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QUALITY AND PRODUCTIVITY OF SUGAR BEET AS AFFECTED BY INTERCROPPING ONION IN VARIOUS DENSITIES.

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ABSTRACT: Two field trials in RCB design were carried out in Shandaweel Experimental Station Agricultural Research Center (ARC). Sohag governorate (26, 34 oN) during 2000/ 2001 and 2001/2002 seasons, to study the effect of intercropping onion in various densities (77000, 115.500 and 154000 plants/fed., represent 50, 75 and 100 of the sole onion crop) on the quality and productivity of sugar beet planted in two ridge width i.e. 50 and 100 cm (without any change in beet density). In the same time, economic evaluation of intercropping such as farmer net return (NR) and profitability was take in consideration. The results revealed that; intercropping onion in various densities on sugar beet planted in both ridge width had insignificant effect on most quality and productivity traits in both seasons, except pol% (in the first season), extractable sugar (sugar recovery), extractability % and sugar yield ton/fed. (In both seasons).

The highest beet quality and productivity were obtained from beet planted on 100 cm ridge width and intercropped with two onion rows (represent 50% (77000 plant/fed) density of onion in pure stand in both seasons while, intercropping onion on the other side of beet ridge 50 cm width (gave the same previous onion density) was high and negatively affected beet quality and productivity.

Average beet bulb, yield/fed and TSS were significantly reduced by various intercropping patterns on both seasons as compared with onion in pure stand, meantime yield of onion / Fed increased gradually with the increase in onion density. All intercropping treatments are increased markedly farmer net return and profitability per unit capital input (one LE), but intercropping two or three of onion (represent 50 and 75 %density of onion on pure stand) on the wide ridge of beet were maximized those traits.

INTRODUCTION

Egypt agriculture has the advantage of enjoying rich endowments of natural and man-made resources, with favorable temperature and abundance of sunshine available throughout the year. The fertile soil and water also can profitably be used to maximize crop production per unit area of land and other capital resources. This approach known as multiple cropping or intercropping. Intercropping may be defined as the growing of two or more crops simultaneously in the same field. This results in crop intensification in time and space (Androws and Kassan, 1975).

Intercropping is wide spread in most developing countries of Africa, Asia and America, moreover. The previous studies showed that this patterns is more suitable for small holder former due to the increase in the productivity and the net return (Nelliat et al, 1974; Panner, 1975; Osman and Haggag, 1981. El-Geddawy et al, 1988; Farrag 1990; EL-Ammary et al, 1999; Enan 1999; Beshay et al, 2000 and Toaima et al, 2001). In Egypt, intercropping patterns are used successfully from long time using various summer or winter crops. In this connection, the available literature showed that a major advantage of intercropping beet with some winter crops is an increase in the productivity of land as measured by sugar yield per unit area and farmer net return without any effect on the productivity of cultivated area of beet (Baker and Norman, 1975; Nour and Farag, 1984; Beshay et al, 2000 and Toaima et al, 2001).

Onion (Allium cepa L.) one of the most important winter crops grown for local consumption and exportation. Under Sohag governorate conditions, where, the first onion drying factory was established since 1960. Moreover, the production of sugar beet in Sohag governorate since 1990 had proved successful. Therefore, the aime of this work was to study the effect of intercropping onion in various densities on beet planted in two between ridges spacing, and to assessed the impact of this system on the quality and productivity of both crops as well as economic evaluation.

MATERIALS AND METHODS

Two field trails were carried out in Shandaweel Experimental station, Sohag governorate during 2000/2001 and 2001/2002 seasons.

Each trial consisted of six treatments as follows:

T_1- Pure stand of sugar beet (Beta valgaris) Oscarpoly multigerm variety was planted on 50 cm ridges on hills 20cm apart to give target plant population of 30000/fed. (Tradional sugar beet cultivation).

T_2- Pure stand of onion Allium Cepa L. var Giza 6, was planted on 25 cm rows and hills 10 cm apart to give target plant population of 154000/fed.

T_3 - Intercropping onion with sugar beet by planting sugar beet as in T1 while, onion was planted on the other side of the ridges in hills 10 cm apart to give 77000 plant/fed (represent 50% of the sole onion crop).

