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Effect of Spatial Distribution on Competition, Yield and Economics of Spring-Planted Sugarcane Intercropped With Some Oil Crops

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Abstract

The effect of two sugarcane row arrangements and intercropping systems with three densities of soybean and/or sunflower on yield and quality of sugar-cane as well as the companion crops were investigated in two successive seasons. The study conducted at Mallawi Research Station, Sugar crops Institute, Giza, Egypt during 2013/2014 and 2014/2015. Results showed that, spatial distributions had no significant effects on the most of studied traits. Furthermore; the higher the dense of intercrop the lower the number of millable canes. Sole cane and cane intercropped with 15 and/or 30% soybean showed significant superiority over the other systems in terms of millable stalk weight and cane and sugar yields (ton fed^{-1}).

The low dense systems of soybean (15 %) gave the greatest plant yield (kg) and the lowest seed yield (ton fed^{-1}). Moreover; sole systems of soybean and sun-flower presented the highest seed and oil yields (ton fed^{-1}). Maximum land equivalent ratios (LERs) were showed in case of sugarcane intercropped 30 % soybean. In addition; data revealed that sunflower showed more competitive than sugarcane when they grew in associations.

Keywords: *sugarcane, soybean, sunflower and intercrop.*

Introduction

Sugar and edible oils are a major constituents of human food. They are also inputs to other industries. In Egypt, Sugarcane contributes about 50 % of total sugar production. The annual planted area with sugarcane in Egypt is about 322,000 feddan (which concentrated in five governorates in Middle and Upper Egypt) with average productivity of 48.8 ton fed^{-1}. There is a relative stability in the cultivated area with sugarcane due to the experience gained by the farmers of these regions in the cultivation and marketing of sugarcane.

Another one of the major problems in the Egyptian agricultural system is the sever shortage of edible oil production. The total production does not cover more than 9.0 % of the total consumption rate. Egypt annually imports more than 876,000 tons of soybean seeds, 46,000 tons of sunflower seeds and more than 600 thousand tons of edible oils (AOAD-Khartoum;. 2015). Because oil crops faced the competition with berseem and wheat in winter, along with cotton, corn or sorghum in summer, it is difficult to expand the cultivated area of oil crops to narrow the huge oil gap which increasing day by day due to the increase in the population and the changes in consumption patterns.

Intercropping may contribute a large part to solve these problems by increasing the productivity of the unit area. In general, sugarcane is planted in wide rows and has a juvenile period of 110 – 120 days and takes several months to canopy cover so that, the intercrops of soybean and/or sunflower with sugarcane are widely practiced.

Cane-soybean intercropping systems were examined in several works. Ndarubu *et al*. (2000) Showed that, Sole sugarcane attained the highest cane yield of 34.7 ton ha^{-1} whereas; intercropping cane with soybean and sesame remarkably reduce cane yield which recorded approximately 24.3 ton ha^{-1}. They concluded that, intercropping sugarcane with fast growing and short duration crops like soybean has advantage of suppressing weeds. Yang *et al*. (2005) studied the effect of sugarcane-soybean intercropping on cane yield, quality and economic benefit. They concluded that, stalk diameter, millable stalks, cane yield and estimated sugar production were significantly affected by intercropping while the quality characters were not changed obviously. Also, total income of sugarcane-soybean intercropping was increased compared to monoculture system. Xiuping Li *et al*. (2013) showed that, dry weight of biomass and yield under sugarcane-soybean intercropping was increased by 35.44 and 30.57 % for sugarcane, and decreased by 16.12 and 9.53 % for soybean, respectively. Hence; mixed grown sugarcane and soybean have some degree of advantages in terms of growth and yield.

Concerning; sugarcane-sunflower intercropping systems were widely investigated, Farid *et al*. (2000) stated that, ratoon cane-soybean significantly surpassed ratoon cane + sunflower on number of shoots per stump. Khakwani *et al*. (2001) concluded that, sole cane significantly superior the other tested cane-sunflower intercropping systems in all sugarcane tested characters. Moreover, the pattern of 2-sugarcane rows + 1.0 and/or 2-sunflower rows ranked first in all sunflower tested characters except seed yield. They added that, geometry of 1:1 sugarcane-sunflower at 30: 90 cm row pattern was recommended for getting higher net income. Nazir *et al*. (2002) revealed that, the minimum cane yield was recorded for sugarcane intercropped sunflower and wheat. They added that, the different intercrops had no significant effect on juice quality and the sucrose content in cane juice.

This work aimed to examine and evaluate the possibility of intercropping soybean and/or sunflower with spring planted sugarcane under Middle Egypt conditions to help in overcoming the gap of oil production.

