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EFFECT OF INTERCROPPING ONION WITH AUTUMN PLANTED SUGAR CANE ON CANE YIELD AND JUICE QUALITY

ZOHRY, A.H.A

Field Crop Res. Inst., Agricultural Research Centre, Giza, Egypt.

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Abstract

Two field trials were conducted at Shandaweel Experimental station during 1994/95 and 1995/96 seasons to investigate the effect of intercropping onion with autumn-planted sugar cane under different plant densities of onion. The experimental design was randomized complete blocks with four replications. Each experiment included five treatments (sugar cane + three rows of onion, sugar cane + four rows of onion, sugar cane + five rows of onion and pure stand of sugar cane and onion).

The important results could be summarized as follows:

1. Sugar cane yield was significantly affected by onion intercropping. The average yield of cane was reduced by about 9.9 and 8.4 compared with pure stand in first and second seasons, respectively.
2. Brix, sucrose and purity percentages of sugar cane juice showed no statistical significance between treatments.
3. Yield and yield components of onion were decreased by intercropping patterns as compared with onion alone. Yield of intercropped onion was increased by increasing of plants density of onion, whereas the diameter and weight of bulbs were decreased by increasing plant density of onion.
4. Intercropping onion with sugar cane increased the land usage by 43-59%.
5. The aggressiveness values of intercropping components showed that the sugar cane crop was dominant while onion was dominate in the three different patterns.
6. The economic analysis clearly show that intercropping five rows of onion produced the highest economic value and gross profit/fed compared with other treatments Finally, it could be recommended that intercropping five rows of onion with sugar cane was successful and profitable to production under conditions in upper Egypt.

INTRODUCTION

Many farmers who grow sugar cane are used to intercrop other crops in the same area of cane. Planting sugar cane in Autumn produced higher yield than Spring planting. During winter, sugar cane grows slowly due to prevailing low temperatures. Therefore, attention was focused on some annual, short lived, winter crops that may be grown as companion crops with sugar cane. Verma, *et al.*, (1966) found that yield of cane was not affected by intercropping with onion, pea, maize and berseem. Kar, *et al.*, (1972) reported that sugar cane germination was not affected by intercropping with 2 or 3 onion rows, but the number of tillers and millable canes was reduced. Rathi, *et al.*, (1974), Randhawa (1975) and Randhawa (1976) showed that intercropping cereals, mustard, potatoes, onion, fodder crops, tomato and sugar beet were more profitable than growing autumn planted cane alone. Also they found that intercropping sugar cane with onion gave the highest net return followed by intercropping sugar cane with tomato. Venkataraman, *et al.*, (1978) showed that tillering and number of millable canes were slightly reduced by intercropping with onion, black gram, cowpea or sunflower and especially with double intercrops. Parachar, *et al.*, (1979) showed that cane yield was reduced when sugar cane was intercropped with several crops, including carrots, peas, garlic, cauliflowers, onion and redish but quality was unaffected. The greatest yield reduction occurred when garlic was the intercrop and the least reduction was with onion Nour, *et al.*, (1980) found that when the sugar cane was intercropped with onion can yield was reduced slightly but sucrose and purity percentages were unaffected.

Bhutada and Parashar (1981) found that cane yield grown with onion, mung bean, cowpea or urd was 51.3, 57.9, 51.9 and 50.0 tt/h. respectively, while pure stand yield was 59.6 t/h. Rathor, *et al.*, (1981) found that when sugar cane was planted with wheat, potatoes, onions, onion gave the best results with regard to cane yield and sugar production while potatoes and garlic gave the next best result. Wheat depressed can yield by 3%. Zhan, (1985) concluded that length, weight and diameter of cane stalk were increased with intercropping onion or soybean compared with pure stand.

On other hand, an increase in onion or yield by growing plants alone was recorded (Ashoub, 1978). He added that intercropping had no effect on the diameter of neck bulb. Kamel, *et al.*, (1989) found that bulb yield increased by increasing plant density of onion but the plant height, bulb length and weight of bulb decreased at high plant density of onion. El-Habbak, *et al.*, (1993) showed that intercropping onion

with cotton significantly decreased average weight of fresh and dry matter/bulb and surviving plants percentage, while the bulb diameter was not affect. Souza, *et al.*, (1987), El-Geddawy, *et al.*, (1988), El-Gergawi, *et al.*, (1995) and Eweida, *et al.*, (1996) suggested that yields of intercropping of bean, wheat, maize or soybean with sugar cane raised the landuse capacity by 50, 70, 330, 40% respectively. Also the high values of the relative crowding coefficient (K) indicated a distinct yield advantage from intercropping these crops with sugar cane.

