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AGRO-ECONOMIC IMPACT OF INTERCROPPING CANOLA AND ONION ON SOME SUGAR BEET VARIETIES UNDER DIFFERENT NITROGEN RATES

Masri, M.I. and S.A. Safina

Agronomy Department, Fac. of Agric., Cairo Univ., Giza, Egypt

Corresponding author email: mimasri73@gmail.com; drsayedsafina@agr.cu.edu.eg

ABSTRACT

Two field experiments were conducted at the Agricultural Experimental Station, Faculty of Agriculture, Cairo University, Giza, Egypt during 2013/2014 and 2014/2015 seasons to study the agro-economic effect of three nitrogen fertilization rates (60, 80 and 100 kg N/fed), three cropping systems (sugar beet sole, sugar beet + canola and sugar beet + onion) and four multi-germ sugar beet varieties (Farida, Carola, Gloria and Demapoly). The experimental design was a split- split plot in randomized complete block arrangement with three replications.

Results revealed that increased N rates, from 60 to 100 kg fed^{-1} and Growing sugar beet as a sole crop significantly increased root weight, root yield and sugar yield in both seasons. Sugar beet variety Carola was superior in root weight, root yield and sugar yield followed by the variety Farida in both seasons. The main effects of nitrogen, cropping systems and varieties had no significant effect on root quality traits in terms of total soluble solids%, sucrose%, purity% and extractable sucrose% during the two seasons.

The highest significant values of mean root weight (1.019 and 1.109 kg), root number (28.69 and 28.21 thousand plants/fed), root yield (29.35 and 31.47 ton/fed) and sugar yield (3.72 and 3.75 ton/fed) resulted from fertilized sugar beet sole plants with 100 kg N/feddan in the 1st and 2nd seasons, respectively. Irrespective of cropping systems, fertilized sugar beet varieties Farida and Carola plants with 100 kg N/ feddan gave the highest mean values of root weight, root yield and sugar yield during the two seasons. The interaction of cropping systems x varieties had a significant effect on mean root weight, root number, root yield and sugar yield during the two seasons. Among the tested varieties, sole planting of Carola had maximum beet root weight (0.953 and 1.043 kg), beet root yield (28.65 and 31.07 ton/fed) and sugar yield (3.69 and 3.74 ton/fed.) in the 1st and 2nd seasons, respectively, followed by Farida when planted as a sole crop. The highest and significant root and sugar yields were obtained from the sugar beet variety Carola when planted as a sole crop and fertilized with 100 kg N/feddan during the two seasons.

It was observed that irrespective of sugar beet varieties and cropping systems, the highest cost of production and gross revenue were recorded when plants received 100 kg N/feddan. The cost of sugar beet (sole) production was LE. 5350 fed^{-1} against the production costs of LE. 5650 and 6950 fed^{-1} when sugar beet was intercropped with canola and onion, respectively. The highest gross revenue (19002 and 17650 LE/fed) resulted from intercropping sugar beet varieties Carola and Gloria, respectively with onion under 100 kg N/feddan. The maximum net returns was obtained under combination of sugar beet variety Carola + onion (12052 LE/ fed), followed by sugar beet variety Gloria + onion (10700 LE/fed) when plants fertilized with 100 kg N/feddan. The maximum cost benefit ratios of 1.73 and 1.54 were

obtained with nitrogen rate of 100 kg/feddan under combination of sugar beet variety Carola + onion and sugar beet variety Gloria + onion, respectively.

The results showed that for obtaining higher net returns from the unit area, preference may be given to intercrop sugar beet variety Carola with onion and fertilized plants with 100 kg N feddan^{-1}.

Keywords: *Beta vulgaris* L.*, Brassica napus* L., *Allium cepa* L., Nitrogen fertilization, Cropping systems, Sugar yield, Cost- benefit ratio

INTRODUCTION

In view of lessening resources like irrigation water, arable land and energy, there is a dire requirement to devise and practice new strategies and techniques of crop production to meet the expanding needs for food, feed and fiber through sustainable utilization of available inputs(Jabbar *et al* ٢٠١٠ ،

In Egypt, the agriculture intensification had become urgent necessity to optimize the utilizing of limited cultivated area and to maximize the monetary returns of unit area .Egyptian farmers are developing different crop production systems to increase productivity and sustainability since ancient times .This includes crop rotation, relay cropping and intercropping of major crops with other crops .Intercropping is a widespread agronomic practice because it reduces the losses caused by pests, diseases and weeds ،and also guarantees better yield) Andrews, 1974 .(However, several factors like cultivar selection, seeding ratio ،fertilization, planting pattern and competition between mixture components affect the growth of species in intercropping) Caballero *et al* ١٩٩٥ ،.and Carr *et al* .(٢٠٠٤ ،.

In agriculture, several studies have been carried out to evaluate potential agronomic and economic benefits of intercropping. In some cases productivity is enhanced in intercrops (Fukai and Trenbath, 1993), but in the majority of studies intercrop yields are intermediate to the sole crops, or comparable to those of the highest yielding sole crop (Jensen, 1996 and Hauggaard and Jensen, 2001). Krall *et al*. (1996) and Tichy *et al*. (2001) observed that intercropping of sugar beet with mustard have less disease incidence and increased net returns as compared to the sole crop cultivation. Azad and Alam (2004) found that sugar beet + mustard and sugar beet + garlic intercropping systems were poorer in respect of yield and economic returns, while sugar beet +onion showed better performance to get interim benefit from the same piece of land. Usmanikhail *et al*. (2012) evaluated the effect of intercropping three sugar beet varieties with oilseeds (mustard and canola) and lentil. They reported significant differences among the three varieties in leaf area, mean root weight and beet root yield, while they had nearly the same percentage of sucrose either in the sole crop or under intercropping systems. Maximum sugar beet yields and monetary benefits were obtained in lentil intercropping compared to oilseeds intercropping. Besheit *et al*. (2002), Farghaly *et al*.(2003) and Abdel Motagally and Metwally (2014) reported insignificant reduction in sugar beet yield as well as the highest values of land equivalent ratio (LER) and gross return when intercropped with onion.