T_4, T_5 and T_6- Intercropping onion with sugar beet by planting sugar beet on 100 cm ridges on hills 20 cm apart on both sides of ridges (100% of the sole beet crop) and planting 2,3and 4 rows of onion on the top of the ridges, 10 cm within plant to gave 77000,115500 and 154000 plant /fed. (Represent 50, 75 and 100 of the sole onion crop), respectively.

Treatments were arranged in randomized complete block design with four replications. Each plot (21 m^2) consisted of six ridges 50 cm apart for T_1, T_2 and three ridges (1 m apart) for T_3, T_4, T_5 and T_6 and both 7 m long.

Beet was planted on September 5 and 10, 2000 and 2001, respectively, while onion was planted two months later after beet planting. Super phosphate (15.5% P_2O_5) at the rate of 15.5 Kg/fed and Potassium sulphate (48% k_2o) at the rate of 24 kg /fed was applied during land preparation. Nitrogen fertilizer was applied at the rate of 75 kg /fed in the from of ammonium nitrate (33.5%N) in three equal doses the first after beet thinning (30 days from sowing), the second was one month later (at onion planting) and the third one after month later, (where, beet age was three months and onion was one month age).

Other normal practices of both sugar beet and onion were maintained at the recommended level to assure optimum production. Beet and onion were harvested in both seasons in the first week of April, where beet and onion age reached about 6 and 5 months, respectively.

At harvest, a sample of ten guarded plants were taken at random to determine juice quality in the fresh roots using an automatic French system (HY-CEL) apparatus as follows

1- Sugar beet quality parameters:

a- Sucrose percentage (pol%) was polarimeterically determined according to the methods of le Docte (1927).

b. Juice impurities which including.

c. Purity percentage.

d. Potassium and sodium (flame photometry).

e. α amino nitrogen determined using ninhydrin methods according to Carruthers et al. (1962).

2- Sugar beet technological parameters:

a- Sugar loss in molasses and purity according to Devillers (1988)

b- Sugar extraction (Recovery or Rendement) and Extractability according to Dexter et al. (1967).

3- Sugar beet productivity:

a- Root characteristics and root yield T/fed.

b- Plant top weight and top yield ton/fed.

c- Sugar yield ton/fed.

4- Percentage of total soluble solids (TSS) of onion bulb was measured using hand referactometer:

5- Economic evaluation was carried out.

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

RESULTS AND DISCUSSION

1-Sugar beet quality parameters:

a- Sucrose percentage (pol%)

Results of the first season (Table 1) indicate that intercropping onion on the other side of the ridges (50 cm) planted with sugar beet (T_3) significantly reduced sucrose percentage (pol%) of the extracted juice as compared with

beet planted on ridges 50 cm in pure stand. Meantime various densities of onion (77000, 115500 and 154000 plants/fed) intercropped on sugar beet planted on 100 cm ridges (T_4, T_5 and T_6) had insignificant effect on this trait as compared with beet in pure stand (T_1). However, in the second season; various intercropping patterns insignificantly affected sucrose percentage (Table 1). Data also manifested that intercropping 2 rows of onion (77000 plant /fed) on the back of wide ridges (100 cm) of beet (T_4) exhibited the highest sucrose percentage in both seasons as compared with the same onion density bur on the norrow ridges 50 cm of beet (T_2) where intrinsicall reduction in sucrose percentage was detected (Table 1). Such effect of (T_3) may be due to the better spatial use of light and other resources, while inter-cropping on narrow ridges (T_3) may be due to the high competition between the two crop on various resources.

The obtained results are in harmony with those obtained by of Nour and farag (1984) Beshay et al (2000) and Toaima et al (2001).

Table (1): Root quality and of sugar beet as affected by intercropping patterns.