Materials and Methods

Spatial distributions by sugarcane intercropping systems were conducted during 2013–2014 and 2014–2015 seasons at Mallawi Research Station, Sugar Crops Institute, Giza, Egypt, at (27.44º N, 30.51º E, 52 m) on a clay loam soil with 29.50 % clay, 7.51 pH, 12.10 ppm available P and 1.10 % O.M. A randomized complete block design with split plot arrangement was used with four replications. Each experiment consisted of; Two spatial distributions (D) occupied the main plots:

D1. 120 : 80 cm dual rows east-west direction.

D2. 140 : 60 cm dual rows east-west direction.

Seven intercropping systems (T) randomly distributed in sub plots:

T1. Sole sugarcane.

T2. 100 % Sugarcane + SO2 [15 % soybean (21000 plant fed^{-1}, 1 row at 20-cm hill spacing, 2-plants $hill^{-1}$)].

T3. 100 % Sugarcane + SO3 [30 % soybean (42000 plant fed^{-1}, 2-rows at 20-cm hill spacing, 2-plants $hill^{-1}$)].

T4. 100 % Sugarcane + SO4 [45 % soybean (63000 plant fed^{-1}, 3-rows at 20-cm hill spacing, 2-plants $hill^{-1}$)].

T5. 100 % Sugarcane + SF2 [15 % sunflower (5250 plants fed^{-1}, 1-row, at 40-cm hill spacing, 1-plant $hill^{-1}$)].

T6. 100 % Sugarcane + SF3 [30 % sunflower (10500 plants fed^{-1}, 2-rows, at 40-cm hill spacing, 1-plant $hill^{-1}$)].

T7. 100 % Sugarcane + SF4 [45 % sunflower (15750 plants fed^{-1}, 3-rows, at 20-cm hill spacing, 1-plant $hill^{-1}$)].

Pure stands of soybean and sunflower crops were;

SO1. 100 % Soybean [140000 plants fed^{-1}, 60 cm between rows planting on the two sides of furrow and 20-cm hill spacing, 2-plants $hill^{-1}$].

SF1. 100 % Sunflower [35000 plants fed^{-1}, 60-cm between rows and 20-cm hill spacing 1-plant $hill^{-1}$].

The desired interval row spacing was achieved by skipping some rows spaced at 80 and/or 60 cm. The furrows were skipped to leave 120 and/or 140 cm intervals spacings respectively. Size of sub-plots was 36 m^2 including six rows with six m long were filled with 72 bud-cuttins of G.T.54-9 sugarcane variety. 1.0 m allay between each sub plot. Sugarcane planted on 17 and 21 March in the 1st and 2nd seasons respectively. In the third week of May, the first hoeing process (scribble) of sugarcane was carried out and 1,300 g of urea (46.5%) were added to each plot (150 kg fed^{-1}), then the field was irrigated directly. After 48 hours, soybean (G.83 variety which inoculated by *Rhizobium japonicum*) and sunflower (Sakha 53 variety) seeds were planted (the commonly known Herati method) on the previously mentioned distances.

Ten days later (after soybean and sunflower germination), 280 g of urea was added to each plot below soybean and sunflower plants (15 kg fed^{-1}) and then the field was quickly irrigated. A week later, soybean and sunflower were thinned to obtain the previous mentioned plant densities. Fifteen days later, the second hoeing process of sugarcane was carried out (heaping around the stalks using hoes), with only manual removal of the weeds which germinating among soybean and sunflower plants.

After the hoeing finished, 1,700 g of urea (200 kg fed^{-1}) were added to each plot below the sugarcane stalks and 280 g urea below sunflower plants. No urea was added below soybean plants after assurance the successful formation of bacterial nodes. Irrigation was then followed at the appropriate times until signs of maturity appeared on soybean and sunflower plants, where irrigation was prevented until their harvesting. Immediately after harvesting of the intercrop, 1300 g of urea was added to each plot and then irrigated. Irrigation was continued at the appropriate times until 30 days before sugarcane harvest.

Collected data

Sugarcane

Sugarcane was harvested after twelve months of planting. In each sub plot, the millable stalks were counted, cleaned and weighed to estimated the parameters of: number of millable stalks fed^{-1}, millable stalk weight (kg), and cane yield (ton fed^{-1}). A random 10-stalk hand-harvested sample was taken from each sub plot for estimating TSS, sucrose % and sugar recovery % according to AOAC (1995) to calculate the expected sugar yield (ton fed^{-1}).