Successful intercropping systems often are characterized by greater efficiency in the use of solar radiation, nutrients, and soil moisture when compared with monocropped production under the same conditions (Vandermeer, 1989 and Andow, 1991). Over-fertilizing of sugar beet with nitrogen has negative consequences on both the beet grower (low sugar content and therefore lower beet price) and the sugar industry (lower beet quality and therefore poorer sugar extraction performance). Sugar beet is a deep-rooting crop (up to 3 m) and an excellent nitrogen user, extracting most of the available nitrogen left in the soil by preceding crops. Therefore, the most important purpose of sugar beet growers is to increase nitrogen use efficiency. In Egypt, the recommended rate of nitrogen for sugar beet varied from 60 to 120 kg per feddan, depending on the use of organic fertilizers and on a range of site specific characteristics like soil type and climate as well as cropping systems (El-Sarag, 2009; Mahmoud *et al*., 2012 and Masri *et al*., 2015). Effect of nitrogen rates on sugarbeet yield and its attributes was studied by Sharif and Eghbal (1994), Shalaby *et al*. (2003), Ismail and Abo El- Ghit (2005), Mahmoud and Masri (2009) and Abdelaal and Sahar Tawfik (2015) who reported high values of root length, root diameter, fresh root weight, root yield and total soluble solids (TSS%) of pure stand sugar beet when fertilized with 100 to 120 kg N/fed compared to other low levels of mineral nitrogen. Sugar beet is an efficient nitrogen user. Whitmore and Schroder (2007) reported that crops that do compete for a nutrient might be successfully intercropped with one another in the field in order to control environmental losses of that nutrient. Stoyanov *et al*. (1997) observed that intercropping sugar beet with oilseeds such as sugar beet + sunflower combination was more advantageous under recommended nutrient application as compared with higher doses of the macro and micro nutrients.

The objective of this study was to evaluate the impact of intercropping canola and onion in sugar beet under three different nitrogen rates on yield and quality traits of sugar beet as well as monetary returns.

MATERIALS AND METHODS

Two field experiments were conducted at the Agricultural Experimental Station, Faculty of Agriculture, Cairo University, Giza, Egypt during 2013/2014 and 2014/2015 seasons. Experiment location was 22.50 m above sea level and it is situated within 30°, 02´ N latitude and 31°, 13´ E longitude. The preceding summer crop was corn (*Zea mays* L.) during the two seasons. Soil samples (0–0.3 m) were taken in autumn before application of fertilizers and soil properties were determined according to the standard method. The experimental soil texture was clay loam with pH value of 7.82, electrical conductivity (EC) of 0.72 mmhos/cm and organic matter of 2.89%. Total nitrogen (N) content was 0.46%, available phosphorus (P) was 4.81 mg kg^{-1}, available potassium (K) was 84.00 mg kg^{-1}, available sodium (Na) was 115 mg kg^{-1}, available iron (Fe) was 4.6 ppm, available manganese (Mn) was 4.7 ppm, available zinc (Zn) was 3.8 ppm and no salinity problems were observed.

The experiment was carried out to study the effect of three nitrogen fertilization rates (60, 80 and 100 kg N/fed), three cropping systems (sugar beet sole (*Beta vulgaris* L.), sugar beet + canola (*Brassica napus* L.) and sugar beet + onion (*Allium cepa* L.) and four multi-germ sugar beet varieties (Farida, Carola, Gloria and Demapoly) on yield and quality of sugar beet as well as to evaluate the economic return under the different combinations. Variety Giza 20 of onion and variety Serw-4 of canola were used in this study .The experimental design was a split- split plot in randomized complete block arrangement with three replications. Nitrogen rates were allocated to the main plots, while the sub plots were assigned for cropping systems. Sugar beet varieties were distributed at random in the sub-sub plots. Each sub-sub plot area (19.20 m^2) included 4 ridges (strips) each was 4 m in length and 1.20 m in width. Sugar beet seeds were sown on both sides of ridge (1.20 m wide) at 20 cm between plants leaving one plant per hill to give 35000 plants/fed (100 % of sole crop). Canola seeds were sown on the back of ridge (1.20 m wide) in one row, 10 cm between plants leaving two plants per hill to give plant density of 70000 plants/fed (100 % sugar beet + 50 % of canola sole crop). Onion seedlings were sown on the back of ridge (1.20 m wide) in three rows; 20 cm between rows and 10 cm between plants to give plant density of 105000 plants/fed (100% sugar beet + 50 % of onion sole crop). Sugar beet seeds were sown on the first week of October 1^{st} and 3^{rd} in the first and second seasons, respectively. Canola seeds were sown on November 15^{th} and 17^{th} in the first and second seasons, respectively. Onion seedlings were transplanted to the experimental field during the first week of December 3^{rd} and 5^{th} in the first and second seasons, respectively. Nitrogen was added in the form of ammonium nitrates (33.5% N) in three equal splits, the first was applied after thinning of sugar beet at 4-leaf stage and other splits were added at one and two months later. Phosphorous in the form of super phosphate (15.5%) at rate of 30 kg P_2O_5 /fed was added before sowing and during land preparation. Potassium in the form of potassium sulfate (48%) was added at the rate of 48 kg K_2O/fed with the first dose of nitrogen. Thinning of sugar beet took place to one plant/hill at 4- leaf stage (4 weeks from planting), while thinning of canola took place to two plants/hill after one month from planting. Other cultural practice procedures were done as recommended.

Sugar beet was topped and harvested by hand on April 20^{th} (about 200 days old) in both seasons. Harvested roots from the whole area of each sub-sub plot were weighed and adjusted to ton per feddan (one fed = 4200m^2). Total soluble solids were determined by using digital refractometer model PR-1, ATAGO, Japan. Sucrose % was determined polarimetrically on a lead acetate extract of fresh macerated roots according to Carruthers and Oldfield (1960). Purity was calculated by dividing sucrose by TSS. Extractable sucrose % was calculated using the following equation from Dexter *et al.* (1967):

$$\text{Extractable sucrose \%} = [\text{sucrose \%} - 0.3]\left[1 - \left(1.667\left(\frac{100^{-\text{purity}}}{\text{Purity}}\right)\right)\right]$$

Sugar yield was calculated according the following equation:

Sugar yield ton fed^{-1} = root yield ton fed^{-1} × Extractable sucrose %.

Canola was harvested at the age of 160 days of planting and seed yield ton feddan^{-1} was calculated on plot basis. Onion was harvested at the age of 150 days after transplanting of seedlings and dry onion yield ton feddan^{-1} was calculated on plot basis.

Collected data were statistically analyzed using analysis of variance of the spilt-split plot design according to procedures outlined by Steel *et al.* (1997) using MSTAT-C computer package (Freed *et al*., 1989). Treatment mean comparisons were performed using least significant differences (LSD) at 5% level of probability.

Economic analysis:

Economic analysis was done according to Usmanikhail *et al*. (2012). Prices of sugar beet, onion and canola (averaged across seasons) were calculated as follow:

One ton of beet root yield = 350 L.E according to the price of Egyptian sugar beet industry companies.

One ton of onion bulbs = 1500 L.E and one ton of canola seeds = 3000 L.E according to the price of market.

RESULTS AND DISCUSSION

Main effects:

A-Effect of nitrogen rate:

Data presented in Table 1 show the effect of N rates on yield, yield component and juice quality traits of sugar beet in 2013/2014 and 2014/2015 seasons.

