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EFFECT OF FYM AND N FERTILIZER ON YIELD AND LAND USE EFFICIENCY OF MAIZE – SOYBEAN INTERCROPPING.

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ABSTRACT

Two field experiments were carried out at Sanhout village Menia Al-Kamh district- Sharkia province under Agronomy Department supervision, Faculty of Agriculture, Zagazig University, Egypt, during two summer successive growing seasons i.e. 2009 and 2010.The investigation aimed to study the effect of farmyard manure (FYM) (Without, 20 and 40 m3 /fed.) and nitrogen fertilizer levels (Without, 45 ,90 and 135 kg N / fed.) on yield and land use efficiency of maize (*Zea mays* L.) – soybean (*Glaycine max* (L.) Merr.) intercropped. Soybean variety Giza-22 was sown at 93.333 plant per fed. as pure stand and intercropping as well and maize variety TWC 324 which was sown at 23,333 plant per fed. as pure stand and intercropping (3:3) were used in this investigation included: Pure stand of maize variety TWC 324 (23,333 plant per fed.), Pure stand of soybean variety Giza-22 (93.333 plant per fed.), maize was sowing on one side and two plants per hill (46.666 plant per fed) instead of one plant per hill in the solid plots, simultaneously, soybean was always sown and thinned as two plants in hill 10 cm apart on both sides of the ridge (186.666 plant / fed) instead of one side of the ridge in the solid plots (growing three ridges of maize in alternation with three ridges of soybean).

The obtained results showed that: Grain and seed yields of maize and soybean components significantly reduced by intercropping ,compared to the pure stand yield, However, the relative yield of those two components was 82 and 85% for maize and soybean ,respectively. Thus, intercropping efficiency i.e. economic yield advantage of the combined intercrop yield reached 67% in the maize – soybean intercrop. Grain and seed yields of maize and soybean components were significantly increased due to FYM application up to 40 m3 and N up to 135 kg N / fed.Further more, land equivalent ratio (LER), area time equivalent ratio (ATER) and its LER average , land equivalent coefficient (LEC) and Agressivity (A) criterions were observed that addition of FYM did not have any significant effect on aforementioned traits in both seasons and their combined analysis. But, adding N fertilizer have significant effect on those traits (combined analysis). However, intercropping of maize and soybean, again, was more productive than growing them separately, as can be observed from the LER, ATER and its average values which were greater than unity and from the LEC values which were greater than 0.25 and from sign of agressivity values which were positive for soybean component and negative for maize at three FYM and four N fertilizer levels.

Keywords: Soybean, maize, intercropping, LER, ATER, LEC, agressivity, FYM monocrop, nitrogen. land use efficiency.

INTRODUCTION

Intercropping agriculture, as defined by many researchers is growing of two or more crops simultaneously in the same land area. This system helps farmers to manage more than one crop in the same field. The main reason for greater stability of yield in intercropping is that; if one crop fails, or grows poorly another comparison can compensate and such compensation cannot occur if crops are grown separately. Asmat *et al.* (2007) indicated that, soybean + maize in 90 cm spaced double row strips gave maximum maize grain yield and LER (6.71 and 1.62 tonne/ha),respectively. Mouneke *et al.* (2007) indicated that, the productivity of the intercropping system showed yield advantage of 2.63% as depicted by the LER of 1.02- 1.63 cleared efficient utilization of land resource by growing the crops together. Solank *et al.* (2011) found that, grain yield of maize was significantly reduced by 17.3 and 12.6% during 2007 and 2008, respectively in maize + soybean intercropping as compared yield that obtained in sole maize.