Soybean and sunflower

At harvest a sample of 10 plants was taken at random whether from the pure stands and/or from the intercropped subplots to estimate plant yield (g), seed yield (ton fed^{-1}) and oil yield (kg fed^{-1}).

Competition indices

Land equivalent ratio (LER) was calculated according to Willey (1979). as LER = LER_{cane} + $LER_{int.}$ Where LER_{cane} =Ycq /Yc and LER_{int} = Yqc / Yq where Yc and Ycq are the yields of sugarcane as sole and intercrops, respectively and Yq and Yqs are the yields of intercrop (soybean and/or sunflower) as sole and intercrops respectively.

Competitive ratio (*CR*) was calculated according to Dhima *et al.* (2007) as CR_{cane} = (LER_{cane} / $LER_{int.}$) (Zqc /Zcq), and $CR_{int.}$ =($LER_{int.}$ / LER_{cane}) (Zcq / Zqc) where, Zcq and Zqc are the proportions of sugarcane and intercrop in the mixture respectively.

Monetary advantage index (MAI) was calculated according to Ghosh. (2004) as; MAI = (value of combined intercrops)(LER-1) / LER. Where the current price of sugarcane is 620 L.E., soy bean is 10000 L.E. and sunflower is 4500 L.E. for ton respectively.

Data were analyzed statistically using M-State program. The simple and interactions effects were evaluated by the least significant difference (LSD) test at $p \leq 0.05$ according to Gomez and Gomez (1984).

Results and Disscussions

Sugarcane results

Listed means in Table 1 indicated that, the main effect of spatial distributions was insignificant for all sugarcane studied characters which affected in a highly significant manner by intercropping systems. These results were in harmony with Patel *et al.,* 2005 who stated that, spatial geometries did not exert any significant effect on cane and sugar yields.

Concerning; number of millable stalks fed^{-1} data clear that, high intensive treatments (45 % intercrop) significantly decreased the number of millable stalks in the two growing seasons. Insignificant differences were found among the other tested systems. Similar findings were reported by Nazir *et al*. (2002). On the contrary, Bekheet (1997) stated that, intercropping of soybean with sugarcane almost appeared a statistical reduction with respect to number of millable cane. Moreover, the interaction between D and T showed similar trend with the exception of D2T7 in the 2nd season which ranked with superior treatments whereas; D1T7 presented the lowest values of; 36.67 and 37.92 for 1st and 2nd seasons respectively.

Sugarcane stalk weight (kg) is greatly influenced by the tested intercropping systems in both seasons. It could be noticed that, there were significant increase appeared with 15% and 30% soybean cropping systems in comparison to sunflower cropping systems. As expected sugarcane + 45 % sunflower attained the lowest stalk weight with values of 1.07 and 1.03 kg for 1st and 2nd seasons respectively. Results were in agreement with Hossain *et al*., (2003) and El-Gergawi *et al.,* (1995). Single stalk weight (kg) varied significantly from 1.27 kg (D2T1 and D2T3) to 1.03 kg (D2T7) in the 1st season and from 1.03 kg (D1T7 and D2T7) to 1.30 kg (D2T1 and D2T2) in the 2nd season. It is worth noting in the 2nd season, except the treatments of D1T7 and D2T7 differences among the other tested interactions were not great enough to reach the level of significance.

With regard to millable cane tonnage fed^{-1}, data in Table 1 illustrated that, millable cane yield differed significantly between the tested seven intercropping systems and ranging from 40.90 to 55.18 ton fed^{-1} in the 1st season and from 40.20 to 53.11 ton fed^{-1} in the 2nd season.

Table 1. Effect of spatial distribution and intercropping systems on number of millable stalks (1000 Fed^{-1}), millable stalk weight (kg), cane and sugar yields (ton fed^{-1}) at harvest of sugarcane.