Data presented in Table 1 revealed that N rates exhibited significant effect on root fresh weight in both seasons. A gradual increase in root weight as N rate increased up to 100 Kg/fed was recorded. The increase amounted to 17.54% and 40.18% in the first season and 10.79% and 27.52% in the second season as N rate increased from 60 to 80 and 100 Kg/fed, respectively. This increase in root weight is mainly due to the role of N in stimulating the meristematic growth activity which contributes to the increase in number of cells in additions to cell enlargement. Similar findings were reported by Shalaby *et al*. (2003), Ismail and Abo El- Ghit (2005) and Abdelaal and Sahar Tawfik (2015). Number of plants at harvest was significantly increased by increasing N rate over 60 kg/fed. This result is in agreement with that obtained by Mahmoud *et al*. (2012). Root yield was significantly affected by N rate in both seasons (Table 1). Increasing N rates from 60 to 80 kg/fed and from 80 to 100 kg/fed increased root yield by about 19.21% and 26.61% in the 1st season, corresponding to 13.57 % and 14.67% in the 2nd season, respectively. The increase in root yield accompanying high N rate might have been due to the increase in number of harvested roots as well as individual root weight as mentioned before. Such results are in accordance with those reported by Sharif and Eghbal (1994), Shalaby *et al*. (2003), Ismail and Abo El- Ghit (2005), Mahmoud and Masri (2009), Abdelaal and Sahar Tawfik (2015) and Masri *et al*.(2015).

Table 1. Sugar beet agronomic traits as affected by nitrogen fertilization rates during 2013/14 and 2014/15 seasons.

Nitrogen rates (kg/fed)	Agronomic traits							
	Mean root weight (kg)	No. of harvested plants (10^3/fed)	Root yield (ton/fed)	TSS %	Sucrose %	Purity %	Extractable sucrose %	Sugar yield (ton/fed)
2013/2014 season								
60	0.667	25.48	17.18	20.17	17.37	86.10	12.47	2.14
80	0.784	25.95	20.48	20.29	17.59	86.72	12.87	2.64
100	0.935	27.62	25.93	20.32	17.54	86.33	12.70	3.29
LSD at 0.05	0.115	0.74	2.35	NS	NS	NS	NS	0.58
2014/2015 season								
60	0.723	26.39	19.21	20.23	17.48	86.42	12.67	2.43
80	0.801	27.15	21.82	20.27	17.07	84.19	11.53	2.54
100	0.922	26.87	25.02	20.65	17.93	86.77	13.18	3.24
LSD at 0.05	0.136	0.75	2.60	NS	NS	NS	NS	0.69

NS = Non significant

Increasing N rates from 60 up to 100 kg/feddan had no significant effect on root quality traits, in terms of total soluble solids percentage (TSS%), sucrose %, purity % and extractable sucrose % (Table 1). Results in Table 1 cleared that sugar yield was significantly increased by increasing N rates from 60 to 100 Kg/fed. These results were true in the two growing seasons. Such increase amounted to 53.91 % in the first season and 33.33 % in the second one. It is worth to mention that increasing sugar yield by increasing nitrogen rate was firstly due to higher root yield. Similar results were reported by Shalaby *et al*. (2003), Ismail and Abo El- Ghit (2005), Abdelaal and Sahar Tawfik (2015) and Masri *et al*. (2015).

B- Effect of cropping systems:

Data presented in Table 2 revealed that beet root yield and its attributes as well as sugar yield were significantly affected by cropping systems during the two growing seasons. However, cropping systems had no significant effect on root quality traits in both seasons.

The highest significant values of mean root weight (0.893 and 0.967 kg), root number (28.14 and 27.98 thousand plants/fed), root yield (25.26 and 27.14 ton/fed) and sugar yield (3.22 and 3.37 ton/fed) were recorded when sugar beet was grown as a sole crop during the first and second seasons, respectively. The lowest values of beet root yield and its attributes as well as sugar yield were recorded when sugar beet was intercropped with canola, However, this may be due to the high competition between sugar beet and canola on water, solar radiation and fertilization. The reduction in beet root yield was 29.78% and 39.39% when intercropped with canola, while it was 18.47% and 17.22% when intercropped with onion. Similar results were reported by Azad and Alam (2004), Usmanikhail *et al*. (2012) and Abdel Motagally and Metwally (2014).

Table 2. Sugar beet agronomic traits as affected by canola and onion cropping systems during 2013/14 and 2014/15 seasons.

Cropping systems	Agronomic traits							
	Mean root weight (kg)	No. of harvested plants (10^3/fed)	Root yield (ton/fed)	TSS %	Sucrose %	Purity %	Extractable sucrose %	Sugar yield (ton/fed)
2013/2014 season								
Sugar beet sole	0.893	28.14	25.26	20.83	17.88	85.80	12.73	3.22
Sugar beet+Canola	0.724	24.25	17.74	20.36	17.58	86.35	12.74	2.26
Sugar beet + Onion	0.768	26.67	20.59	19.58	17.04	87.01	12.58	2.59
LSD at 0.05	0.032	0.67	1.86	NS	NS	NS	NS	0.22
2014/2015 season								
Sugar beet sole	0.967	27.98	27.14	20.85	17.79	85.29	12.49	3.37
Sugar beet+Canola	0.657	25.12	16.45	20.25	17.50	86.39	12.70	2.11
Sugar beet + Onion	0.822	27.30	22.46	20.05	17.18	85.71	12.19	2.74
LSD at 0.05	0.067	0.70	2.10	NS	NS	NS	NS	0.59

NS = Non significant

C- Effect of sugar beet varieties:

Results in Table 3 revealed that sugar beet varieties differed significantly in mean root weight, root number at harvest, root yield and sugar yield in both seasons. The four sugar beet varieties had nearly the same values of quality traits.

Table 3. Sugar beet agronomic traits as affected by verities during 2013/14 and 2014/15 seasons.

Varieties	Agronomic traits							
	Mean root weight (kg)	No. of harvested plants (10^3/fed)	Root yield (ton/fed)	TSS %	Sucrose %	Purity %	Extractable sucrose %	Sugar yield (ton/fed)
2013/2014 season								
Farida	0.809	28.04	22.86	20.39	17.57	86.11	12.63	2.91
Carola	0.851	27.57	23.69	20.15	17.37	86.16	12.51	2.96
Gloria	0.770	25.56	19.91	19.95	17.31	86.79	12.69	2.52
Demapoly	0.751	24.23	18.33	20.54	17.76	86.47	12.89	2.36
LSD at 0.05	0.042	0.89	0.78	NS	NS	NS	NS	0.16
2014/2015 season								
Farida	0.821	27.78	22.85	20.42	17.51	85.69	12.44	2.82
Carola	0.841	27.94	23.72	20.08	17.21	85.64	12.21	2.87
Gloria	0.823	26.14	21.64	20.81	17.92	86.11	12.89	2.79
Demapoly	0.778	25.34	19.86	20.21	17.32	85.74	12.30	2.46
LSD at 0.05	0.061	1.03	1.89	NS	NS	NS	NS	0.25

NS = Non significant

The highest and significant mean root weight values were recorded by the sugar beet variety Carola in the first season (0.851 kg) and in the second one (0.841 kg). The same variety (Carola) surpassed the other varieties in root yield (23.69 and 23.72 ton/fed) and sugar yield (2.96 and 2.87 ton/fed) in the first and second seasons, respectively. The superiority of variety Carola in root yield might be due to its superiority in mean root weight. Moreover, high root yield from Carola and Farida varieties led to high sugar yield during the two seasons. These results are in agreement with those obtained by Masri (2008), Usmanikhail *et al*. (2012) and Neamatollahi *et al*. (2013) they reported significant differences among sugar beet varieties in mean root weight, root number, root yield and sugar yield.

