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Yield and its Components of Maize/Soybean Intercropping Systems as Affected by Planting Time and Distribution

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Abstract: Two field experiments were carried out at El-Gemmeiza Agriculture Experiments and Research Station, ARC, El- Gharbia Governorate, Egypt during 2008 and 2009 seasons. The objectives were to study the effect of three cropping systems soybean/maize, three time of soybean planting and two distribution of maize plants on yield and its components for both crops. A split-split plot design with three replications was used in RCBD. Data analysis indicated that, all studied traits recorded significant effects due to the interactions between cropping systems and Time of planting and distribution maize plants in both seasons. The highest ear leaf area and 100-grain weight were found with treatment cropping system (2:4) x soybean planted 21 days after maize and second distribution of maize planting in both seasons. While, grain yield /fed. was different from season to anther, but treatment cropping system (2:2) x Soybean planted 21 days before maize and the first distribution of maize planting recorded the highest values of grain yield/fed. in the first season, and the same cropping system in the second season with both distribution maize plants and soybean planted 21 days after maize. The highest seed yield/fed. was found with the interactions between cropping system (2:4) and the second distribution of maize planting and both time of planting soybean planted with maize and soybean planted 21 days after maize in first and second season, respectively. The highest values of LER recorded with intercropping systems (2:2) and (2:4) in both seasons.

Key words: intercropping, distribution plants, soybean, land equivalent ratio, Competitive ratio.

INTRODUCTION

Soybean [*Glycine max* (L.) Mrrill] could be considered as the most important protein and oil crops in the world. It has been commercially grown in Egypt since early 1970s and gained local interest since that time. The cultivated form is used as a human food and livestock feeds.

Maize (*Zea mays* L.), which is one of the most important cereal crops grown in Africa and ranks as the third most cultivated crop in Egypt (Ayeni, 1987), features prominently in inter-cropping systems involving legume and non-legume crops such as soybean, cowpea, cassava, etc. Maize is used for human food, livestock feed and as a source of industrial raw material for the production of oil, alcohol and starch.

The growth of two crops together in the same field during a growing season may result in inter specific competition or facilitation between the plants (Zhang and Li, 2003). Thus, the overall mixture densities and the relative proportions of component crops are important in determining yields and production efficiency of cereal-legume intercrop systems (Willey and Osiru, 1972; Lakhani, 1976).

Intercropping, in Egypt, is also recommended to increase profitability for Egyptian farmers and agricultural production against food crises in Egypt (Metwally, 1999; Metwally *et al.,* 2003; Metwally *et al.,* 2005). The intercropping may lead to an overall yield advantage (Sayed Galal *et al.,* 1979; Ahmed and Rao, 1982; Sayed Galal, 1984; Assey *et al.,* 1992; Shafik, 2000; Metwally, 1999 and Shafik and Soliman, 1999).

Abd El-Gawad *et al.,* (1985) and Hammad (1998) found that, grain yield, weight of 100-grain and land equivalent ratio increased when soybean intercropped with maize.

In maize/soybean intercropping, the yields of the cereals were not affected by intercropping with soybean when arranged in either single or double alternate rows (Mohta and De, 1980).

Sowing date is one of the most important agronomic factors affecting soybean. In Egypt, Several investigators reported that, sowing date plays an important role in crop productivity. Seed yield of soybean cultivars decreased with delayed sowing. They also found that, higher yields were associated with more pods and higher seed weight/plant as well as higher weight of 100 seeds (Johanson *et al.,* 1960; Beaver and Johnson, 1981; Board and Hall, 1984; Sarmah *et al.,* 1984; Boquet *et al.,* 1985; Moore *et al.,* 1991; Ali, 1993; Shafshak *et al.,* 1997; Mohamed, 1994; Hassan *et al.,* 2002 and Soliman *et al.,* 2007).

The objective of this investigation was to study intercropping systems of maize with soybean planting time of soybean and maize plant distribution on yield and its components as well as Land equivalent ratio in both seasons.