Treatments		N. millabe stalks fed^{-1}		Millable stalk weight (kg)		Millable cane yield (ton fed^{-1})		Sugar yield (ton fed^{-1})	
		1st seas	2nd seas	1st seas	2nd seas	1st seas	2nd seas	1st seas	2nd seas
D1		41.25	41.18	1.18	1.19	48.77	48.93	5.56	5.49
D2		42.37	40.40	1.18	1.21	50.30	48.72	5.83	5.64
T1		44.97	42.42	1.23	1.25	55.18	53.11	6.61	6.36
T2		43.55	39.85	1.20	1.29	52.17	51.35	6.11	6.02
T3		43.03	41.55	1.26	1.23	54.14	51.21	6.15	5.94
T4		37.58	39.84	1.14	1.21	42.83	47.92	5.01	5.29
T5		42.77	41.08	1.19	1.18	51.01	48.44	5.93	5.59
T6		42.53	41.72	1.19	1.19	50.50	49.53	5.88	5.61
T7		38.21	39.07	1.07	1.03	40.90	40.20	4.18	4.14
D1T1		45.62	43.72	1.18	1.21	54.24	52.70	6.29	6.17
D1T2		43.03	40.78	1.20	1.28	51.38	52.38	6.01	6.10
D1T3		43.20	42.67	1.24	1.23	53.68	52.46	6.00	5.99
D1T4		36.69	40.73	1.18	1.19	43.21	48.43	4.95	5.21
D1T5		43.45	41.13	1.16	1.17	50.40	48.36	6.01	5.51
D1T6		40.06	41.30	1.19	1.18	47.78	49.00	5.57	5.35
D1T7		36.67	37.92	1.11	1.03	40.68	39.14	4.07	4.07
D2T1		44.33	41.13	1.27	1.30	56.12	53.52	6.92	6.56
D2T2		44.08	38.93	1.20	1.30	52.96	50.33	6.21	5.93
D2T3		42.85	40.42	1.27	1.24	54.59	49.95	6.29	5.89
D2T4		38.48	38.95	1.10	1.22	42.45	47.40	5.07	5.37
D2T5		42.09	41.03	1.23	1.18	51.63	48.51	5.85	5.68
D2T6		44.99	42.14	1.18	1.19	53.22	50.06	6.18	5.87
D2T7		39.74	40.21	1.03	1.03	41.11	41.26	4.29	4.22
D	F.test	ns	ns	ns	ns	ns	ns	ns	ns
	LSD	-	-	-	-	-	-	-	-
T	F.test	**	*	**	**	**	**	**	**
	LSD	2.84	2.11	0.06	0.08	3.62	3.41	0.45	0.55
DxT	F.test	ns	ns	*	*	*	*	*	*
	LSD	-	-	0.08	0.12	5.13	4.83	0.63	0.78

** = high significant * = significant ns = nonsignificant

As expected treatments of T1, T2 and T3 ranked first while, systems of T5 and T6 achieved the second place. High dense systems (45 % soybean and/or sunflower) attained the lowest tonnage of cane yield. These observations were true in both seasons with one exception of, T6 in the 2nd season showed progress to become among the first rankers with value of 49.53 ton fed^{-1}. Similar trends were observed by Jayabal *et al*. (1991) who reported that, intercropping soybean with sugarcane scored highest cane yield compared to sole cane. Moreover; intercropping sunflower with sugarcane resulted in a reduction in cane yield (Kannappan *et al*., 1990). On the contrary Stanford (1988) stated that, after the intercrop was removed, the differences become less significant and final yields of sugarcane were about the same for intercropped as for sugarcane pure stand.

The interaction between D and T was significant in both seasons. It could be noticed that, in the 1st season overall results show a real decline in the yield of millable canes only in cases of high density intercropping systems, irrespective of the pattern of distribution. Same behavior was shown in the 2nd season but only high intensive sunflower intercropping treatments (D1T7 and D2T7) led to a significant decrease. Differences among the other tested combinations were almost insignificant.

Data in Table 1 illustrated that, sugar yield varied greatly among studied intercropping systems. In the 1st season, sole cane had the highest sugar yield of 6.61 tons. No significant differences found between T2, T3, T5 and T6. In contrast, Little decrease appeared in case of cane intercropped with 45 % soybean (5.1 tons) while a great one was shown when sugar cane intercropped with 45 % sunflower (4.18 tons). Xiuping *et al.* (2013) also found that, mixed grown sugarcane and soybean have some degree of advantages in terms of cane and sugar yields. In the 2nd season systems of T1, T2 and T3 scored maximum 6.36, 6.02 and 5.94 tons of sugar respectively with insignificant differences among their values. Cane intercropped with 45 % sunflower was still the lowest sugar yield with value of 4.14 tons. These findings were in line with Kanappan *et al.* (1990) who found that, intercropping with sunflowers reduced sugarcane yield and gave a lower profit than sugarcane grown alone.

Significant interaction were shown in both seasons. In the 1st season, the estimated sugar yield ranged from 6.92 tons (D1T1) to 4.07 tons (D1T7). Moreover; there was a clear decline on sugar yield appeared when cane intercropped with 45 % soybean while minimum values obtained by cane intercropped with 45 % sunflower with both spatial distributions. In the 2nd season, no significant differences were cleared among D2T1, D1T1, D1T2, D1T3, D2T2, D2T3, D2T5 and D2T6. These combinations presented maximum sugar yield which ranged from 6.56 to 5.68 tons. Other tested combination took a similar behavior which happened in the 1st season.