Interaction effects:

- **Effect of the interaction between nitrogen rates and cropping systems:**

Results in Table 4 indicated that mean root weight, number of plants at harvest, root yield and sugar yield were significantly affected by the interaction between nitrogen rates and cropping systems in both seasons. The highest values of mean root weight (1.019 and 1.109 kg), root number (28.69 and 28.21 thousand plant/fed), root yield (29.35 and 31.47 ton/fed) and sugar yield (3.72 and 3.75 ton/fed) resulted from fertilized sugar beet sole plants with 100 kg N/feddan in the 1^{st} and 2^{nd} seasons, respectively. The interaction between nitrogen rates and cropping systems had no effect on measured root quality traits. However, under each nitrogen rate, sugar beet + onion was the second after sugar beet sole and gave reasonable values of sugar beet yield and all of its attributes during the two growing seasons. This result was in the same line with that reported by Besheit *et al*. (2002), Farghaly *et al*. (2003) and Abdel Motagally and Metwally (2014) they reported that insignificant reduction in sugar beet yield when intercropped with onion.

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- **Effect of the interaction between nitrogen rates and sugar beet varieties:**

Interactive effect of nitrogen rates x varieties was significant for mean root weight, root yield, sucrose percentage and sugar yield in both seasons (Table 5). Fertilized sugar beet varieties Farida and Carola plants with 100 kg N/ feddan gave the highest mean values of root weight (0.958 and 0.978 kg), root yield (27.63 and 28.63 ton/fed) and sugar yield (3.54 and 3.53 ton/fed) respectively, in the first season, corresponding to 0.928 and 1.013 kg, 25.98 and 29.15 ton/fed, 3.26 and 3.56 ton/fed, respectively, in the second season. The highest percentage of sucrose (18.13%) in the first season was recorded by the variety Farida when fertilized with 80 kg N/fed., while in the second season, the highest percentage of sucrose (18.50%) was recorded by the variety Gloria followed by the variety Farida (18.0 %) when fertilized with 100 kg N/fed. Differences in the performance of sugar beet varieties under different nitrogen rates were reported by Stevens *et al*. (2008) and Mahmoud *et al*. (2012).

Table 5. Interactive effect of nitrogen rates x varieties on sugar beet agronomic traits during 2013/14 and 2014/15 seasons.

Nitrogen rates (kg /fed)	Varieties	Agronomic traits							
		Mean root weight (kg)	No. of harvested plants (10^3/fed)	Root yield (ton/fed)	TSS %	Sucrose %	Purity %	Extractable sucrose %	Sugar yield (ton/fed)
2013/2014 season									
60	Farida	0.672	28.10	19.04	19.78	16.80	84.90	11.62	2.24
	Carola	0.735	26.35	19.57	20.18	17.37	86.07	12.46	2.42
	Gloria	0.642	23.97	15.50	20.40	17.73	86.96	13.06	2.02
	Demapoly	0.618	23.49	14.62	20.32	17.57	86.46	12.76	1.86
80	Farida	0.797	27.30	21.91	20.80	18.13	87.19	13.46	2.94
	Carola	0.840	27.14	22.87	20.30	17.57	86.53	12.79	2.95
	Gloria	0.750	25.56	19.27	19.42	16.87	86.86	12.39	2.40
	Demapoly	0.748	23.81	17.87	20.63	17.80	86.30	12.86	2.29
100	Farida	0.958	28.73	27.63	20.60	17.77	86.25	12.83	3.54
	Carola	0.977	29.21	28.63	19.97	17.17	85.88	12.28	3.53
	Gloria	0.918	27.14	24.96	20.03	17.33	86.55	12.61	3.14
	Demapoly	0.887	25.40	22.51	20.67	17.90	86.66	13.07	2.93
LSD at 0.05		0.075	NS	1.23	NS	0.81	NS	NS	0.38
2014/2015 season									
60	Farida	0.763	27.94	21.27	20.60	17.77	86.28	12.82	2.72
	Carola	0.775	26.51	20.73	20.17	17.50	86.78	12.83	2.65
	Gloria	0.707	25.56	18.18	20.52	17.73	86.38	12.87	2.33
	Demapoly	0.648	25.56	16.67	19.62	16.90	86.25	12.15	2.03
80	Farida	0.772	27.62	21.30	19.77	16.77	84.79	11.56	2.49
	Carola	0.728	28.89	21.26	19.98	16.87	84.39	11.46	2.42
	Gloria	0.873	26.83	23.49	20.88	17.53	83.97	11.75	2.79
	Demapoly	0.832	25.24	21.22	20.43	17.10	83.63	11.34	2.46
100	Farida	0.928	27.78	25.98	20.90	18.00	85.99	12.95	3.26
	Carola	1.013	28.41	29.15	20.10	17.27	85.75	12.33	3.56
	Gloria	0.890	26.03	23.25	21.03	18.50	87.98	14.04	3.25
	Demapoly	0.855	25.24	21.69	20.57	17.97	87.35	13.41	2.89
LSD at		0.106	NS	2.27	NS	1.17	NS	NS	0.61

0.05									

NS = Non significant

- **Effect of the interaction between cropping systems and sugar beet varieties :**

Interactive effect of cropping systems x varieties had significant effect on mean root weight, root number, root yield and sugar yield during the two seasons (Table 6).Sugar beet varieties planted as sole showed significantly higher values of most studied traits. Among the tested varieties, sole planting of Carola had maximum beet root weight (0.953 and 1.043 kg), beet root yield (28.65 and 31.07 ton/fed) and sugar yield (3.69 and 3.74 ton/fed) in the 1st and 2nd seasons, respectively, followed by Farida when planted as sole. Sugar beet + onion intercropping was also better which showed the second lowest values as compared to sugar beet sole planting. However, minimum values of sugar beet characters were noted in the cropping systems of sugar beet + canola. The interactive effect of main crop varieties and intercrops have been studied by many researchers including Singh and Singh (1995), Banaszak *et al*.(1998), Anonymous (2000), Osman and Haggag (2000) and Usmanikhail *et al*. (2012) and their findings coincide the results of the present study, suggesting winter crops + sugar beet intercropping with respect to suitable varieties. They also reported that new varieties of sugar beet showed a positive response to productivity of intercrops and worked to suppress insect pests.