Ghosh *et al.* (2004) found that, in sole soybean, the combined use of organic and inorganic treatments yielded higher than inorganic in all the crops. The effect if FYM was more distinct on soybean. Abera *et al.* (2005) reported that, FYM significantly affected LER of maize-climbing bean cropping system. Badr and Othman (2006) added that, the increases in GY were 20.4, 122.6 and 156,0% in the 1st season and 32.4, 491.0 and 56.7% in the 2nd one with N levels of 60, 80 and 100 kg per fed. with adding organic manure compared with the control in respectively order. Khan *et al.*, (1999) found that, FYM application at 20 ton/ha combined with 60 kg N/ha performed better than all other treatments and resulted higher 1000-grain weight and greater grain and biological yields.

Tijani *et al.* (2000) reported that, grain yield increased (32%) with the application of 30 kg N/ha in soybean. They also added that, the highest grain yield (GY) of maize (3.25 t/ha) was obtained with addition of 60 kg N /ha. The land equivalent ratio LER of > 1 for the cropping system suggested an advantage in intercropping maize with soybean. Geno and Geno (2001) concluded that interspecific competition and facilitation occurs at the same time. Morgado and Willey (2003) reported that, adding N up to 50 kg N/ha significantly increased biomass yield of maize, There was a tendency for lower harvest index of intercropped maize at 100 kg N/ha, suggested that the proportion of corn yield related to biomass yield decreased at higher N availability to plants. Shivay and Singh (2003) grains/pod, grain weight/plant,1000-grain weight and yield increased with increasing N up to 40 kg/ha in soybean. the highest grain protein content were recorded with N at 80 kg/ha for soybean. Panhwar *et al.* (2004) found that,1000-grain weight of maize increased with an increase in nitrogen levels. Maximum grain yield of 1692 kg/ha was recorded from highest dose (120 kg N/ha).Meena *et al.*, (2007) stated that, application of 75% recommended dose of fertilizer (RDF) to maize (90 kg N and 40 kg P/ha) and 50% to soybean (60 kg N and 40 kg P/ha) significantly increased their respective yields and maize-equivalent yield in maize and no fertilizer in soybean. Mbah *et al.*, (2007) revealed that, intercropping reduced the yields were generally low due to the shading effect of the maize component. and applying fertilizer significantly increased the yield of the component crops than when no fertilizer was applied. Meantime, the productivity of soybean/maize mixture showed yield advantage of 68 and 79% in both 1st and 2nd seasons, respectively. Undie *et al.* (2010) found that application of 100 kg N/ha to maize increased 100-grain weight, cob yield and grain yield by 35, 138 and 153%, respectively in 2007 and by 48, 88 and 109%, respectively in 2008, over no nitrogen application. Similarly, application of 100 kg N/ha to soybean increased no. of pods/plant and 1000-seed weight by 53 and 16% respectively in 2007 and by 55 and 14% respectively in 2008 over no nitrogen application. The objective of this study was to investigate the effect of FYM and N fertilizer on yield and land use efficiency of maize (*Zea mays* L.) – soybean (*Glaycine max* (L.) Merr.) intercropping.

MATERIALS AND METHODS

Two field experiments were conducted on administration field in Menia Al-Kamh district- Sharkia Governorate under Agronomy Department supervision, Faculty of Agriculture, Zagazig University, during two summer successive growing seasons i.e. 2009 and 2010. to study the effect of farm yard manure (FYM) and N fertilizer on yield and land use efficiency of maize(*Zea mays* L.) – soybean (*Glaycine max* (L.) Merr.) intercropping system. The soil was clay loam in texture had an average pH value of 7.4 ;1.51 organic matter and had 34.11, 9.6 and 111.0 ppm available N, P and K, respectively (averaged over the two seasons for the upper 30 cm of soil depth). N,P and K of FYM 1.3, 0.3 and 1.38 as average during two seasons, respectively. In maize – soybean intercrop, each crop was planted separately as a pure stand and in association by using 3:3 intercropping system i.e. growing three ridges of maize in alternation with three ridges of soybean. For those two planting patterns, ridge width is 90 cm. in solid planting as well as cropped maize, both component crops were planted in one side of the ridge. Whereas, cropped soybean present in both sides. Here, the distances between and within ridges are the same in both sowings i.e. 20 x 90 cm for maize and 10 x 90 cm for soybean. However, each hill contained two plants; this is true in all cases of the intercrops, except sole maize (one plant per hill). Thus, total population percentage reach 200% in 3:3 cropping system (100% component population of each crop).. Seeds of soybean and maize were sown when soil moisture was adequate for germination i.e. 14 May and 6 June and 10 and 30 May in 2009 and 2010 seasons, for two crops in sole planting and intercropping system, respectively. After three weeks from planted in solid as well as intercropping planting, the plants were thinned to one plant per hill after 21 days for maize and to two plants per hill for soybean after 30 days from planting.