Soybean results

Data in Table 2 showed a highly significant effect for all studied trails of soybean due to intercropping systems. Regarding with plant yield (g) in the 1st season systems of 15 % soybean attained greatest values of; 24.60 and 24.12 g, for D2 and D1 cane distributions respectively, followed by SO3 with both cane distributions. In the 2nd season, D2SO2 showed its significant superiority with value of 27.07, followed with significant difference by D1SO2 and D2SO3.

Table 2. Effect of cropping systems on plant yield (g), seed yield (ton fed-1) and oil yield (ton fed^{-1}) of soybean intercropped with sugarcane.

Treatments	Seed yield (g) plant^{-1}		Seed yield (ton fed^{-1})		Oil yield (kg fed^{-1})	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
SO1	18.33	18.73	1.674	1.719	336.50	338.40
D1SO2	24.12	24.29	0.370	0.386	65.27	69.71
D1SO3	21.75	21.03	0.622	0.631	123.20	119.40
D1SO4	13.95	14.05	0.582	0.577	100.40	96.08
D2SO2	24.60	27.07	0.381	0.428	66.45	76.17
D2SO3	21.90	23.86	0.634	0.703	120.70	136.00
D2SO4	14.02	13.66	0.588	0.573	113.10	111.30
F. test	**	**	**	**	**	**
LSD at 0.05	0.66	1.86	0.047	0.048	10.72	10.66

** = high significant * = significant ns = nonsignificant

The two systems including 45 % soybean presented the lowest seed yield plant^{-1} in both seasons. These results may be due to the decrease in yield component characters i.e.; number of branches, pods and seeds per plant as a result of dense systems.

With respect to seed yield (ton) it could be noticed that, sole soybean was the most advantageous with values of 1.674 and 1.719 ton fed^{-1} for 1st and 2nd seasons respectively. In the 1st season cropping systems of D2SO3, D1SO3 and D2SO4 came in the 2nd place with in significant differences among their values. However, in the 2nd season D2SO3 ranked the second with value of 0.703 ton followed with significant difference by D1SO4 and D2SO4. Systems including 15 % soybean showed the lowest tonnage yield in both seasons. Similar results presented by Xiuping *et al*. (2013) who reported that, soybean showed a certain degree of plant dry matter loss during intercropping with sugarcane.

Concerning; oil yield varied from 65.27 to 336.50 kg oil fed^{-1} in 1st season and from 69.71 to 338.40 kg oil fed^{-1} in the 2nd season. Sole soybean significantly surpassed the other tested systems as a direct reflection of the high seed yield. D1SO3 and D2SO3 attained similar values in the 1st season whereas; in the 2nd season D2SO3 significantly surpassed D1SO3 with value of 136.0 kg oil fed^{-1}. As expected; the two systems including 15% soybean ranked the last with insignificant differences between their values. Weil and McFadden (1991) also mentioned that, maize yield was not affected by the presence of soybean while soybean yield was reduced significantly under maize intercropping.

Sunflower results

Means listed in Table 3 indicated that, the effect of intercropping systems was significant for all sunflower tested trails in the two seasons. The highest plant yield (36.64 g) attained by D2SF3 in the 1st season whereas; the greatest one in the 2nd season (40.45 g) scored by D2SF2 system. Sole sunflower ranked second in both seasons. Khanzada *et al*. (1989) also found increasing in yield of sunflower when intercropped with sugarcane. The high dense system (D1SF4) ranked last with values of 24.69 and 25.26 g for 1st and 2nd seasons respectively.

Table 3. Effect of cropping systems on plant yield (g), seed yield (ton fed^{-1}) and oil yield (kg fed^{-1}) of sunflower intercropped with sugarcane.

Treatments	Seed yield (g) $plant^{-1}$		Seed yield (ton fed^{-1})		Oil yield (kg fed^{-1})	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
SF1	35.93	37.80	1.210	1.276	505.92	542.07
D1SF2	35.22	37.11	0.180	0.193	75.45	80.92
D1SF3	32.35	33.78	0.329	0.344	125.76	128.60
D1SF4	24.69	25.26	0.374	0.380	134.35	141.54
D2SF2	35.58	40.45	0.184	0.207	77.71	89.33
D2SF3	36.64	34.30	0.373	0.349	148.11	139.34
D2SF4	30.27	29.76	0.463	0.459	167.79	168.38
F. test	**	**	**	**	**	**
LSD at 0.05	0.33	1.19	0.015	0.015	4.84	14.80