Treatments	POL %	Impurities			Purity %	Sugar lostin molassces %	Extract able sugar %	Extractablelity %
		α A.N.	Na	K				
2000/2001 season								
T1	15.98	1.35	2.22	4.57	92.09	1.79	13.59	85.04
T3	15.46	1.39	2.27	4.58	91.60	1.81	13.05	84.41
T4	16.04	1.36	2.25	4.55	92.10	1.79	13.65	85.10
T5	15.92	1.30	2.25	4.60	92.05	1.79	13.53	84.99
T6	15.82	1.32	2.35	4.56	91.94	1.80	13.42	84.83
L.S.D $_{0.05}$	0.31	NS	NS	NS	NS	NS	0.15	0.15
2001/2002 season								
T1	14.65	0.87	1.68	3.53	93.43	1.45	12.60	86.01
T3	14.48	0.91	1.78	3.55	93.21	1.47	12.41	85.70
T4	14.80	0.87	1.74	3.53	93.44	1.46	12.74	86.08
T5	14.67	0.92	1.75	3.51	93.35	1.47	12.60	85.89
T6	14.40	1.02	1.85	3.53	93.11	1.51	12.49	85.55
L.S.D $_{0.05}$	NS	0.09	0.10	NS	NS	NS	0.16	0.20

b- Juice impurities (Non sugars)

Data in (Table 1) show that various densities of onion intercropped on sugar beet planted on both narrow and wide ridges had insignificant effect on juice impurities α amino nitrogen, Na and K in the first season only, while this trend was the same in the second season for juice k content.

In general, the content of impurities show inconsistent trend with various densities of onion intercropping patterns. The obtained results were partly similar to those obtained by Beshay et al (2000).

c- Purity percentage.

Slight variation in juice purity percentage (statistically insignificant) has been detected in both seasons between beet in sole crop and various densities of onion intercropped on beet planted on both norrow and wide ridges (Table1). In general, intercropping onion on the other side of beet ridges, 50 cm width (T3) and 4 onion rows (the highest density) on the wide beet ridges (100 cm) exhibited a marked reduction in juice purity in both seasons (Table1). Similar effect has been also detected on sucrose percentage. These findings are in line with those of Beshay et al. (2000) and Toaima et al (2001).

2-Sugar beet technological parameters.

a- Sugar losses in molasses

Data in (Table 1) cleared that various densities of onion intercropped on beet planted on norrow or wide ridges had insignificant effect on sugar losses in molasses in both seasons. Such effect may be due to the slight effect on juice impurities as mentioned before. The present results are in accordance with those reported by Beshay et al (2000) who showed that onion or garlic intercropped on beet had a slight effect on sugar losses in molasses. In this connection Last and Draycott (1977) pointed to the highly negative and significant correlation between the loss of sugar to molasses and the non sugar K, Na and α Amino.N. Similar results were olso reported by Hilde et al. (1983) and Van Geijn et al. (1983).

b- Extractable sugar and Extractability percentages.

Extractable sugar percentage (Recovery) and extractability (extractable sugar as a percentage of beet Pol%) were significantly affected by various intercropping patterns (Table1). In general, the reduction in both traits was depended not only on density of the intercropped crops but also upon beet ridges width. In both season intercropped onion T_3 (density of 77000 plants /fed) on the other side of the narrow ridges (50 cm) planted with beet exhibited the highest reduction in extractable sugar and extractability percentages as compared with beet in pure stand (Table 1), followed by onion intercropped in 4 rows (density of 154000 plants/fed) with beet planted on wide ridges (100 cm T6). On the other hand, both traits were maxmized (differed insignificant with beet in pure stand) when onion intercropped in 2 rows (density of 77000 plants/fed) with beet planted on wide ridges (100 cm T4). Such effect may be due to that the two crops canopies had not overlapped and a better temporal use of light was verified under these condition. Similar findings are reported by Beshay et al (2000) who found that beet intercropping with onion and garlic gave nearly equal extractable sugar and extractability values to those of sole beet.

3-Sugar beet productivity.

3-a Root characteristics and root yield T/fed.

Data presented in (Table 2) reveale insignificant effect of various intercropping patterns in both seasons on root characteristics expressed as length, diameter and weight and root yield ton/fed. The best root performance in terms of length, diameter and weight and root yield T/fed were resulted from beet planted on wide ridges and intercropped with two onion rows (T_4) as compared with sole beet, followed by T_5 (beet planted in wide ridges and intercropped with three onion rows). On the contrary the lowest root characteristics and yield of T_3 (onion intercropped on the other side of ridges 50 cm width) (Table 2).