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MATERIAL AND METHODS

The present investigation was carried out at El-Gemmeiza Agriculture Experiments and Research Station, ARC, El- Gharbia Governorate, Egypt during the two successive growing summer seasons 2008 and 2009 to study the effect of intercropping systems, planting time for soybean and distributions of maize plants on the productivity of maize [Tetra Cross (T.C. 310)] and soybean [Giza 111].

The experiments were laid out split-split plots with three replications, three Cropping Systems (CS) were randomly allocated in the main plots:
(CS_1)= one row maize : 2 rows soybean.
(CS_2)= two rows of maize : two rows of soybean.
(CS_3)= two rows of maize : four rows of soybean.
The sub-plots were randomly assigned by three Time of planting for soybean (T):
(T_1) = Soybean planted 21 days before maize.
(T_2) = Soybean planted with maize.
(T_3) = Soybean planted 21 days after maize.
Sub-sub plots were randomly assigned by the two distributions of maize plants (D):
(D_1)= One plant/hill, 20 cm apart.
(D_2)= Two plant/hill, 40 cm apart.

All the previous patterns resulted in 30000 maize plants. Each sub-plot included of 12 ridges, each ridge was 3 m long and 0.7 m wide (25.2 m^2). The proceeding crop was wheat in the two seasons. Soybean was planted at 15 and 20 May on 2008 and 2009 seasons, respectively. Maize was thinned to 1 plant/hill in intercropping patterns with distance of 20 cm between hills and 2 plants/hill with distance 40 cm between hills, Soybean was thinned to 2 plants/hill with distance of 20 cm between hills. All another cultural practices for maize production were undertaken as recommended.

At harvest time a random sample of ten plants from each sub-sub-plot were taken in both seasons to determine the following characters:

A-Maize yield and its components
1- Plant height (cm)
2- Ear leaf area (cm).
3- 100- grain weight (g).
4- Grain yield/ear (g).
5- Grain yield/fed. (aradab).

B- Soybean yield and its components
1- Plant height (cm).
2- No.of pods/plant.
3- 100-seed weight (g).
4- Seed yield/plant (g)
5- Seed yield/fed (kg)

Land Equivalent Ratio (LER): the ratio of area need under sole cropping to that of intercropping at the same management level to produce an equivalent yield, accrordeing to Mead and Willey (1980). It is Calculated as follows:

$LER = (Y_{ab}/Y_{aa}) + (Y_{ba}/Y_{bb})$

Where, Y_{aa} and Y_{bb} are the sole crop yields of crops a and b, respectively, Y_{ab} is the intercrop yield of crop a, and Y_{ba} is the intercrop yield of crop b.

Competitive ratio (CR) indicates the number of times by which one component crop is more competitive than the other. Relative species competition is often evaluated using competitive ratios (Putnam *et al.*, 1984).This was calculated as:

CR = La/Lb x zba/zab

Where CR is the competitive ratio of crop a and La and Lb are the LERs of crops a and b respectively, zba is the proportion of crop a in the ab intercrop and zab is the proportion of crop b in the ab intercrop. If Ra < 1, there is a positive benefit and the crop can be grown in association; if Ra > 1, there a negative benefit. The reverse is true for Rb.

Data statistically analyzed as the technique analysis of variance (ANOVA) of split-split plot design as mentioned by Gomez and Gomez (1984). Treatment means were compared using the Least Significant Difference (LSD at 5%) test as outlined by Waller and Duncan (1969).

RESULTS AND DISCCUSSION

1-Maize Yield and its Components:

Data presented in Table (1) showed that, the intercropping systems had significant effects on yield and other traits in both seasons, except plant height in the first season. Similar results were found by Metwally *et al.*, (2005) recorded that, there were significant increases in the grain yield/plant for intercropped maize in alternating ridges than mixed intercropping and solid plantings. Also with Metwally, *et al.,* (2009 a) who reported that, cropping patterns significantly affected all traits of maize and soybean. Results in Table (1) showed that, cropping system 2 maize : 2 soybean (CS_2) had significant increments in each plant height and grain yield/fed. in both seasons, while cropping system 2 maize: 4 soybean (CS_3) recorded the highest

significant values for ear leaf area, 100-grain weight, and grain yield/ear in both seasons. Similar results were found by Metwally, *et al*.,(2009 a) who found significant differences between the two intercropping patterns (2:2 and 2:4) for total leaf area/plant, grain yield per plant and feddan. Sole maize recorded the higher grain yield/fed.(17.28 and 18.44), compared with intercropped mean (11.58 and 12.55) in both seasons, respectively.