- **Effect of the interaction among nitrogen rates, cropping systems and sugar beet varieties:**

The second order interaction was significant for mean root weight, root yield and sugar yield during the two seasons. The highest and significant means of root weight (1.085 and 1.275 kg), root yield (33.59 and 38.86 ton/fed) and sugar yield (4.58 and 4.55 ton/fed) were recorded by the sugar beet variety Carola under solid cropping and nitrogen rate of 100 kg N/feddan in the first and second seasons, respectively.

Table 6. Interaction effect of cropping systems x varieties on sugar beet agronomic traits

Cropping systems	Varieties	Agronomic traits							
		Mean root weight (kg)	No. of harvested plants (10^3/fed)	Root yield (ton/fed)	TSS %	Sucrose %	Purity %	Extractable sucrose %	Sugar yield (ton/fed)
2013/2014 season									
Sugar beet sole	Farida	0.905	30.80	27.85	21.00	18.03	85.87	12.87	3.58
	Carola	0.953	30.00	28.65	20.78	17.87	85.97	12.79	3.69
	Gloria	0.868	26.83	23.39	20.63	17.73	85.92	12.68	2.94
	Demapoly	0.847	24.92	21.15	20.92	17.87	85.42	12.57	2.66
Sugar beet + Canola	Farida	0.735	25.87	19.08	20.32	17.40	85.54	12.32	2.38
	Carola	0.777	24.92	19.54	20.13	17.33	86.05	12.45	2.43
	Gloria	0.703	23.33	16.68	20.02	17.43	87.15	12.90	2.13
	Demapoly	0.68	22.86	15.66	20.97	18.17	86.66	13.28	2.08
Sugar beet + Onion	Farida	0.787	27.46	21.65	19.87	17.27	86.92	12.71	2.76
	Carola	0.822	27.78	22.88	19.53	16.90	86.46	12.29	2.77
	Gloria	0.738	26.51	19.66	19.20	16.77	87.30	12.48	2.48
	Demapoly	0.727	24.92	18.18	19.73	17.23	87.34	12.84	2.35
LSD at 0.05		0.075	1.55	1.23	NS	NS	NS	NS	0.38
2014/2015 season									
Sugar beet sole	Farida	1.013	27.78	28.18	20.97	17.63	83.99	11.87	3.32
	Carola	1.043	29.69	31.07	20.35	17.33	85.05	12.09	3.74
	Gloria	0.915	27.30	24.96	21.35	18.53	86.83	13.62	3.38
	Demapoly	0.897	27.14	24.33	20.72	17.67	85.28	12.37	3.03
Sugar beet + Canola	Farida	0.618	26.99	16.66	20.52	17.90	87.20	13.31	2.23
	Carola	0.65	25.55	16.44	20.35	17.47	85.83	12.44	2.08
	Gloria	0.732	24.13	17.69	20.35	17.63	86.53	12.88	2.26
	Demapoly	0.630	23.81	15.00	19.77	17.00	86.00	12.17	1.87
Sugar beet + Onion	Farida	0.832	28.57	23.72	19.78	17.00	85.87	12.14	2.92
	Carola	0.823	28.57	23.63	19.55	16.83	86.05	12.09	2.81
	Gloria	0.823	26.99	22.26	20.73	17.60	84.97	12.17	2.73
	Demapoly	0.808	25.08	20.25	20.13	17.30	85.95	12.36	2.49
LSD at 0.05		0.106	1.79	2.27	NS	NS	NS	NS	0.61

NS = Non significant

Monetary benefits:

Beet root yield (ton fed^{-1}):

Impact of intercropping different sugar beet varieties with canola and onion was assessed by measuring the crop productivity under different N rates and resultant impact on the net returns (Table 7). It was observed that sugar beet varieties fertilized with 100 kg N/fed gave the highest beet root yield either in sole crop or when intercropped with other crops. Sole cropping sugar beet, variety Carola showed the highest beet root yield of 36.23 ton fed^{-1}, followed by variety Farida with beet root yield of 32.85 ton fed^{-1}, while the minimum beet root yield of 25.31 ton fed^{-1} was recorded in variety Demapoly. The interaction of sugar beet varieties when intercropped with onion showed that beet root yield was slightly higher as reported under Carola + onion (27.64 ton fed^{-1}) , followed by interactions of variety Farida + onion (26.49 ton fed^{-1}). The beet root yield was decreased when canola crop

was intercropped. Krall *et al*.(1996), Stoyanov *et al*. (1997), Azad and Alam (2004) and Usmanikhail *et al*. (2012) reported reduction in sugar beet yield when intercropped with some oilseed crops; however, the overall crop productivity was remarkably higher under intercropping systems as compared to sole cropping and onion crop was recorded to determine the effect of intercropping. The data showed that the canola seed yield was highest (0.690 ton fed^{-1}) when canola was intercropped with sugarbeet variety Demapoly. The highest dry onion yield of 6.22 and 6.14 tons $fed^{-1}$was obtained when intercropped with sugar beet varieties Carola and Gloria, respectively. Stoyanov *et al*. (1997, Azad and Alam (2004) and Usmanikhail *et al*. (2012) reported no significant decrease in the yields of intercrops when sown with sugar beet under good soil and crop management.

Cost of production and gross revenue:

It was observed that irrespective of sugar beet varieties and intercropping system the highest cost of production and gross revenue were recorded when plants received 100 kg N/feddan (Table 7). The cost of sugar beet (sole) production was LE 5350 fed^{-1} against the production costs of LE 5650 and 6950 fed^{-1} when sugar beet was intercropped with canola and onion, respectively. In term of cost of production, a nominal difference was noted when sugar beet was intercropped with onion. Intercropping sugar beet varieties with onion resulted in improved overall productivity and returns over the sole crop cultivation. The highest gross revenue (19002 and 17650 LE/fed) resulted from intercropping sugar beet varieties Carola and Gloria, respectively with onion under 100 kg N/feddan. The gross revenue has been universally reported markedly higher under intercropping systems under good management conditions as compared to sole cropping and sugar beet + onion have proved to generate high revenues. These findings are in concurrence with those of Besheit *et al*. (2002), Farghaly *et al*. (2003) Azad and Alam (2004) and Abdel Motagally and Metwally (2014).