Table (2): Root characteristics, and yield of sugar beet as affected by onion intercropped in various patterns.

Treatments	Root length (cm)	Root diameter (cm)	Root weight (g)	Root yield t/f	Plant top wt. (g)	Top yield t/f	Sugar yield t/f
				2000/2001 season			
T1	32.30	13.60	990	32.60	600	21.65	4.43
T3	32.10	13.30	935	31.15	625	20.45	4.07
T4	32.30	13.80	995	32.75	660	21.70	4.47
T5	32.30	13.50	980	32.35	645	21.30	4.38
T6	32.20	13.50	950	31.33	640	21.10	4.21
L.S.D $_{0.05}$	NS	NS	NS	NS	NS	NS	0.24
				20001/2002 season			
T1	33.10	14.30	1015	33.55	635	20.90	4.23
T3	32.80	13.80	980	32.25	615	20.70	4.00
T4	33.20	14.50	1025	33.75	645	21.35	4.30
T5	33.30	14.20	1010	33.35	640	21.10	4.21
T6	32.90	14.00	990	32.65	630	20.85	4.08
L.S.D $_{0.05}$	NS	NS	NS	NS	NS	NS	0.16

The obtained results give evidence to the possibility of growing beet and onion crops simultaneously in the same field, but only by change in ridges with width, keeping the same beet density and productivity.

These results are in line with those of Nour and Farag (1984) who stated that intercropping bean with sugar beet increased root yield, EL-Ammary et al (1999) pointed out that intercropping pattern (autumn sugar cane +onion) maxmized cane yield than does wheat or been. More recently, similar results are also reported by Beshay et al (2000) and Toaima et al (2001) who showed that intercropping onion or garlic with sugar beet increased root yield ton/fed.

3-b Plant top weight and top yield ton/fed.

Slight variation in individual plant top weight /g and top yield t/fed (statistically insignificant) has been detected in both seasons between sole crop and various intercropping patterns (Table 2). Such effect may be due to the better spatial use of light and other resources by either beet alone or beet + onion especially under in wide ridges.

Contrary results were reported by Beshay et al (2000), and Toaima et al (2001). who found that intercropping onion or garlic on beet decreased top fresh weight and top yield.

3-c Sugar yield ton/fed.

Various densities of onion intercropped on beet planted on both narrow (T_3) and wide (T_4, T_5 and T_6) ridges had insignificant effect on sugar yield ton/fed. In 2000/2001 and 2001/2002seasons. Intercropping onion on the other side of beet ridges 50 cm width (T_3) by 8.13% and 5.44% (tradional planting of beet) significantly reduced sugar yield in both seasons, respectively as compared with sole beet followed by T_6 and T_5 in descending order (onion intercropped in 4 and 3 rows, density of 154000 and 115500 plants/ fed with beet planted and wide ridges 100 cm Table 1).

On the other hand onion intercropped in two rows (T_4) plant density of 77000plants/f with beet planted in wide 100 cm increased slightly sugar yield t/fed by 0.90% and 1.66% in 2000/2001 and 2001/2002 seasons respectively. Such effect my be due to the highest sugar yield components in terms of pol %, purity, extractable sugar, extractability and root yield meantime the lowest in purities and sugar losses in molasses have been also recorded for T4. The obtained results are in harmony with those of EL-Geddawy et al (1988), Srivatava et al (1988), EL-Ammary et al (1999) and Beshay et al (2000).

4-Effects onion yield component diameter, yield of bulb (ton/fed.) and total soluble solids (TSS).

Data in (Table 3) show that average bulb weight, bulb yield (t/f) and TSS were significantly affected by various intercropping patterns in both seasons, however bulb diameter insignificantly affected. The highest onion yield (ton/fed.) was achieved in pure stand while various intercropping patterns were significantly decreased onion yield in both seasons. Data in (Table 3) also manifested that the reduction on onion yield was depended not only on the density of intercropped crop beet also upon the ridges width where beet was planted. The reduction percent of onion yield as compare to

pure stand of onion (T_2 154000 plant /f) were 52.56, 46.98, 22.79 and 7.44 in the first experiments compared with the corresponding reduction present 56.02, 51.04, 27.39 and 14.11 in the second experiment for T3 (77000 plants/f, 50cm ridges width T_4 (77000 plant/f on 100 cm ridges width, T_5 (115500 plant t/f, 100 cm ridge width) and T_6 154000 plant 100 cm ridge width, Kafou

Table (3): yield, yield component and total soluble solids of onion as affected by intercropping with sugar beet.