Table 1: Effect of intercropping systems, time of soybean planting, distribution maize plants and their interaction on maize yield and its components.

Treatments		Plant height (cm)			Ear leaf area(cm)			100 grain weight (g)			Grain yield/ear (g)			Grain yield/fed (ardab)		
		D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean
Season 2008																
CS_1	T_1	317.33	321.00	319.17	879.33	883.33	881.33	22.90	22.10	22.50	140.67	143.75	142.21	11.18	10.65	10.92
	T_2	326.67	330.00	328.34	901.67	905.67	903.67	20.80	20.01	20.41	132.12	134.67	133.40	11.49	11.19	11.34
	T_3	332.00	333.00	332.50	912.33	928.67	920.50	23.00	23.60	23.30	138.33	141.83	140.08	11.41	10.98	11.20
	mean	325.33	328.00	326.67	897.78	905.89	901.83	22.23	21.90	22.07	137.04	140.08	138.56	11.36	10.94	11.15
CS_2	T_1	322.00	330.00	326.00	785.00	788.33	786.67	21.70	20.50	21.10	132.50	136.92	134.71	13.14	12.83	12.99
	T_2	329.00	330.00	329.50	793.33	800.33	796.83	21.50	22.30	21.90	134.17	143.30	138.74	12.32	11.30	11.81
	T_3	336.00	350.00	343.00	815.33	829.33	822.33	21.47	23.10	22.29	131.17	137.69	134.43	12.60	12.56	12.58
	mean	329.00	336.67	332.83	797.89	806.00	801.94	21.56	21.97	21.76	132.61	139.30	135.96	12.69	12.23	12.46
CS_3	T_1	315.00	318.00	316.50	913.67	921.00	917.34	23.43	23.97	23.70	147.20	156.25	151.73	11.13	10.70	10.92
	T_2	328.00	345.67	336.84	929.67	936.00	932.84	23.30	24.20	23.75	147.17	152.44	149.81	11.70	11.43	11.57
	T_3	330.00	330.00	330.00	947.33	967.33	957.33	21.13	23.77	22.45	150.83	178.30	164.57	11.68	10.23	10.96
	mean	324.33	331.22	327.78	930.22	941.44	935.83	22.62	23.98	23.30	148.40	162.33	155.37	11.50	10.79	11.15
mean		326.22	331.96	329.09	875.30	884.44	879.87	22.14	22.62	22.38	139.35	147.24	143.30	11.85	11.32	11.58
Solid Maize		310.7			886.1			22.37			157.13			17.25		
Season 2009																
CS_1	T_1	294.57	297.30	295.94	793.67	826.33	810.00	19.30	19.70	19.50	139.33	140.00	139.67	9.90	10.50	10.20
	T_2	302.00	303.20	302.60	844.00	871.67	857.84	21.40	22.00	21.70	141.93	142.13	142.03	12.90	10.90	11.90
	T_3	303.20	306.00	304.60	878.67	891.00	884.84	22.60	23.00	22.80	143.97	146.13	145.05	10.87	11.33	11.10
	mean	299.92	302.17	301.05	838.78	863.00	850.89	21.10	21.57	21.33	141.74	142.75	142.25	11.22	10.91	11.07
CS_2	T_1	310.00	312.60	311.30	927.33	934.33	930.83	23.30	24.20	23.75	128.63	131.83	130.23	13.20	13.60	13.40
	T_2	314.17	327.00	320.59	947.67	954.33	951.00	24.50	25.00	24.75	135.70	136.13	135.92	13.80	14.40	14.10
	T_3	329.20	335.67	332.44	963.33	967.33	965.33	25.10	25.40	25.25	136.70	140.03	138.37	15.90	15.90	15.90
	mean	317.79	325.09	321.44	946.11	952.00	949.05	24.30	24.87	24.58	133.68	136.00	134.84	14.30	14.63	14.47
CS_3	T_1	276.30	279.30	277.80	972.00	980.67	976.34	25.50	26.40	25.95	149.43	153.90	151.67	11.67	11.90	11.79
	T_2	284.80	285.00	284.90	986.67	992.00	989.34	26.60	26.70	26.65	158.63	162.57	160.60	11.63	12.10	11.87
	T_3	291.30	292.00	291.65	995.00	1001.67	998.34	27.20	27.50	27.35	166.67	170.40	168.54	12.50	12.90	12.70
	mean	284.13	285.43	284.78	984.56	991.45	988.00	26.43	26.87	26.65	158.24	162.29	160.27	11.93	12.30	12.12
mean		300.62	304.23	302.42	923.15	935.48	929.32	23.94	24.43	24.19	144.55	147.01	145.78	12.49	12.61	12.55
Solid Maize		305.12			943.7			34.19			160.11			18.44		
LSD0.05		2008	2009		2008	2009		2008	2009		2008	2009		2008	2009	
	SC	NS	11.9		16.71	6.31		0.59	1.55		9.04	4.08		1	1.54	
	T	8.32	5.83		6.56	4.06		NS	1.32		3.06	2.56		NS	1.27	
	D	NS	NS		3.16	2.85		NS	NS		3.46	1.15		0.3	NS	
	SC x T	10.01	5.83		6.56	4.06		1.02	1.32		3.06	2.56		0.47	1.27	
	SC x D	NS	15.45		5.48	4.93		1.82	1.29		5.99	1.99		0.52	1.39	
	T x D	NS	NS		5.48	4.93		NS	NS		5.99	1.99		0.52	NS	
	SC x T X D	18.6	26.76		9.49	8.54		3.16	2.24		10.38	3.46		0.89	2.4	