Net returns and cost benefit ratio:

Irrespective of cropping systems and varieties, the maximum net returns and benefit cost ratios were obtained by fertilized plants with 100 kg N/feddan (Table 7). The net returns of cultivation Carola, Farida, Gloria and Demapoly as sole cropping were 7329, 6148, 4186 and 3509 LE/fed, respectively. The net returns was maximized under combination of sugar beet variety Carola + onion (12052 LE/ fed), followed by sugar beet variety Gloria + onion (10700 LE/fed) and sugar beet variety Farida + onion (10350 L.E./ fed) when plants were fertilized with 100 kg N/feddan, while it was minimized when the same varieties in order intercropped with canola (3885, 3637 and 2983 LE/fed). The results showed that for obtaining higher net returns, preference may be given to intercrop sugar beet variety Carola with onion. The data indicated that maximum cost benefit ratios of 1.73 and 1.54 were obtained with nitrogen rate of 100 kg/feddan under combination of sugar beet variety Carola + onion and sugar beet variety Gloria + onion, respectively. The cost benefit ratios of cultivation Carola and Gloria with canola were considerably reduced to 0.69 and 0.64, respectively, under the same rate of nitrogen (100 kg N/fed). For improved cost benefit ratios, intercropping of sugar beet varieties Carola and Gloria with onion and fertilized plants with

100 kg N/feddan could be preferred .The net returns varied with the production costs and revenue generated from a cropping system. Besheit *et al*. (2002), Farghally *et al*.(2003), Azad and Alam (2004) and Abdel Motagally and Metwally (2014) indicated that intercropping sugar beet with onion was found to be superior in respect of agronomic yield, monetary benefits and adjusted beet root yield. Hence, the results suggested that, application of 100 kg N/feddan and intercropping of sugar beet variety Carola with onion for getting higher gross revenues and net returns from the unit area.

Table 7. Economic evaluation of various intercropping practices with sugarbeet (averaged across seasons).

Nitrogen rates (kg/fed)	Cropping systems	Varieties	Beet root yield (ton/fed.)	Intercrop yield (ton/fed)	Cost of production (L.E. /fed)	Gross revenue (L.E. /fed)	Net return (L.E./fed)	Benefit cost ratio
60 kg	Sugar beet sole	Farida	24.33	0.00	4950	8515	3565	0.72
		Carola	25.68	0.00	4950	8986	4036	0.82
		Gloria	20.11	0.00	4950	7039	2089	0.42
		Demapoly	18.92	0.00	4950	6622	1672	0.34
	Sugar beet + Canola	Farida	15.19	0.30	5350	6209	859	0.16
		Carola	15.16	0.40	5350	6496	1146	0.21
		Gloria	12.56	0.41	5350	5635	285	0.05
		Demapoly	11.92	0.58	5350	5923	573	0.11
	Sugar beet + Onion	Farida	20.95	4.56	6550	14175	7625	1.16
		Carola	19.62	5.42	6550	14995	8445	1.29
		Gloria	17.84	5.35	6550	14264	7714	1.18
		Demapoly	16.10	4.87	6550	12939	6389	0.98
80 kg	Sugar beet sole	Farida	26.87	0.00	5150	9405	4255	0.83
		Carola	27.67	0.00	5150	9685	4535	0.88
		Gloria	25.17	0.00	5150	8809	3659	0.71
		Demapoly	24.00	0.00	5150	8398	3248	0.63
	Sugar beet + Canola	Farida	17.33	0.35	5500	7129	1629	0.30
		Carola	16.01	0.49	5500	7065	1565	0.28
		Gloria	18.02	0.53	5500	7905	2405	0.44
		Demapoly	14.80	0.65	5500	7141	1641	0.30
	Sugar beet + Onion	Farida	20.62	4.94	6750	14629	7879	1.17
		Carola	22.51	5.80	6750	16584	9834	1.46
		Gloria	20.94	5.72	6750	15915	9165	1.36
		Demapoly	19.83	5.26	6750	14826	8076	1.20
100 kg	Sugar beet sole	Farida	32.85	0.00	5350	11498	6148	1.15
		Carola	36.23	0.00	5350	12679	7329	1.37
		Gloria	27.25	0.00	5350	9536	4186	0.78
		Demapoly	25.31	0.00	5350	8859	3509	0.66
	Sugar beet + Canola	Farida	21.08	0.42	5650	8633	2983	0.53
		Carola	22.80	0.52	5650	9535	3885	0.69
		Gloria	20.96	0.65	5650	9287	3637	0.64
		Demapoly	19.27	0.69	5650	8814	3164	0.56
	Sugar beet + Onion	Farida	26.49	5.36	6950	17311	10361	1.49
		Carola	27.64	6.22	6950	19002	12052	1.73
		Gloria	24.11	6.14	6950	17650	10700	1.54

		Demapoly	21.71	5.67	6950	16103	9153	1.32

REFERENCES

Abdel Motagally, F.M.F. and A.K. Metwally (2014). Maximizing productivity by intercropping onion on sugarbeet. Asian Journal of Crop Sci., 6(3): 226-235.

Abdelaal, Kh.A.A. and Sahar, F. Tawfik (2015). Response of sugar beet plant (*Beta vulgaris* L.) to mineral nitrogen fertilization and bio-fertilizers. Int. J. Curr. Microbiol. App. Sci., 4(9): 677-688.

Andow, D. (1991). Vegetational diversity and arthropod population response. Annu. Rev. Entomol., 36: 561-586.

Andrews, D.J. (1974). Response of sorghum varieties to intercropping. Experimental Agriculture, 10: 57-63.

Anonymous (2000). Feasibility of Intercropping oilseeds in sugarbeet. Proc. 7th Int Symp. on profitability of intercropping oilseeds in major crops, Nov. 3-5, CIMMYT, Nairobi, Kenya.

Azad, M.A.K. and M.J. Alam (2004). Popularizing of Sugarcane Based Intercropping Systems in Non Millzone. J. Agron., 3(3): 159-161.

Banaszak, H.; M. Nowakowski; J. Szymczak-Nowak and K. Ojczyk (1998). Limiting of Heterodera schachtii Schm. diseases and weeds of sugar beet by tillage system based on mustard or radish intercrops and mulches. J. Plant Protec.Res., 38(1): 70-80.

Besheit, S.Y.; A.M. Abo Elwafa; A.S. Abo EL-Hamd and M.A. Bekheet (2002). Quality and productivity of sugar beet as affected by intercropping onion in various densities. Al-Azhar J. Agric. Res., 36:87-101.

Caballero, R.; E.L. Goicoechea and P.J. Hernaiz (1995). Forage yield and quality of common vetch and oat sown at varying seed ratios and seeding rates of

Carr, P.M.; R.D. Horsley and W.W. Poland (2004). Barley, oat and cereal-peamixtures as dryland forages in the Northern Great Plains. Agron. J., 96: 677-684.

Carruthers, A. and J.F.T. Oldfield (1960). Methods for the assessment of beet quality. Int. Sugar J., 63: 72-74, 103-105, 137-139.

common vetch. Field Crops Res., 41: 135-140.

Dexter, S.T.; M.G. Frankes and F.W. Snyder (1967). A rapid and practical method of determining of extractable white sugars as may be applied to the evaluation of agronomic practices and grower deliveries in the sugar beet industry. J. Amer. Soc. Sugar Beet Technol., 14: 433 – 454.

El-Sarag, E.I. (2009). Maximizing sugar beet yield, quality and water use efficiency using some agriculture practices under North Sinai conditions. Bull. Fac. Agric., Cairo. Univ., 60(2): 155-167.

Farghaly, B.S.; A.A. Zohry and S.A.A. Bssaly (2003). Crop management for intercropping sugar beet with some essential crops to maximize area unit productivity. J. Agric. Sci. Mansoura Univ., 28:5183-5199.