Treatments	Bulb diamete (mm)	Bulb wt. (g)	Bulb yield t/f	T.S.S	Bulb diameter (mm)	Bulb wt. (g)	Bulb yield t/f	T.S.S
	2000/2001 season				2001/2002 season			
T2	54.2	63.99	10.75	13.45	56.50	71.73	12.05	13.25
T3	49.80	56.71	5.10	13.43	52.00	63.10	5.30	13.02
T4	53.50	67.10	5.70	13.61	54.50	73.15	6.15	13.48
T5	56.50	65.77	8.30	13.60	55.00	69.45	8.75	13.51
T6	51.50	59.23	9.95	13.25	53.30	61.37	10.35	12.95
L.S.D $_{0.05}$	NS	5.02	0.41	0.19	NS	5.85	0.28	0.17

Economic evaluation:

The effect of various intercropping pattern on beet former Net Return (NR) per area unit and profitability per capital unit are summer in (Table 4).

Average data over the two seasons indicated that intercropping onion on beet increased markedly former netreturn and profitability per capital input (one LE) as compared with beet (T_1) or onion (T_2) in pure stand. Such effect may be due to the extra income from intercropped onion on beet ridges.

Intercropping 2,3 and 4 rows of onion (T_3, T_4 and T_5) which represent 50% 75% and 100% of onion in pure stand (T_2) on beet ridges, 100 cm width (in these treatments beet density were equal the some of beet in pure stand) maximized former NR which amounted 27182, 3410 and 3654 LE respectively as compare with beet (1280 L E) or onion (196 LE) in pure stand (Table 4).

Table (4): Economic evaluation of intercropping patterns (Average of 2000/2001 and 2001/2002 seasons)

Treatments	Yield (t/f)		TR	Costs		Economic criteria		
	Beet	onion		Vc	Tc	G.R	NR	Prof %
T_1	33.08	--	3307.50	777.65	2027.65	2529.35	1279.85	63.12
T_2	--	11.40	3543.00	1637.67	3337.67	1896.33	196.33	5.88
T_3	31.70	5.20	4782.00	1106.66	2356.66	3675.34	2425.34	102.91
T_4	33.25	5.93	5161.75	1130.15	2380.15	4031.60	2781.66	116.87
T_5	33.05	8.53	5947.75	1288.04	2538.04	4659.71	2409.71	134.34
T_6	32.00	10.15	6346.50	1442.67	2692.91	4903.59	2653.59	135.67

(TR) Total return (TR) = yield x price
(GR) Gross margin (GR) = Total return - variable cost (VC)
(NR) Net return (NR) = Total return - Total cost (TC)
Prof =profitability = (NR/TC)/100

• Prices and costs used in this calculations urea from Agricultural Economic, Vol. 1, Winter crops statistics, 2000.

Based on, intercropping two, three and four rows of onion on beet ridges of 100 cm width slightly affected quality and technological characteristics of roots and yield productivity sueh as root and sugar yield (T4 exhibited slight increase in all mentioned characters while T_5 and T_6 were slightly decreased (statistically insignificant) all those characters than equivalent sole crop on the other hand intercropping onion on the other side of beet ridges of 50 cm width in spit of the marked increase in farmer NR (2425 LE) as compared with beet on onion in pure stand, beet quality and yields of roots sugar were obviously decreased (Table 4)

The obtained results give evidence that a main advantage of intercropping system increase land productivity and farmer NR without any deterious effect on the productivity and or the cultivated area of the main crop (sugar beet) herein;These results could be easy recognize by only chamse the width of beet ridges from 50 cm to 100 cm without ony effect on beet density.

The obtained results are in line with those of Baker and Norman (1975), Nour and Farag (1984), EL-Ammary et al (1999), Beshay et al (2000) and Toaima et al (2001).