Soybean planted 21 days after maize (T_3) recorded the highest values of plant height, ear leaf area, 100 grain weight, grain yield/ear and grain yield/fed. in both seasons as shown as in Table (1).

Also, in the same Table obtained that, increasing distance between hills of maize plant (D) significantly increased values of ear leaf area, grain yield/ear in both seasons and grain yield/fed only in the first season. Olufajo (1992) reported that, maize/soybean intercrops, increasing maize plant density significantly increased maize yield.

On the other hand there were no significant difference for plant height, 100-grain weight in both seasons and grain yield/fed. in the second season.

The interaction between CS x T shown as in Table (1) was significant for all studied traits. Treatment CS_3 x T_3 recorded the highest values for ear leaf area and grain yield/ear. in both seasons, while the highest grain yield/fed. were differed from season to another, this mean that there was no clear trend in this aspect as results of Table (1). On the other hand, the highest grain yield/fed. found with treatment CS_2 x T_1 and T_3 in the first and second seasons, resp.

It was quite apparent from the data illustrated in Table (1) that, the interaction between cropping systems (CS) and distribution maize plants (D) had significant effects on yield and other traits in both seasons, except plant height in the first season. From the same table, it could be noticed that, treatment T_3 x D_2 recorded the highest ear leaf area, 100-grain weight and grain yield/ear in both seasons. These results are in agreements with those obtained by Abdel-Lateef (1988) and Muoneke *et al*.,(2007) who found that, grain yield/plant was increased by increasing the distance between hill. While, treatment CS_2 significantly recorded the maximum grain yield/fed. with both distribution maize plants in both seasons.

Plant height and 100-grain weight showed insignificant effects in both seasons with the interactions between planting time and distribution maize plants. On the other hand, ear leaf area and grain yield/ear were significant effects in both seasons and the highest values were found with treatment T_3 and D_2. While, treatment T_3 x D_1 recorded the highest grain yield/fed. in the first season, but in the second season there was no significant difference between interactions.