MATERIALS AND METHODS

Two field trials were conducted at Shandaweel Agric. Exp. Sta. in two successive seasons (1994/95 - 1995/96) to investigate the effect of intercropping onion (cv. Giza 6) with sugar cane (c.v. G.T.C. 54/9) under different plant density of onion on yield and yield components of cane and onion. A randomized complete blocks design design was used with four replications. Plots were 20 m2 consistint of five ridges 4m. Long and one m. in width. Each experiment included included five treatments as follows:

1. Intercropping one row of sugar cane with three rows of onion (T1)
2. Intercropping one row of sugar cane with four rows of onion (T2)
3. Intercropping one row of sugar cane with five rows of onion (T3)
4. Pure stand of onion (T4)
5. Pure stand of sugar cane (T5)

Sugar cane was planted on October, 10 and 15 in the first and second season, respectively. Trasplanting of onion took place on November, 10 and 15 in the first and second seasons, respectively. At the time of the second cane irrigation.

Sugar cane was planted as an autumn crop in rows one meter wide. Onion seedling were transplanted between sugar cane ridges. The distances between rows of onion were 25, 20 and 15 cm. when intercropping with three, four and five rows of onion, respectively. Fertilization program for sugar cane included 200 kg/fed. calcium super phosphate 15.5% applied during land preparation. Nitrogen was added at a rate of 200 kg/fed as urea (46%) in two equal doses two months from planting and after harvesting onion. Potassium sulphate (48% K2O) at rate of 100 kg/fed, was applied with the first dose of nitrogen of cane. The normal agronomic practices for sugar can and onion were done. Onion was harvested after 5.5 months from trans-

planting while sugar cane was harvested after 12 months of cane planting. At harvest a sample of ten guarded plants was chosen randomly from onion to estimate whole plant height (including vegetation) (cm), bulb diameter (cm) culls (double + bolter), bulb weight (gm.), total bulbs yield (ton/fed) and total solubl soilds (T.S.S.).

Also, a sample of 20 stalk/plot of sugar cane at harvest was taken at random for fallowing morphological and chemical properties: stalk height (cm.), number of millable stalks/fed., stalk diameter (cm.), stalk weight (gm.) and cane yield (ton/fed). Apparent juice purity % of cane was calculated according to Spencer and Mead (1945) commercial cane sugar yield was estimated using the following equation (Yadav and Sharm, 1980).

Commercial cane sugar = cane yield/ha x available sugar/100

Available sugar = {S-0.4 (B-S)} x 1.73.

where S = Sucrose % in juice and B = Brix %

To determine the competitive relationships and intercropping advantage the following parameters were calculated:

L.E.R. (land Equivalent Ratio) according to Willey (1979).

K. (Relative crowding coefficient) according to Hall (1974)

A: (Aggressivity value) according to McGilchrist (1965).

Cereal units:

Cereal units as proposed by Brokhous (1962) were calculated. Cereal units of all agricultural products were evaluated based on starch vlue. This measure avoid fluctuation of agricultural products perices which occurred from time to time. Each 100 kg of Rye, Barley, Wheat and Oats are considered standared having one unit as 100 kg of onion has 0.30 unit and 100 kg of sugar cane has 0.28 unit.

Economic evaluation:

Gross profit was calculated on the basis of onion and sugar cane current prices in 1995 and 1996 seasons and were evaluated on the following basis:

1. Ton of onion = L.E. 383.

2. Ton of sugar cane = L.E. 90.

Data collected were subjected t statistical analysis according to Snedecor and Chochran (1980) using M.S.T.A.T. Computer V4 (1986) L.S.D. at 1 and 5% level at significance was used to compare between means of treatments.