Freed, R.S.P.; S. Einensmith; S. Gutez; D. Reicosky; V.W. Smail and P. Wolberg (1989). MSTAT-C analysis of agronomic research experiments. Michigan Univ. East Lansing, USA.

Fukai, S. and B.R. Trenbath (1993). Intercropping for the management of pests and diseases. Field Crops Res., 34: 381- 405.

Hauggaard, H. and E.S. Jensen (2001). Evaluating pea and barley cultivars for complementarity in intercropping at different levels of soil N availability. Field Crops Res, 72: 185-196.

Ismail, A.A.A. and R.A. Abo El-Ghit (2005). Effect of nitrogen sources and levels on yield and quality of sugar beet. Egypt. J. Agric. Res., 83(1): 229-239.

Jabbar, A.; R. Ahmad; I.H. Bhatti; A. Rehman; Z.A. Virk and S.N. Vains (2010). Effect of different rice-based intercropping system on rice grain yield and residual soil fertility. Pakistan. J. Bot., 42(4): 2339-2348.

Jensen, E.S. (1996). Grain yield and symbiotic N2 fixation and interspecific competition for inorganic N in pea-barley intercrops. *Plant and Soil*, 182: 25-38.

Krall, J.M.; D.W. Koch, F.A. Gray and Yun LiMei (1996). Potential of sugar beet and mustard for use in sugar beet intercroppings. Progress in new crops: Proceedings of the Third National Symposium Indianapolis, Indiana. pp. 619-622.

Mahmoud E.A.; M.A. Hassanin; I.R. Emara Eman (2012). Effect of organic and mineral nitrogenous fertilizers and plant density on yield and quality of sugar beet (*Beta vulgaris* L.). Egypt. J. Agron., 34(1): 89-103.

Mahmoud, E.A. and M.I. Masri (2009). Effect of nitrogen rates and its time of application on productivity of sugar beet under sprinkler irrigation in newly reclaimed soils. J. Agric. Sci. Mansoura Univ., 34(8): 9037-9048.

Masri, M.I (2008). Genotype × environment interaction and stability analysis in sugar beet. Proceedings of Meeting the Challenges of Sugar Crops and Integrated Industries in Developing Countries, Al-Arish, Egypt, pp. 186-191.

Masri, M.I.; B.S.B. Ramadan; A.M.A. El-Shafai and M.S. El-Kady (2015). Effect of water stress and fertilization on yield and quality of sugar beet under drip and sprinkler irrigation systems in sandy soils. Int. J. Agric. Sci., 5(3): 414- 425.

Neamatollahi, E.; M.M. Khademosharieh; A.S. Darban and M.R. Jahansuz (2013). Application of different amounts of $ZnSO_4$ in five varieties of sugar beet. Advances Environ. Biol., 7(6): 1113-1116.

Osman, M.S. and M.E.A. Haggag (2000). A study on the feasibility of intercropping sugar beet with other winter crops. Research Bulletin, Faculty of Agriculture, Ain Shams University, pp. 1-7.

Shalaby, M.T.; M.B. Doma; F.A. Abd El-latif and sohair M.E. Sadik (2003). Agricultural chemical, technological studies on sugar beet. 2- Effect of nitrogen application on yield, chemical constituents and juice quality characteristics of sugar beet. J. Agric. Sci. Mansoura Univ., 28 (3): 1853-1864.

Sharif,A.F. and K. Eghbal (1994). Yield analysis of seven sugar beet varieties under different levels of nitrogen in a dry region of Egypt. Agribiological Res., 47 (¾): 231-241.

Singh, A.K. and R.A. Singh (1995). Optimum Plant Densities for sesame, blackgram and sorghum in pigeon pea-based intercroping systems. *International Chickpea and Pigeon Pea Newsletter*, 2: 58-59.

Steel, R.G.D.; J.H. Torri and D.A. Dickey (1997). Principles and Procedures of Statistics: A Biometrical Approach, 3rd ed,. Mc Graw-Hill, New York. 666p.

Stevens, W.B.; R.D. Violett; S.A. Skalsky and A.O. Mesbah(2008).Response of eight sugar beet varieties to increasing nitrogen application: I. root, sucrose, and top yield. Journal of Sugar Beet Res., 45(3 & 4):65-83.

Stoyanov, D.; I. Atanassova and S. Stratieva (1997). Increase of sugar beet and sunflower yields. *Pochvoznanie,Agrokhimiya y Ekologiya*, 32(3):16-20.(C.F. computer search).

Tichy, I.; Z. Muchova and H. Franaková (2001). Technological quality of wheat, barley and sugar beet in relation to nutrition. *Agrochémia*, 28(12): 362-365.

Usmanikhail, M.U.; S.D. Tunio; G.H. Jamro; F.C. Oad, U.L. Hassan; Q.D. Chachar; M. Ali Khanzada and A.W. Gandah (2012). Agronomic and economic effect of intercropping sugar beet with oilseeds and lentil. Pakistan. J. Bot., 44(6): 1983-1988.

Vandermeer, J. (1989). The ecology of intercropping. Cambridge University Press, Cambridge, UK.

Whitmore, A.P. and J.J. Schroder (2007). Intercropping reduces nitrate leaching from under field crops without loss of yield: a modelling study. Europ. J. Agronomy, 27: 81–88.

التأثير الزراعي الاقتصادي لتحميل الكانولا والبصل على بعض أصناف بنجر السكر تحت معدلات مختلفة من السماد الازوتى

محمد إبراهيم مصري و سيد أحمد سفينة
قسم المحاصيل – كلية الزراعة – جامعة القاهرة

أجريت تجربتان حقليتان بمحطة التجارب والبحوث الزراعية - كلية الزراعة - جامعة القاهرة - الجيزة خلال موسمي ٢٠١٣/٢٠١٤ و 2014/2015 لدراسة التأثير الاقتصادي الزراعي لثلاثة معدلات من التسميد الازوتى 60) و ٨٠ و ١٠٠ كجم ن / فدان)، وثلاثة نظم محصولية (بنجر السكر منفرد ، بنجر السكر + الكانولا وبنجر السكر + البصل) وأربعة أصناف متعددة الأجنة من بنجر السكر (فريدة، كارولا، جلوريا وديمابولي) و تم توزيع المعاملات في تصميم القطاعات المنشقة مرتين في تصميم القطاعات الكاملة العشوائية و في ثلاثة مكررات.