** = high significant * = significant ns = insignificant

Regarding with seed yield (ton) its clear that, results took the same behavior in both seasons. Sole sunflower recorded maximum yield with values of 1.210 and 1.276 ton fed^{-1} for 1st and 2nd seasons respectively as a direct reflection of high number of plants. The two systems including 15 % sunflower attained minimum seed yield in both seasons. In addition; in the 1st season, D1SF4 and D2SF3 showed approximately same seed yields of sunflower. similar findings were showed by Amujoyegbe *et al*. (2013) who stated that, the grain yield of the sunflower under sole cropping were significantly higher than those under intercropping. On the contrary; De la Fuente *et al*. (2014) reported that, sunflower grain yield in intercrops did not differ from that in sole crops however, soybean yield was significantly lower in intercrops. Furthermore, sole system recoded maximum oil yields of; 505.92 and 542.07 followed by D2SF4 which yielded 167.79 and 168.38 kg oil fed^{-1} for 1st and 2nd seasons respectively. As expected, the two systems including 15% sunflower attained minimum oil yields in both seasons due to the low tonnage of seed. Moreover, D2SF3 significantly surpassed D1SF4 only in the 1st season.

Competition indices

Land equivalent ratio (LER) method was the most generally useful single index for expressing the yield advantage. It is defined as the relative land area required as sole crop to produce the same yield as intercropping. Data in chart 1 indicated that, LER values were insignificantly affected by the tested spatial distributions, while the main effect of intercropping systems was highly significant. The greatest values of LER were observed at cane + 30 % soybean in both seasons whereas; systems including 15 and/or 45 % sunflower scored minimum LER in both seasons. These findings were in harmony with Wang *et al*. (2011) who suggested that, sugarcane/soybean intercropping had higher LER than monoculture sugarcane.

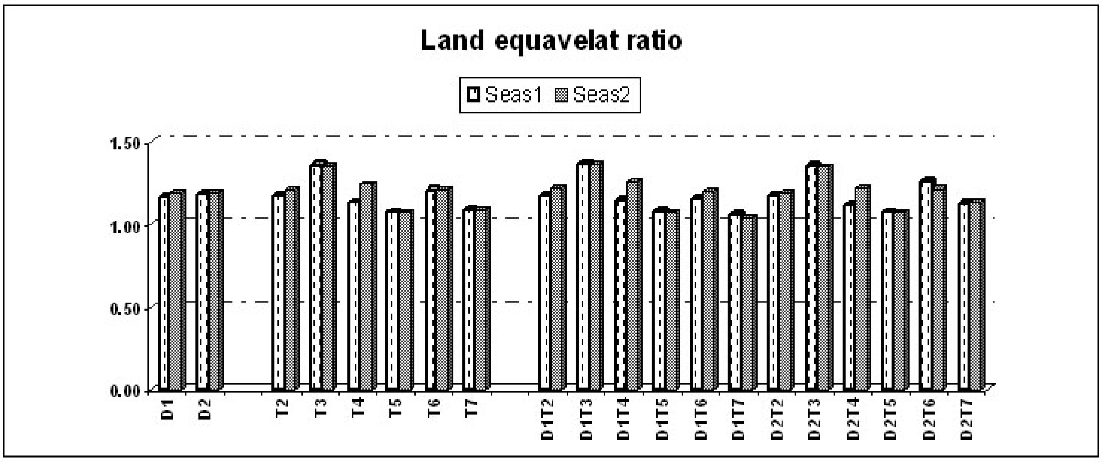

Fig. 1: Effect of spatial distribution and intercropping systems on land equivalent ratio.