RESULTS AND DISCUSSION

1. Effect of intercropping on sugar cane:

1. Cane yield:

Data presented in Table (1) showed that characters under study of sugar cane were significantly affected by intercropped patterns in the two seasons. Values of stalk height, stalk diameter, number of millable stalks/fed. and cane yield were reduced by intercropping with onion. The reduction in characters under study were greater when intercropped with five rows of onion (T3) while the reduction in the same characters was low when intercropping three rows of onion with sugar cane. The cane yield of intercropped were estimated to be 97.3, 93.8 and 90.1% and 95.9, 94.4 and 91.6 % of pure stand for three, four and five rows of onion both seasons, respectively. These results showed that the greatest yield reduction (9.9 and 8.4%) were recorded when intercropping five rows of onion (high density of onion) in the first and second seasons, respectively.

It is that inter-specific competion between cane plants were higher than the interspecific competition between sugar cane with onion components in any intercropping system especial using high desity of onion. These results are in agreement with those obtained by Verma, *et al.*, (1966), Venkatarman, *et al.* (1978) and Zhan, (1985).

2. Juice quality:

Data in Table (2) showed that intercropping patterns had not significantly affected cane quality characters except for the reducing sugar % and sugar yield/fed in both seasons. The results show that brix, sucrose and purity percentages were unaffected by intercropping patterns.

These results are in conformity with the findings of Parachar, *et al.*, (1979) and Nour, *et al.*, (1980) who stated that when the sugar cane was intercropped with onion the juice quality was unaffected.

Sugar yield ton/fed. was consistently reduced with intercropping patterns. The intercropping sugar yield was 97 .4, 92.8 and 88.7% and 96.0, 93.3 and 90.7% of pure stand when intercropping by three, four and five rows of onion in both seasons, respectively. These results are in agreement by Parashar, *et al.*, (1979), Nour *et al* (1980) and Bhutada and Parashar (1981).

Table 1. Effect of intercropping patterns of onion with sugar cane on yield and yield components of sugar cane in 1994/95 and 1995/96 seasons.

Treatment	Season 1994/95				Season 1995/96			
	Stalk height (cm)	Stalk diameter (cm)	Number of millable stalks 1000	Cane yield ton/fed	Stalk height (cm)	Stalk diameter (cm)	Number of millable stalks 1000	Cane yield ton/fed
Sugar cane + Three rows of onion T_1	260.67	2.71	34.26	51.87	259.33	2.62	34.10	50.55
Sugar cane + Four rows of onion T_2	257.67	2.62	33.33	50.03	256.67	2.55	33.02	49.77
Sugar cane + Five rows of onion T_3	256.33	2.55	31.99	48.07	256.00	2.50	32.08	48.30
Pure stand of sugar cane T_5	277.67	2.73	36.10	53.30	266.67	2.72	36.17	52.70
L.S.D at $_{0.05}$	6.93	0.11	0.71	0.68	5.71	0.10	0.28	0.84

Table 2. Effect of intercropping patterns of onion with sugar cane on juice quality and yield of sugar in 1994/95 and 1995/96 seasons.

Treatment		Season 1994/95 Brix degre	Sucrose %	Purity %	Reducing sugar %	Redment %	Sugar yield in ton//fed	Season 1995/96 Brix degre	Sucrose %	Purity %	Reducing sugar %	Redment %	Sugar yield in ton//fed
Sugar cane + Three rows of onion	T_1	21.00	18.52	88.18	41.33	13.38	6.94	20.97	18.13	86.49	39.33	12.86	6.50
Sugar cane + Four rows of onion	T_2	21.07	18.42	87.42	42.33	13.20	6.61	21.00	18.03	85.87	44.67	12.70	6.32
Sugar cane + Five rows of onion	T_3	21.13	18.40	87.07	43.00	13.14	6.32	21.07	18.07	85.76	52.33	12.70	6.14
Pure stand of sugar cane	T_5	21.07	18.53	87.98	40.67	13.37	7.12	20.98	18.13	86.42	38.00	12.85	6.77
L.S.D at $_{0.05}$		N.S	N.S	N.S	1.49	N.S	0.14	N.S	N.S	N.S	5.82	N.S	0.10