Data in Table (1) showed that, all studied traits recorded significant effects due to the interactions between cropping systems (CS), Time of planting (T) and distribution maize plants (D) in both seasons. The highest ear leaf area, 100-grain weight and grain yield/ear were found with treatment CS_3 x T_3 x D_2 in both seasons. While,

grain yield /fed. was different from season to anther, but treatment CS_2 x T_1 X D_1 recorded the highest values in the first season, and the same cropping system in the second season with both distribution maize plants and soybean planted 21 days after maize (T_3).

2-Soybean Yield and its Components:

Data presented in Table (2) showed that, the intercropping systems had significant effect on yield and other traits in both seasons. Cropping system 2 maize: 4 soybean (CS_3) had significant increments in each no.of pods/plant, 100-seeds weight, seed yield/plant and seed yield/fed. in both seasons, while treatment CS_1 (one maize row: 2 soybean rows) recorded significant for plant height in both seasons. Metwally, *et al.,* (2009 a) obtained that, alternating ridges (2 maize: 2 soybean) and (2 maize: 4 soybean) had significant increments in each leaf area and seed yield per plant. Also, he found that, solid soybean planting had higher values of yield/feddan than those on intercropping patterns. These data are in agreements with those obtained by others (Sayed Galal *et al.,* 1979 and Abd El-Lateef, 1988). The higher seed yield of sole over intercropped soybean had been reported by other workers (Olufajo, 1992; Muneer *et al.,* (2004). Also, the reduction in intercropped soybean could be due to shading by the taller maize plants. Olufajo (1992) and O'Callaghan *et al.,* (1994) reported that, shading by the taller plants in mixture could reduce the photosynthetic rate of the lower growing plants and thereby reduce their yields.

Table 2: Effect of intercropping systems, time of soybean planting, distribution maize plants and their interaction on soybean yield and its components.