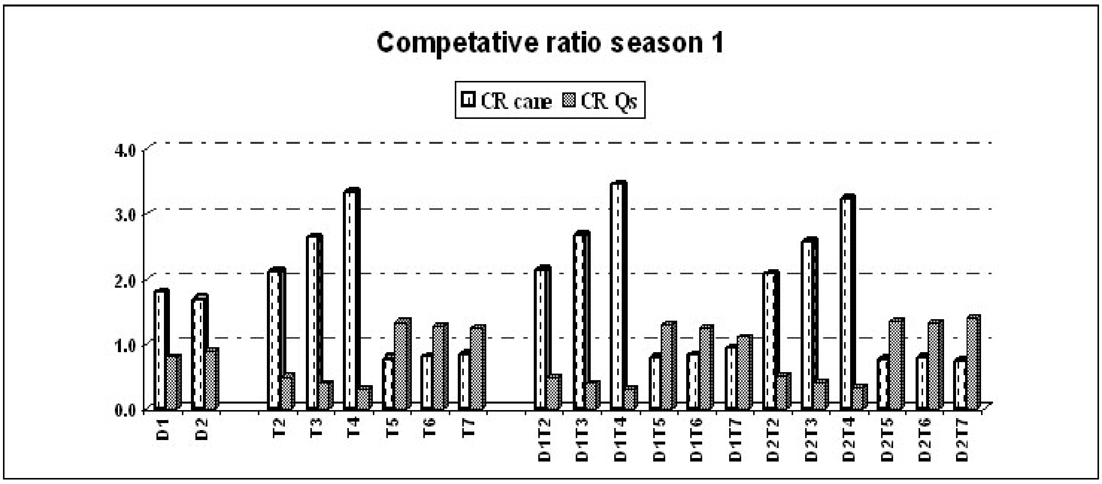

Fig. 2: Effect of spatial distribution and intercropping systems on competitive ratio of sugarcane and intercrop (soybean and/or sunflower).

Competitive ratio (CR) is an important indicator to know the degree with which one crop competes with the other. Data in charts 2 and 3 showed insignificant effect of spatial distributions on CR values. Sugarcane grown in association with soybean under various systems exhibited the greatest CR values. Moreover, the higher the density of soybean the greatest the CR of sugarcane when they grew in association.

On the other word, higher CR values of sunflower indicated that, for all tested intercropping systems sunflower was more competitive than sugarcane when grown in association. Ghosh *et al*. (2006) also indicated that if competitive ratio was less than 1.0, there is a positive benefit and the crop can be grown in association, but if greater than 1.0, there was negative benefits.

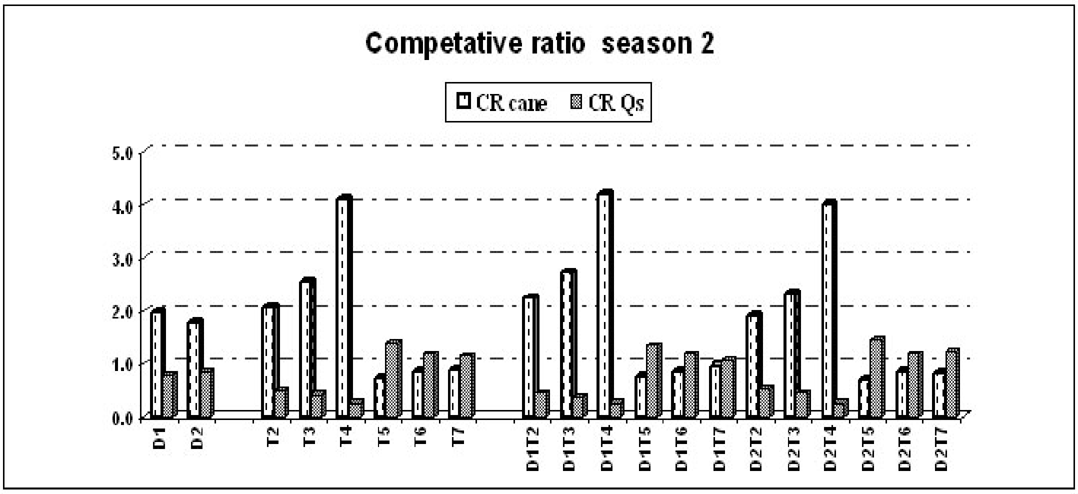

Fig. 3: Effect of spatial distribution and intercropping systems on competitive ratio of sugarcane and intercrop (soybean and/or sunflower).
Qs = the intercrop (soybean and/or sunflower)

The monetary advantage index (MAI) values were positive in all planting patterns and intercrop proportions, which shows definite yield and economic advantages compared to the sole systems. Chart 4 showed that, MAI values were insignificantly influenced by the tested spatial distributions in both seasons.