II. Effect of intercropping on onion:

Data presented in Table (3) showed that intercropping onion with sugar cane had significant effects on the estimated characters of onion in the two seasons. Values of these characters were decreased by intercropping except total soluble solids (T.S.S %) which increased by tintercropping in both seasons. The greatest reductions in these characters was obtained when intercropping five rows of onion and the lowest reduction with three rows of onion. Pure stand of onion had higher bulbs yield/fed. than intercropped onion yield. Intercropped onion yield were 46.8, 57.0 and 62.7% and 47.1, 60.1 and 67.3% of stand when using three, four and five rows of onion. These results show that intercropped onion yield was increased by increasing plant density of onion and decreased by decreasing plant density of onion. Whereas, bulb diameter and bulb weight were decreased at the highest plant density of onion. The reduction in onion yield due to the severe inter-specific competition between sugar cane and onion plants for light, water and nutrients. Similar results were reported by Ashoub (1978) and El-Habbak, *et al*, (1992).

III. Competitive relationships and yield advantages:

Competitive relationship and yield advantages for intercropping onion with sugar cane are presented in Table (4). The results showed that values of land equivalent ratio (L.E.R.) were greater than one for intercropping onion with sugar cane under different plant densities of onion. Intercropping sugar cane and onion increased land usage by 44.0, 51.0% and 43.0, 54.0 and 59.0%, when plant density of onion was three, four and five rows between cane ridges in both seasons, respectively. Sugar cane relative yield (RY) was larger at low plant density of onion. Whereas, onion relative yield (RY) was increased with increasing plant density of onion.

Relative crowding coefficient (R.C.C.) was shown in Table 4. It was increased by increasing plant density of onion. It could be concluded that the product of the coefficient showed land use efficiency increased by incropping sugar cane and onion.

Aggressivity (Agg.) was affected by intercropping patterns (Table 4). Aggresivity values of sugar cane were positive (dominant), whereas those of onion were negative (dominated). These results of competition relationship and yiel advantage are in agreement with those obtained by El-Geddawy, *et al.*, (1994).

IV. Cereal units:

Table (5) shows the differences among the studied traits evaluated in cereal

Table 3. Effect of intercropping patterns of onion with sugar cane on yield and yield components of onion in 1994/95 and 1995/96 seasons.

Treatment		Season 1994/95						Season 1995/96					
		plant height (cm)	Bulb diameter (cm)	Culls % by number	Bulb weight (gm)	T.S.S.% dry matter	Total bulbs yield ton/fed	plant height (cm)	Bulb diameter (cm)	Culls % by number	Bulb weight (gm)	T.S.S.% dry matter	Total bulbs yield ton/fed
Sugar cane + Three rows of onion	T_1	55.93	4.36	15.12	76.57	18.65	7.20	54.70	4.38	14.57	74.57	18.83	7.00
Sugar cane + Four rows of onion	T_2	55.10	4.27	13.17	70.63	19.73	8.78	53.47	4.10	13.70	71.77	19.40	8.93
Sugar cane + Five rows of onion	T_3	53.13	4.03	11.30	63.13	20.80	9.65	52.77	4.03	12.70	68.63	20.08	10.00
Pure stand of onion	T_4	56.73	4.42	14.20	82.03	18.87	15.40	55.97	4.63	14.60	79.27	18.97	14.85
L.S.D at $_{0.05}$		1.02	0.18	1.91	4.24	0.77	0.79	1.09	0.68	1.16	1.52	0.55	0.78

Table 4. Effect of intercropping patterns of onion with sugar cane on yield and yield components relationship in 1994/95 and 1995/96 seasons.

Treatment	Season 1994/95						Season 1995/96					
	Land Equavelant Ratio			Relative crowding coeffi. coef	Aggressivity		Land Equavelant Ratio			Relative crowding coeffi.	Aggressivity	
	Onion	Cane	Total		Onion	Cane	Onion	Cane	Total		Onion	Cane
Sugar cane + Three rows of onion T_1	0.47	0.97	1.44	31.56	-0.50	+0.50	0.47	0.96	1.43	21.16	-0.49	+0.49
Sugar cane + Four rows of onion T_2	0.57	0.94	1.51	20.20	-0.37	+0.37	0.60	0.94	1.54	25.82	-0.26	+0.26
Sugar cane + Five rows of onion T_3	0.63	0.90	1.53	16.55	-0.27	+0.27	0.67	0.92	1.59	22.50	-0.25	+0.25

units/fed. It is clear that intercropping three rows or four rows of onion with sugar cane produced the highest cereal units/fed in first and second seasons, respectively.