Treatments		plant height (cm)			no.of pods/plant			100 seed weight (g)			seed yield/plant (g)			seed yield/fed (kg)		
		D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean
Season 2008																
CS_1	T_1	97.50	102.20	99.85	46.33	48.33	47.33	8.10	7.37	7.74	10.02	11.20	10.61	437.00	450.00	443.50
	T_2	93.50	95.80	94.65	45.33	47.33	46.33	7.00	7.30	7.15	10.87	12.21	11.54	517.00	533.00	525.00
	T_3	92.50	94.50	93.50	43.67	44.67	44.17	6.40	6.70	6.55	9.97	9.67	9.82	425.00	453.00	439.00
	mean	94.50	97.50	96.00	45.11	46.78	45.94	7.17	7.12	7.15	10.29	11.03	10.66	459.67	478.67	469.17
CS_2	T_1	91.77	94.53	93.15	41.00	42.33	41.67	9.10	9.40	9.25	10.78	11.68	11.23	513.33	542.00	527.67
	T_2	89.20	90.73	89.97	40.00	41.33	40.67	9.80	9.90	9.85	11.26	12.28	11.77	560.00	597.00	578.50
	T_3	86.93	90.07	88.50	39.00	40.00	39.50	8.30	8.47	8.39	10.30	9.62	9.96	535.00	512.00	523.50
	mean	89.30	91.78	90.54	40.00	41.22	40.61	9.07	9.26	9.16	10.78	11.19	10.99	536.11	550.33	543.22
CS_3	T_1	86.97	87.63	87.30	47.33	52.67	50.00	10.30	10.80	10.55	11.11	12.25	11.68	633.00	650.00	641.50
	T_2	80.30	82.70	81.50	45.67	47.33	46.50	10.20	10.83	10.52	11.78	12.27	12.03	657.00	674.00	665.50
	T_3	80.97	82.03	81.50	44.67	46.33	45.50	10.00	10.20	10.10	10.61	9.85	10.23	613.33	569.67	591.50
	mean	82.75	84.12	83.43	45.89	48.78	47.33	10.17	10.61	10.39	11.17	11.46	11.31	634.44	631.22	632.83
mean		88.85	91.13	89.99	43.67	45.59	44.63	8.80	9.00	8.90	10.74	11.23	10.99	543.41	553.41	548.41
Solid soybean		87.11			48.81			9.23			12.81			954.28		
Season 2009																
CS_1	T_1	106.33	114.67	110.50	50.67	51.67	51.17	8.43	8.00	8.22	11.10	11.10	11.10	468.47	498.50	483.49
	T_2	113.33	113.67	113.50	47.67	49.33	48.50	8.00	7.70	7.85	11.40	11.50	11.45	504.53	509.00	506.77
	T_3	117.00	119.67	118.34	44.67	46.00	45.34	7.30	7.00	7.15	11.10	10.30	10.70	537.00	574.00	555.50
	mean	112.22	116.00	114.11	47.67	49.00	48.34	7.91	7.57	7.74	11.20	10.97	11.08	503.33	527.17	515.25
CS_2	T_1	99.67	100.00	99.84	40.67	42.00	41.34	10.00	10.00	10.00	12.50	12.20	12.35	574.50	599.50	587.00
	T_2	103.33	101.33	102.33	39.00	40.00	39.50	9.70	9.30	9.50	12.10	11.90	12.00	600.13	610.00	605.07
	T_3	102.67	104.67	103.67	37.33	38.33	37.83	9.30	8.70	9.00	11.80	11.50	11.65	617.50	642.00	629.75
	mean	101.89	102.00	101.95	39.00	40.11	39.56	9.67	9.33	9.50	12.13	11.87	12.00	597.38	617.17	607.27
CS_3	T_1	85.67	93.00	89.34	54.33	56.33	55.33	11.30	11.30	11.30	14.07	13.70	13.89	611.77	646.33	629.05
	T_2	94.00	95.33	94.67	52.00	53.33	52.67	11.00	10.70	10.85	13.60	13.17	13.39	653.50	663.50	658.50
	T_3	97.67	98.33	98.00	49.33	51.00	50.17	10.70	10.30	10.50	13.40	12.60	13.00	673.00	699.50	686.25
	mean	92.45	95.55	94.00	51.89	53.55	52.72	11.00	10.77	10.88	13.69	13.16	13.42	646.09	669.78	657.93
mean		102.19	104.52	103.35	46.19	47.55	46.87	9.53	9.22	9.37	12.34	12.00	12.17	582.27	604.70	593.49
Solid soybean		91.72			49.13			10.3			13.32			975.25		
LSD0.05		2008	2009		2008	2009		2008	2009			2008	2009		2008	2009
	CS	7.71	16.14		1.31	3.8		0.64	0.83			0.21	1.09		81.99	31.15
	T	3.65	30.66		0.62	NS		0.47	0.36			0.28	0.71		35.85	NS
	D	3.31	NS		0.26	0.26		NS	NS			0.18	NS		NS	NS
	CS x T	3.65	8.86		0.62	0.71		0.47	0.36			0.28	0.81		35.85	30.66
	CS x D	5.73	NS		0.45	0.45		0.56	0.59			0.32	1.14		22.95	40.77
	T x D	NS	NS		0.45	0.45		NS	NS			0.32	NS		22.95	40.77
	CS x T X D	9.92	20.03		0.77	0.77		0.97	1.02			0.55	1.97		39.74	70.62

Metwally *et al.,* (2005) reported that, alternating pattern produced lowest soybean yield/feddan than those obtained from mixed intercropping and solid cultures. Sayed Galal *et al.,* (1979) found that, intercropped soybean yield/feddan ranged from 30 % to slightly more than 50 % of solid soybean plantings under alternating and mixed intercropping patterns.