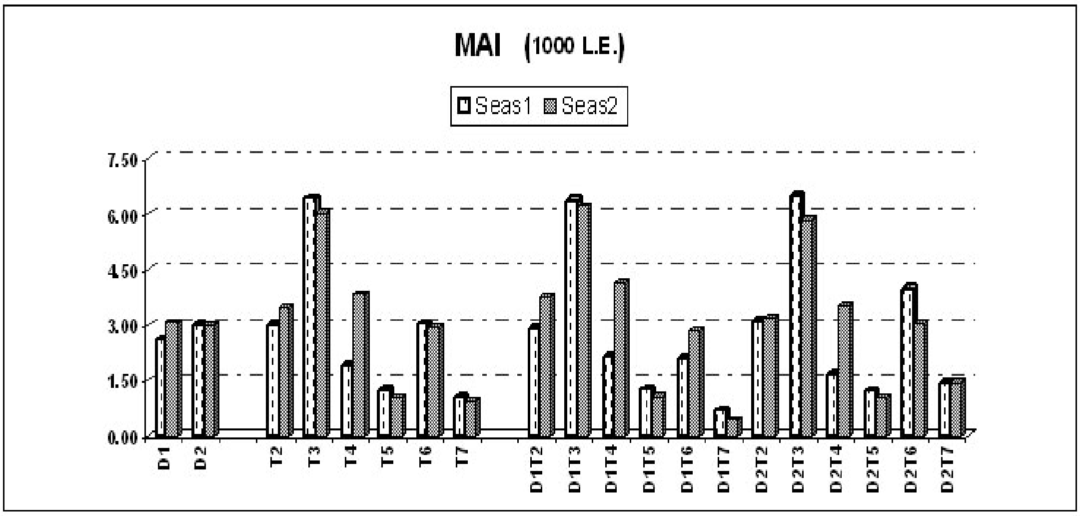

Fig. 4: Effect of spatial distribution and intercropping systems on monetary advantage index (MAI).

On the other side intercropping systems had highly significant effects on the values of MAI. Sugarcane + 30 % soybean showed its significant superiority with values of 6.42 and 6.03 (1000 L.E. fed^{-1}) for 1st and 2nd seasons respectively which implies the most advantageous economic system. These findings are also parallel to those of LER values. Dhima *et al.* (2007) reported that if LER value was higher, there was also economic benefit expressed with MAI value. Systems of T5 and T7 exhibited the lowest MAI values where differences among the other tested systems were insignificant. High significant interactions found between spatial distributions and intercropping systems. It could be noticed that, D1SO3 attained the greatest MAI values while D1SF4 presented the lowest. These findings were true in both seasons.

Conclusion

The present study concludes that, sugarcane yield and its component insignificantly influenced by the tested spatial distributions. Intercropping systems of sugarcane with soybean and/or sunflower densities as well as their interactions with cane spatial distributions significantly affect yields, competition and economics.

Sugarcane intercropped with 30 % soybean was the most advantageous system with respect to yields and economics. Moreover, sunflower shows more competitive than sugarcane and the higher the proportion of sunflower inter-planted with sugarcane, the lower the yields of both crops.

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تأثير التوزيع الفراغي على التنافس و محصول و ربحية قصب السكر الربيعي المحمل ببعض المحاصيل الزيتية

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الملخص

أجريت تجربة حقلية بمحطة بحوث ملوي الزراعية – محافظة المنيا خلال موسمي الزراعة ٢٠١٣ / ٢٠١٤ و ٢٠١٤ / ٢٠١٥ لدراسة تأثير التوزيع الفراغي لقصب السكر الربيعي المحمل بثلاث كثافات نباتية من فول الصويا و عباد الشمس على صفات المحصول والتنافس. وقد اشتملت المعاملات على قصب صنف C9 منفرد و فول صويا صنف جيزة ٨٣ منفرد و عباد شمس صنف سخا ٥٣ منفرد وقصب + ١٥ – ٣٠ – ٤٥ % فول صويا وقصب + ١٥ – ٣٠ – ٤٥ % عباد شمس. و فيما يلي ملخص لأهم النتائج:

- لم يظهر التأثير الرئيسي لمعاملة التوزيع الفراغي أي تأثير معنوي على جميع الصفات المدروسة. في حين أظهرت معاملات التحميل والتفاعل بين التحميل والتوزيع الفراغي تأثيرات عالية المعنوية على جميع الصفات.
- أدت زيادة كثافة المحصول المحمل الى انخفاض ملحوظ في عدد سيقان القصب القابلة للعصير. أيضاَ أعطى القصب المنفرد والقصب المحمل بـ ١٥ – ٣٠ % فول صويا أعلى قيم من وزن العود بالكجم ومحصول العيدان والسكر بالطن.
- الزراعة المنفردة لفول الصويا وعباد الشمس أعطت أعلى ناتج من محصول البذور بالطن في حين معدل التحميل المنخفض (١٥ %) أعطى أعلى محصول بالجم للنبات الفردي.
- أظهر عباد الشمس قدرة تنافسية أعلى من القصب الذي بدورة كان أعلى من فول الصويا في القدرة التنافسية.
- نظام التحميل قصب + ٣٠ % فول صويا أعطى أعلى معدل من المكافئ الأرضي وأعلى عائد اقتصادي