A split-split plot design with three replicates was used. Thirty six treatments were applied i.e. combination of three planting patterns, three farmyard manure rates and four nitrogen levels. Where, the planting patterns occupied the main plots in both solid and intercropped plantings. The farmyard manure in both solid and intercropped were arranged in 1st order sub-plots. the 2nd order sub plots were devoted to the four nitrogen fertilizer levels. The field treatment i.e. sub-sub plots included six ridges, 3m long. Thus, the plot area was 16.2 m^2. The different treatments were as follow: A- Three planting patterns were:1-Pure stand of maize was sown in hills 20 cm apart (23,333 plant per fed) on one side of the ridge and one plant per hill (100% component population). 2- Pure stand of soybean was sown in hill 10 cm apart (93,333 plant per fed) on one side of the ridge and two plants in hill. (100% component population). 3-Intercropping of three ridges of soybean in alternation with three ridges of maize(one side, two plants per hill). While, soybean present on both sides, two plants per hill. Thus, 3:3 cropping system gives 200% total population i.e. 100% from each component crop. B- Three levels of farmyard manure (Without, F1. 20 m^3 per fed. F2. and 40 m^3 per fed. F3. C- Four levels of mineral Nitrogen: Without, N1; 45 kg / fed. N2; 90 kg / fed. N3 and N4 ;135 kg / fed.. was applied to sole and intercropped maize and soybean at form of urea (46.5% N) in three splits given at 20, 30, 40 days after sowing. through the 1st three irrigations . In this cropping system, both Giza 22 soybean cultivar and TWC 324 maize cultivar were used, all the soybean seeds were inoculated with specific bacteria (*Bradyrhizobium japonicum* L.) for soybean at sowing time. The preceding crop was Egyptian clover (*Trifolium alexandrinum* L.) during both seasons. The plots were hand weeded and there was no incidence of insect or disease in either crop. A basal dose of P and K corresponding to 30 kg P_2O_5 as super phosphate fertilizer (15.5% P_2O_5) and 24 kg K2O as potassium sulfate (50% K_2O) fertilizer was uniformly broadcast at the time of seedbed preparation. Maize and soybean component crops was harvested at September 14 and 24 in the first season, and 10 and 17 in the second one. Other agronomic practices were done similar to that prevailing by farmers in the region.

Data recorded: At harvest, ten guarded plants were randomly taken from the central ridge of each component crop were used to determine A- Grain yield of maize fed. (ton) and seed yield / fed.(kg) of soybean component determination grown in all maize-soybean cropping system and in solid planting. Grain and seed yields were adjusted to a constant moisture content of 15%.

