar beet		-	89.24	-	16.60	-	105.87

D1 Sowing Wheat with Sugar. S1 (100%Sugar + 25% Wheat) ridges. N1 80 Kg N/fed.
D2 Sowing Wheat 1st Irrigation. S2 (100%Sugar + 25% Wheat) beds. N2 100 Kg N/fed.
D3 Sowing Wheat 2nd Irrigation. S3 (100%Sugar +33.3% Wheat) ridges. N3 120 Kg N/fed.
S4 (100%Sugar + 33.3% Wheat) beds.

Table 18. Interaction effect between wheat sowing dates, intercropping patterns and N. fertilizer levels of wheat with sugar beet on top and root yields (ton/fed) of sugar beet and straw and grain yields(ton/fed) of wheat at harvesting in combined analysis for (2013/2014 and 2014/2015) seasons.

			sugar beet		wheat	
Sowing dates	**Intercropping patterns**	**N.levels**	**Top yield (ton/fed)**	**Root yield (ton/fed)**	**Straw yield (ton/ fed)**	**Grain yield(ton/ fed)**
D1	S1	N1	13.408	31.522	1.377	1.048
		N2	14.012	32.702	1.390	1.062
		N3	15.595	32.292	1.390	1.055
	S2	N1	12.060	30.837	1.423	1.058
		N2	13.561	31.103	1.439	1.070
		N3	12.915	31.477	1.435	1.067
	S3	N1	12.619	28.572	1.763	1.239
		N2	13.422	30.812	1.776	1.250
		N3	13.436	29.735	1.776	1.246
	S4	N1	12.855	28.273	1.798	1.242
		N2	13.190	30.170	1.807	1.250
		N3	13.276	29.282	1.816	1.253
D2	S1	N1	15.345	32.825	1.416	1.115
		N2	15.550	33.193	1.433	1.129
		N3	16.616	33.383	1.442	1.133
	S2	N1	13.742	31.958	1.460	1.129
		N2	14.267	32.780	1.487	1.152
		N3	14.423	32.765	1.476	1.139
	S3	N1	14.004	32.210	1.828	1.374
		N2	15.652	32.748	1.852	1.392
		N3	15.150	33.170	1.845	1.387
	S4	N1	13.068	30.625	1.867	1.388
		N2	14.438	32.210	1.884	1.401
		N3	13.393	31.625	1.887	1.400
D3	S1	N1	14.792	33.183	1.283	0.951
		N2	16.878	33.893	1.292	0.956
		N3	16.282	33.850	1.297	0.961
	S2	N1	16.298	33.363	1.307	0.960
		N2	17.609	33.865	1.320	0.969
		N3	18.017	32.690	1.326	0.973
	S3	N1	14.371	32.070	1.613	1.140
		N2	15.876	32.432	1.621	1.147
		N3	15.770	33.437	1.624	1.146
	S4	N1	14.288	31.757	1.685	1.145
		N2	15.170	32.705	1.703	1.158
		N3	16.170	33.340	1.702	1.156
L.S.D 5%			**N.S**	**0.758**	**N.S**	**N.S**
Pure Stand			**16.599**	**35.696**	**4.871**	**3.248**

D1 Sowing Wheat with Sugar.
D2 Sowing Wheat 1st Irrigation.
D3 Sowing Wheat 2nd Irrigation.

S1 (100%Sugar + 25% Wheat) ridges.
S2 (100%Sugar + 25% Wheat) beds.
S3 (100%Sugar +33.3% Wheat) ridges.
S4 (100%Sugar + 33.3% Wheat) beds.

N1 80 Kg N/fed.
N2 100 Kg N/fed.
N3 120 Kg N/fed.

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الإدارة المحصوليه المتكامله من خلال الميعاد الامثل للزراعه ومستويات التسميد النتروجينى فى تحميل القمح مع بنجر السكر.

- **العلاقات التنافسيه والميزه المحصوليه.**

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أجريت تجربتان حقليان فى موسمى الزراعه 2014/2013 , 2015/2014 فى محطة البحوث الزراعيه بسرس الليان محافظة المنوفيه – مركز البحوث الزراعيه وذلك لدراسة تاثير ثلاث مواعيد لزراعة القمح مع بنجر السكر واربع نظم لتحميل القمح مع بنجر السكر تحت مستويات مختلفه من التسميد النيتروجينى على العلاقات التنافسيه والميزه المحصوليه ووحدات الحبوب لمحصولى بنجر السكر والقمح وكان التصميم المستخدم قطع منشقة مرتين فى ثلاث مكررات.

وكانت اهم النتائج المتحصل عليها هى:-

1. زاد معدل مكافىء استغلال الارض عن الواحد الصحيح نتيجة للتحميل وتاثر هذا المعدل بمواعيد زراعة القمح ونظم الزراعة والتسميد النيتروجينى. وكانت أعلى القيم لمكافىء استغلال الأرض (1.36) وتم الحصول عليه من زراعة القمح مع بنجر السكر فى الريه الاولى للبنجر (رية المحاياه) ونظم الزراعه 100% بنجر سكر + 33.3% قمح بالزراعه على خطوط (60 سم) ومعدل التسميد النتروجينى 120 كيلو نتروجين /فدان فى التحليل المشترك لكلا الموسمين 2014/2013 , 2015/2014.
2. تاثر معامل الحشد النسبى بمواعيد زراعة القمح مع البنجر ونظم الزراعه والتسميد النتروجينى وكانت افضل القيم لمعامل الحشد النسبى (K) (15.20) ناتجه من معاملة التفاعل زراعة القمح مع بنجر السكر فى الريه الثانيه مع نظام التحميل100% + 25 % بنجر سكر مع القمح فى خطوط (60سم) والتسميد بمعدل 100 كجم نتروجين للفدان (D3 × S1 × N2) فى التحليل المشترك للموسمين.
3. كانت قيم العدوانية فى التحليل المشترك لبنجر السكر سالبه (مسود) والقمح موجب (سائد). وكانت اقل القيم للعدوانيه (0.17) بزراعة القمح مع الريه الثانيه للبنجر مع نظام الزراعة (100% بنجر سكر + 33.3% قمح) على خطوط ومعدل التسميد النتروجينى 12 كجم نيتروجين/فدان (D3 × S3 × N3).
4. زادت وحدات الحبوب الناتجه من وحدة المساحه نتيجة التحميل ولقد تحققت اعلى القيم لوحدات الحبوب حيث كانت (113.80) وحده/فدان فى التحليل المشترك للموسمين ناتجة من زراعة القمح مع بنجر السكر عند الرية الاولى للبنجر ونظام التحميل (100% بنجر سكر + 33.3% قمح) على خطوط ومعدل التسميد النتروجينى 120 كجم/فدان (D2 × S3 × N3) .

ومن الدراسة نستنتج انه للحصول على افضل النتائج لعلاقلات التناقس والميزه المحصولية ووحدات الحبوب زراعة القمح مع الريةالاولى لبنجر السكر (رية المحاياة) ومع نظام التحميل (100% بنجر سكر + 33.3 % قمح) على خطوط مع إضافة 100 او 120 كجم نتروجين/فدان تحت ظروف التجربه.