Regarding various intercropping patterns on profitability per unit capital input. Data in (Table 4) revealed that any intercropping pattern positively affected profitability as compared beet on onion in pure stand. Moreover, T_4 (beet + 2rows of onion) and T_5 (beet + 3rows of onion) exhibited the best profitability 117 and 134 LE respectively per unit capital input (one LE) without any adverse effect on beet productivity and quality (Table 4)

In his commotion, the increase in profitability per unit capital input give evidence to the magnitude of growing suitable crops together in mixtures rather than in pure stand.

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تأثير تحميل البصل فى كثافات مختلفة على الجودة والإنتاجية لبنجر السكر

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أقيمت تجربتان حقليتان فى تصميم القطاعات الكاملة العشوائية فى أربع مكررات بمحطة البحوث الزراعية بشندويل مركز البحوث الزراعية محافظة سوهاج (خط عرض ٣٤ و ٢٦) وذلك فى شتاء موسمى٢٠٠٠/٢٠٠١ و /٢٠٠٢ ٢٠٠١ بهدف دراسة تأثير تحميل البصل فى كثافات مختلفة (٧٧ ,٥٠ ١١٥ . ١٥٤ ألف نبات / فدان) تمثل ٥٠٪ ٧٥ ٪ ١٠ ٪ من كثافة البصل المنفرد على صفات الجودة والإنتاجية لبنجر السكر المنزرع على مسافتين للتخطيط ٥٠ سم ، ١٠٠ سم من الخطوط أو المصاطب و ٢٠ سم بين الجور. بدون اى تغير فى كثافة البنجر المنزرع . وكانت أهم النتائج مايلى:. أدى تحميل البصل فى كثافات مختلفة على بنجر السكر المنزرع على كلا من مسافتى التخطيط إلى تأثير غير معنوى على معظم صفات الجودة والإنتاجية خلال موسمى الزراعة فيما عدا صفة النسبة المئوية للبول (السكر ٪ عصير) فى الموسم الأول والسكر المستخلص وكفاءة استخلاص السكر ومحصول السكر بالطن للفدان فى موسمى الزراعة.

أشارت النتائج إلى أن أعلى صفات جودة وإنتاجية لبنجر السكر كانت من زراعته على خطوط عريضة ١٠٠ سم ومحمل علية خطين من البصل (تمثل ٥٠٪ ٧٧ ألف نبات / فدان من كثافة البصل المنفرد) فى موسم الزراعة بينما أدى تحميل البصل (بنفس الكثافة السابقة) على الجانب الأخر من خطوط البنجر ٥٠ سم (الزراعة التقليدية) إلى نقص واضح فى جميع الصفات المشار أليها.

كما تشير النتائج أيضا الى أن زيادة كثافة البصل المحمل على خطوط البنجر العريضة (خاصة ٧٥ ٪ من كثافة البصل المنفرد) كانت مصحوبة بتأثير قليل على صفات البنجر تحت الدراسة.

أدى تحميل البصل بكثافات متباينة إلى انخفاض معنوى فى متوسط وزن البصلة ومحصول البصل بالطن / فدان ونسبة المواد الصلبة الذائبة الكلية فى عصير البصل فى موسمى الزراعة مقارنة بمحصول البصل فى الزراعات المنفردة. وفى نفس الوقت تلاحظ زيادة تدريجية فى محصول البصل بالطن للفدان بزيادة كثافة البصل

آدت جميع معاملات التحميل الى زيادة واضحة فى صافى دخل المزارع واربحيتة مقارنة بكل من البنجر أو البصل المنفرد وقد تحققت أعلى دخل عند تحميل البصل بكثافات نباتية ٧٧ ألف ، ١١٥ سم.

وبناء على ذلك فان النتائج المتحصل عليها تبين بوضوح إمكانية تحميل البصل على خطوط البنجر بمحافظة سوهاج بعد تعديل فى عرض الخطوط حيث أدى نظام التحميل الى زيادة إنتاجية وحدة المساحة والاستغلال الأمثل لنفس المصادر كما أثبتت النتائج أن هذا النظام يؤدى الى زيادة فى صافى دخل المزارع واربحيتة مع عدم وجود تأثير على صفات الجودة والإنتاجية لبنجر السكر.