B-Land use efficiency: In order to asses the land use efficiency, Total land equivalent ratio (LER), area time equivalent ratio (ATER) and Aggressivity were determined for each yield recorded per feddan i.e. grain + seed. This was achieved for cropping systems. 1-Total Land equivalent ratio (Total LER). was suggested by Ofori and Stem (1987). It was determined according to do as the sum of yield relative i.e. intercrop yields relative to their solid yield .The Total LER an accurate assessment of the biological efficiency of the intercropping situation, was calculated as: Total LER=(Yab / Yaa) + (Yba / Ybb). Where, Yaa and Ybb are yields as sole crops of a and b and Yab and Yba are yields as intercrops of a and b. Values of total LER greater than 1.0 are considered advantages. While, Values of total LER less than 1.0 are considered disadvantages. 2-Land equivalent coefficient (LEC), a measure of interaction concerned with the strength of relationship was calculated thus, LEC=La x Lb. Where, La= partial LER of main crop and Lb= partial LER of intercrop (Aditiloye *et al.* (1983). For a two- crop mixture the minimum expected productivity coefficient (PC)is 25% that is a yield advantage is obtained if LEC exceeds 0.25. 3-Area time equivalent ratio (ATER), the ratio of number of hectare – days required in monoculture to the number of hectare – days used in the intercrop to produce identical quantities of each of the components, was calculated according to Hiebsch and Mc Collum (1987) as follows:

ATER= (RYa x ta)+ (RYb x tb) /T = $\left(\frac{Yab}{Yaa} \times ta\right) + \left(\frac{Yba}{Ybb} \times tb\right) / T$.

Where, RY=Relative yield of species a or b i.e. yield of intercrop/yield main crop, t= duration (days) for species a or b and T= duration (days) of the intercropping system. 4-Aggressivity (A):is another index represents a simple measure of how much the relative yield increase in crop a is greater than that of crop b in an intercropping system . it was calculated as: Aab=(Yab/Yaa xZab) – (Yba/Ybb xZba). Where, Yaa and Ybb are yields as sole crops of a and b and Yab and Yba are yields as intercrops of a and b. Zab and Zba are the sown proportions of a and b ,respectively. If Aab = 0 ,both crops are equally competitive, if A ab is positive, A is dominant, if Aab is negative a is dominated crop(Ghosh *et al.*,2006). 5-Average of Total LER and ATER to measure land use efficiency instead of Total LER or ATER alone. Statistical analysis: the obtained data were statistically analyzed according to Steel *et al* (1997). Least significant differences was used for the comparison between means. Means having the same letters are not significantly different. A combined analysis was made for the data of the two seasons. In interaction tables capital and small letters were used for comparisons among means of rows and columns, respectively.

RESULTS AND DISCUSSION

A-Grain yield (tonne / feddan) of maize component and seed yield (kg per feddan) of soybean component: Grain yield (tonne) of maize and seed yield (kg) per feddan of soybean as affected by intercropping, FYM and N fertilization are presented in Table (1). The results obtained herein indicated that, economic yield expressed as grain yield (ton) per feddan of maize component and seed yield kg / feddan of soybean component reduced by intercropping. Compared to the pure stand yield, the relative yield of maize component recorded in the 1st and 2nd seasons and their combined analysis was 30.3 , 20.6 and 21.9% and was 15.5, 17.1 and 16.3% for soybean component, respectively due to intercropping (Table1). However, the relative yield of those two components was about 82% for maize and 85% for soybean (Table 1). Thus, intercropping efficiency i.e. economic yield advantage of the combined intercrop yield reached 67% in the maize – soybean intercrop. These results suggest that, the combined leaf canopy or root system may make greater and / or better use of light and N particularly under this system of intercropping, than when the same component crops are grown separately. Similar results have been reported by Ghosh *et al.* (2004) and Solank *et al.* (2011) who found that, grain yield of maize was significantly reduced by 17.3 and 12.6% during 2007 and 2008, respectively in maize + soybean intercropping as compared yield that obtained in sole maize.