أظهرت النتائج أن زيادة معدلات النتروجين من ٦٠ إلى ١٠٠ كجم وحدة أزوت للفدان أدي إلي زيادة معنوية في وزن الجذر، محصول الجذور ومحصول السكر في كلا الموسمين. زراعة بنجر السكر منفردا أعطى أعلى القيم في متوسط وزن الجذر، عدد الجذور، محصول الجذور ومحصول السكر خلال الموسمين، في حين سجلت أدنى قيم لهذه الصفات في زراعة بنجر السكر محمل مع الكانولا. صنف بنجر السكر كارولا سجل تفوق في وزن الجذور، محصول الجذر ومحصول السكر تلاه الصنف فريدة في كلا الموسمين. كانت التأثيرات الرئيسية للنيتروجين، ونظام الزراعة والأصناف ليس لها تأثير معنوي على صفات جودة الجذر من حيث نسبة المواد الصلبة الذائبة٪ و السكروز٪ والنقاوة٪ والسكر المستخلص٪ خلال الموسمين.

أدى تسميد نباتات بنجر السكر المنفرد بـ ١٠٠ كجم وحدة أزوت للفدان لتحقيق أعلى متوسط لوزن الجذر (١,٠١٩ و١,١٠٩ كجم) وعدد الجذور (٢٨,٦٩ و٢٨,٢١الف نبات / فدان) ومحصول الجذور (٢٩,٣٥ و ٣١,٤٧ طن / فدان) ومحصول السكر (٣,٧٢ و ٣,٧٥ طن / فدان.) في المواسم الأول والثاني على التوالي. بغض النظر عن نظام الزراعة أدى تسميد نباتات الصنف فريدة وكارولا بمعدل ١٠٠ كجم وحدة أزوت للفدان إلى الحصول على أعلى قيم لمتوسط وزن الجذر، محصول الجذور ومحصول السكر خلال الموسمين. كان للتفاعل بين أصناف بنجر السكر و نظام الزراعة تأثيرا معنويا على متوسط وزن الجذر، عدد الجذر، محصول الجذور ومحصول السكر خلال الموسمين، حيث سجل الصنف كارولا بزراعته منفردا أعلى القيم لمتوسط وزن الجذر (٠,٩٥٣ و١,٠٤٣ كجم)، محصول الجذور (٢٨,٦٥ و ٣١,٠٧ طن / فدان) ومحصول السكر (٣,٦٩ و ٣,٧٤ طن / فدان) في المواسم الأول والثاني على التوالي، تلاه الصنف فريدة عندما زرع منفردا. تم الحصول على أعلى محصول معنوي من الجذور والسكر بزراعة الصنف كارولا منفردا وتسميده بمعدل ١٠٠ كجم وحدة أزوت للفدان خلال موسمي الزراعة.

ومن الناحية الاقتصادية ، أدى استخدام ١٠٠ كجم وحدة أزوت للفدان إلى تسجيل أعلى تكلفة للإنتاج كما حقق أيضا أعلى اجمالى للإيرادات وذلك بغض النظر عن النظام المحصولي والصنف المنزرع من بنجر السكر، حيث بلغت تكلفة إنتاج بنجر السكر (المنفرد) ٥٣٥٠ جنيه /فدان مقابل تكاليف إنتاج ٥٦٥٠ و٦٩٥٠ جنيه /فدان عندما حمل مع البنجر الكانولا والبصل، على التوالي. وقد سجل أعلى اجمالى للإيرادات (١٩٠٠٢ و ١٧٦٥٠ جنيه / فدان) من زراعة أصناف بنجر السكر كارولا وجلوريا على التوالي مع البصل تحت معدل ١٠٠ كجم أزوت / فدان. تم الحصول على اعلي صافي ربح عند زراعة صنف بنجر السكر كارولا محمل مع البصل (١٢٠٥٢ جنيه / فدان)، تلاه الصنف جلوريا مع البصل (١٠٧٠٠ جنيه / فدان) وذلك عند تسميد النباتات بمعدل ١٠٠ كجم وحدة أزوت / فدان. تم تحقيق أعلى نسبة من الأرباح إلى التكاليف (١,٧٣ و ١,٥٤) بزراعة صنف بنجر السكر كارولا محملا مع البصل والصنف جلوريا مع البصل، على التوالي مع التسميد بمعدل ١٠٠ كحم وحدة أزوت/فدان.

توصى الدراسة بأنه للحصول على أعلى صافى للعائد من وحدة المساحة فانه يفضل زراعة صنف بنجر السكر كارولا محملا مع البصل والتسميد بمعدل ١٠٠ كجم وحدة أزوت للفدان.

الكلمات الدالة: بنجر السكر – الكانولا- البصل - التسميد النيتروجيني- نظام الزراعة - محصول السكر- نسبة الأرباح إلى التكاليف

Table 4. Interactive effect of nitrogen rates x cropping systems on sugar beet agronomic traits during 2013/14 and 2014/15 seasons.

Nitrogen rates (kg/fed)	Cropping systems	Agronomic traits							
		Mean root weight (kg)	No. of harvested plants (10^3/fed)	Root yield (ton/fed)	TSS %	Sucrose %	Purity %	Extractable sucrose%	Sugar yield (ton/fed)
2013/2014 season									
60	Sugar beet sole	0.770	27.62	21.34	20.99	17.90	85.29	12.54	2.66
	Sugar beet + Canola	0.584	22.50	13.14	20.15	17.33	85.92	12.40	1.61
	Sugar beet + Onion	0.646	26.31	17.06	19.38	16.88	87.08	12.48	2.14
80	Sugar beet sole	0.891	28.10	25.09	21.03	18.10	86.09	13.01	3.27
	Sugar beet + Canola	0.714	23.93	17.06	20.25	17.58	86.80	12.89	2.20
	Sugar beet + Onion	0.746	25.83	19.29	19.59	17.10	87.27	12.72	2.46
100	Sugar beet sole	1.019	28.69	29.35	20.49	17.63	86.01	12.64	3.72
	Sugar beet + Canola	0.874	26.31	23.01	20.68	17.85	86.33	12.92	2.96
	Sugar beet + Onion	0.913	27.86	25.43	19.79	17.15	86.66	12.53	3.17
LSD at 0.05		0.042	1.16	1.42	NS	NS	NS	NS	0.39
2014/2015 season									
60	Sugar beet sole	0.829	27.98	23.18	20.81	17.90	86.01	12.83	2.97
	Sugar beet + Canola	0.589	24.40	14.28	19.91	17.38	87.28	12.92	1.85
	Sugar beet + Onion	0.752	26.79	20.19	19.95	17.15	85.99	12.27	2.47
80	Sugar beet sole	0.964	27.74	26.77	21.15	18.05	85.34	12.67	3.38
	Sugar beet + Canola	0.610	26.31	16.02	19.73	16.60	84.09	11.19	1.82
	Sugar beet + Onion	0.830	27.38	22.66	19.93	16.55	83.15	10.73	2.42
100	Sugar beet sole	1.109	28.21	31.47	20.58	17.43	84.52	11.97	3.75
	Sugar beet + Canola	0.774	24.64	19.04	21.10	18.53	87.80	14.00	2.66
	Sugar beet + Onion	0.883	27.74	24.54	20.28	17.85	87.99	13.58	3.32
LSD at 0.05		0.068	1.21	3.64	NS	NS	NS	NS	1.01

NS = Non significant