Results in Table (2) showed that, treatment T_1 recorded the highest values of plant height only in the first season, no.of pods/plant and 100 seed weight in both seasons. As well as, the maximum seed yield/fed was found with treatment T_2 (589.67 kg) and T_3 (623.83 kg) in the first season and the second season, resp. On the other hand, Muoneke *et al.,* (2007) found that, no cropping system effect on soybean plant height in both early and late cropping seasons, except at 8 weeks after planting when intercropped plants were taller than the sole crops. Crops with C4 photosynthetic pathways such as maize have been known to be dominant when intercropped with C3 crops like soybean (Hiebsch, *et al.,* 1995). Muoneke *et al.,* (2007) found that, intercropping reduced the number of soybean pods per plant by 46% in the early season and seed yield per hectare by 42 and 46% in early and late seasons, respectively. The reduction in seed yield by intercropping could be due to inter specific competition and depressive effect of maize, a C4 species on soybean, a C3 crop. El-Harty *et al.,* (2010) found that, the effect of planting date was more important than other factors on no. of

pods and seeds/plant. Interestingly, the effects of both seasons and planting date were more important than other factors on seed yield (t/fed). And also, found that, the highest seed yield/fed (1.28 t) was also obtained from the third sowing date (May 10th), while the lowest one (1.144 t) was obtained from the last one (May 25th). Addo-Quaye *et al.*, (2011) found that, soybean planted before the introduction of maize (maize planted 14 days after soybean, maize planted 28 days after soybean) recorded higher grain yield than soybean introduced after maize. Similarly Nnoko and Doto (1980) observed that, planting soybean before cereal gave significantly higher yields than planting soybean at the same time or after the cereal, with the earlier planting schedule resulting in the highest yield.

Results in Table (2) showed that, plant height, 100-seed weight and seed yield/fed. recorded no significant effects by distribution maize plants in the both seasons. On the other hand, increased by doubling distance between hills of maize plants increased plant height, no.of pods/plant, seed yield/plant and seed yield/fed. in both seasons.

The interaction between cropping systems (CS) and Time of planting (T) recorded significant values for all studied traits as shown as in Table (2). Cropping systems 2 maize:4 soybean (CS_3) recorded the highest significant values for no.of pods/plant and 100-seed weight in both seasons when soybean planted before maize, while seed yield/fed. was differed from season to another, but the highest seed yield/fed. was recorded with the same cropping system (CS_3) and both time of planting T_2 (665.50 kg) and T_3 (686.25 kg) in the first season and the second season, resp. On the other hand, the lowest seed yield/fed. found with treatment CS_1 T_1 in both seasons, as shown as in Table (2).

Table (2) showed that, the interaction between cropping systems (CS) and distribution maize plants (D) had significant effects on yield and other traits in both seasons, except plant height in the second season which recorded no significant. Cropping system (2:4) (CS_3) and (D_2) recorded the highest no.of pods/plant in both seasons and seed yield/plant in first season, while cropping system (2:4) and D_1 recorded the highest values of 100-seed weight in both seasons and seed yield/plant in the second season. These results are in agreements with those obtained by Abdel-Lateef (1988) and Muoneke *et al.*,(2007). While, treatment D_1 and D_2 significantly produced maximum seed yield/fed. with CS_3 in first and second season, resp. on the other hand, the lowest seed yield/fed. recorded with treatment CS_1 x D_1 in both seasons.

Results in Table (2) showed that, the highest seed yield/fed. found with the interactions between (CS_3) x (D_2) and (T_2) and (T_3) in first and second season, respectively.

3- Land Equivalent Ratio (LER) and Competitive Ratio (CR):

Table (3) showed that, CS recorded significantly values of LER for both seasons. In general intercropping systems increased LER as compared to solid plantings of maize and soybean as shown as in Table (2). Similar results found by (Pendleton *et al.*, 1963; Wahua and Miller, 1978; Sayed Galal *et al.*, 1983; Metwally, 1999; Metwally *et al.*, 2003 and Metwally *et al.*, 2005).

Table 3: Effect of intercropping systems on LER, net return/fed and CR in both seasons.