V. Gross profit

Table (5) shows the gross profit in L.E. for sole sugar cane, sole onion and intercropping patterns. The results indicate that intercropping five rows of onion with sugar cane gave the highest gross profit compared with other treatments. These results are in a good agreement with those found by Rathi, *et al.*, (1974), Randhowa (1975), Randhowa (1976) Dixit and Misra (1991) and Zohry (1994) who found increases in net return from intercropping as compared with sole cropped treatments.

In summary, it could be recommended that intercropping five rows of onion with sugar cane is successful and profitable to production under conditions in upper Egypt.

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تأثير تحميل البصل مع قصب السكر الخريفى على المحصول وجودة العصير

عبد الحفيظ احمد زهرى

قسم بحوث التكثيف المحصولى - معهد بحوث المحاصيل الحقليه - مركز البحوث الزراعيه.

أجريت تجربتان حقليتان بمحطة البحوث الزراعيه بشندويل بمحافظة سوهاج خلال الموسمين ١٩٩٥/٩٤ ، ١٩٩٦/٩٥ لدراسة تأثير تحميل البصل على القصب الخريفى الغرس تحت ثلاث كثافات نباتيه واشتملت المعاملات على خمسة معاملات هى :الزراعه النقية لكل من البصل والقصب، القصب + ثلاثة سطور بصل، قصب + أربعة سطور بصل، قصب + خمسة سطور بصل. واستخدم تصميم القطاعات الكاملة العشوائية مع اربعة مكررات وكانت مساحة القطعة التجريبيه ٢٠م٢ وأجريت جميع العمليات الزراعية طبقا للتوصيه ويمكن تلخيص النتائج فيمايلى:-

١. نقص محصول القصب المحمل معنويا بالمقارنة بالزراعة النقية وكان المحصول المحمل هو ٩٧.٣، ٩٣.٨، ٩٠.١ وكان ٩٥.٩، ٩٤.٤ ، ٩١,٦٪ فى الموسم الأول والثانى على الترتيب.

٢. لم تتأثر صفات الجودة للعصير معنويا بالتحميل ماعدا السكريات المختزلة ومحصول السكر للفدان/طن فى خلال الموسمين.

٣. أدى تحميل البصل مع القصب إلى إنخفاض معنوي للمحصول ومكوناته مقارنة بالزراعة المنفردة فى خلال الموسمين.

٤. زاد محصول البصل للفدان/طن مع زيادة الكثافة النباتية للبصل بينما نقص قطر البصلة ووزنها/جرام فى خلال الموسمين.

٥. أدى تحميل البصل مع القصب إلى زيادة كفاءة استغلال الأرض وزاد المعدل مع زيادة الكثافة النباتية للبصل وكان ١,٤٤ ، ١,٥١ ، ١,٥٣ فى الموسم الأول بينما كان ١,٤٣ ، ١,٥٤، ١,٥٩ فى الموسم الثانى وكان نفس الاتجاه لعامل الحشد النسبى وأظهرت النتائج أن القصب هو المحصول السائد بينما كان البصل هو المحصول المسود فى خلال الموسمين.

٦. تحقق أعلى قيم للغلة مقيمة فى صورة وحدات حبوب بزراعة التحميل وذلك بمعدل ثلاثه سطور للبصل فى الموسم الأول واربعة سطور للبصل فى الموسم الثانى.

٧. أدى تحميل القصب مع البصل إلى الحصول على أعلى عائد اقتصادى مقارنة بالزراعة النقية لكل من البصل أو القصب المنفرد بينما زاد العائد الأقتصادى لزراعة التحميل بزيادة الكثافة النباتيه للبصل المحمل فى خلال الموسمين.

وأنتهت الدراسة إلى أن أفضل معاملات التحميل مع القصب هى تحميل القصب الخريفى مع خمسة سطور للبصل فى أراضى مصر العليا حيث أنها حققت أعلى انتاجية وعائد اقتصادى.