Intercropping systems (CS)	Relative yield		LER	Total return/ Fed (L.E)	Netreturn/ Fed (L.E)	CR
	Maize	Soybean				
CS_1	0.49	0.65	1.14	4329.68	2089.18	0.66
CS_2	0.57	0.72	1.29	4914.08	2639.08	1.27
CS_3	0.66	0.65	1.31	4984.32	2743.82	0.49
LSD 0.05			0.12			
CS_1	0.53	0.60	1.13	4496.40	2255.90	0.57
CS_2	0.62	0.78	1.41	5612.48	3337.48	1.26
CS_3	0.67	0.66	1.33	5298.12	3057.62	0.49
LSD 0.05			0.11			
Solid Maize 2008				3795.00	1445.00	
2009				4056.80	1706.80	
Solid Soybean 2008				3817.12	1617.21	
2009				3901.00	1701.00	

Farm gate price 1- Maize, L.E 220/ ardab 2- Soybean, L.E 4000/ ton
Total cost 1- Solid Maize: L.E 2350 2-Solid Soybean: L.E 2200
3- Inter Soybean with corn=total costs of corn+ some variable costs of soybean.
a- Intercropped soybean with corn (1:2) patterns= 2240.5 L.E
b- Intercropped soybean with corn (2:2) patterns= 2275.0 L.E
c- Intercropped soybean with corn (2:4) patterns = 2240.5 L.E

According to Edje (1987), if the LER is equal to 1, then there is no difference in yield between growing the crop in pure or mixed stand. If the LER is greater than 1, there is a yield advantage when both crops were grown as mixed compared to pure stands? If however the LER is less than 1, it will be better in terms of yield to grow both crops separately, as it indicates yield disadvantage. In the present study the LER was greater than 1 in almost all the treatments, indicating that it is advantageous to grow maize and soybean in association than in pure stands. Ghaffarzaeh *et al.*, (1994) showed that, soybean yield tends to be lower whilst maize yield tends to

be higher under soybean/maize intercropping systems. In cereal-legume intercropping, the cereal components usually tend to have greater competitive ability because of their relatively higher growth rate, height advantage, and more excessive root system (Ofori and Stern, 1987).

The highest values of LER showed with CS_2 and CS_3 in both seasons, which were no significant differences between them, as shown as in Table (3). Metwally *et al.,* (2009 a) found that, LER was greatest in alternating ridges (2:2) than alternating ridges (2:4).

The economic return of intercropped maize with soybean as compared with solid plantings has been calculated (Table 3). The prices of the products used were the farm gate prices of maize grains and soybean seeds at 2009 season. Variable costs and total costs were estimated according to Agricultural Statistics Book (2007). Intercropping systems CS_3 and CS_2 recorded the highest net return per fed. (2743.82 and 3337.48) in the first and second seasons, respectively.

Data in Table (3) showed that, the better Competitive Ratio (CR) found at all intercropping systems CS_1 and CS_3, which was less than 1.00 but greater than 1.00 at CS_2 suggesting that competition become more severe at CS_2. Ghosh *et al*. (2006) had indicated that if competitive ratio was less than 1, there is a positive benefit and the crop can be grown in association, but if greater than 1, there was negative benefit. According to Willey and Rao (1980), competitive ratio (CR) gives a better measure of competitive ability of crops and can prove a better index as compared to aggressively.

Conclusions:

From this investigation it could be concluded that, The highest ear leaf area, 100-grain weight and grain yield/ear were found with treatment cropping system (2:4) x soybean planted 21 days after maize and second distribution of maize planting in both seasons. While, grain yield /fed. was different from season to anther, but treatment cropping system (2:2) x Soybean planted 21 days before maize and the first distribution of maize planting recorded the highest values of grain yield/fed. in the first season, and the same cropping system in the second season with both distribution maize plants and soybean planted 21 days after maize.

The highest seed yield/fed. was found with the interactions between cropping system (2:4) and the second distribution of maize planting and both time of planting soybean planted with maize and soybean planted 21 days after maize in first and second season, respectively.

Intercropping system (2:2) and (2:4) recorded the highest values of LER in both seasons. The better Competitive ration (CR) recorded with both cropping systems (1:2) and (2:4) in both seasons. The highest net return/fed. found with (2:4) and (2:2) in first and second season, respectively.

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