In both seasons and their mean, FYM application significantly increased grain yield (ton) per feddan of maize component and seed yield (kg) per feddan of soybean component as compared with the check treatment. The increase in grain and seed yields of maize and soybean components due to FYM application (Table 1) reached 16,27 and 24.1% and 3.2 and 10.02% for 1st and 2nd FYM increment (combined analysis), in respective order. This favorable effect of FYM may be attributed to improving soil physical, chemical and biological environments to better aforementioned traits, besides providing essential nutrients to the crop. These results are similar to those obtained by Badr and Othman (2006) and Khan *et al.*, (2009) found that, FYM application at 20 ton/ha combined with 60 kg N/ha performed better than all other treatments and resulted higher 1000-grain weight and greater grain and biological yields.

Table 1: Grain yield (tonne per fed.) of maize component and seed yield (kg per fed.) of soybean component as affected by intercropping, FYM and N- fertilization in both seasons and their combined analysis.

Main effects and interactions	Grain yield (tonne) per fed. of maize			Seed yield (kg) per fed. of soybean		
	2009	2010	Comb.	2009	2010	Comb.
Planting Patterns (P):						
Solid planting	3.67	3.69	3.68	820.35	835.85	828.35
Intercropping	2.97	3.06	3.02	710.37	714.04	712.20
F-test	*	*	**	*	*	**
LSD05	0.337	0.133	0.141	65.46	29.55	28.92
FYMlevels (F):(m^3/fed.)						
Without	2.96	2.95	2.95	737.54	737.26	737.77
20	3.42	3.44	3.43	756.81	765.97	761.39
40	3.58	3.74	3.66	801.73	821.61	811.67
F-test	**	**	**	N.S	**	**
LSD05	0.245	0.194	0.151	--	22.89	27.00
N-fertilizationN:(kg /fed.)						
Without	2.67	2.68	2.67	682.58	671.66	677.12
45	3.09	3.18	3.14	741.97	745.79	743.88
90	3.59	3.57	3.58	807.88	826.62	817.75
135	3.92	4.07	3.99	829.01	855.70	842.35
F-test	**	**	**	**	**	**
LSD05	0.137	0.206	0.121	21.55	35.67	19.98
Interaction:						
P x F	N.S	N.S	N.S	N.S	N.S	N.S
P x N	N.S	N.S	N.S	N.S	N.S	N.S
F x N	N.S	N.S	N.S	N.S	N.S	N.S
P x F x N	N.S	N.S	N.S	**	N.S	**

NS , * and ** meaning; not significant, significant at 0.05 level and highly significant at 0.01 level, respectively. FYM: farmyard manure, Feddan= 0.42 hectare

The obtained data cleared that, grain yield (ton per feddan) of maize component and seed yield (kg per feddan) of soybean component responded to adding N- fertilizer levels up to 135 kg N per fed. in the both seasons and their combined analysis. Herein, the increase in grain and seed yields of maize and soybean components due to N - application (Table 1) reached 17,6 ,34 and 49.4% and 9.9, 20.8 and 24.4 % for 1st, 2nd and 3rd N -

increment (combined analysis), in respective order. The present data show clearly the prominent role of N on aforementioned traits. These results are in agreement with those obtained by Tijani *et al.* (2000) , Morgado and Willey (2003), Shivay and Singh (2003) , Panhwar *et al.* (2004), Mbah *et al.* (2007), Meena *et al.* (2007) and Undie *et al.* (2010) .

B- Land use efficiency:

1-Land Equivalent Ratio (LER): Total land productivity in terms of LER and its fractions of maize (Lm) and soybean (Ls) obtained from grains and seeds yield per fed. of the maize – soybean intercrop as influenced by FYM and N-fertilization in both seasons and their combined analysis are given in Table (2). Firstly, it should be remember that maize – soybean intercrop was planted at an arrangement of 3:3 ridges using the same ridges and within ridge spacing as in the respective sole system of each component crop. Thus, the intercrop had 200% total population (100% of each component crop). However, total land equivalent ratio (LER) is a measure of the efficiency of the intercrop. It is defined as the relative land area that would be required for sole crops to produce the yields achieved in intercropping. The advantage is measured by the decimal above the unit. Where, LER value greater than 1.0 indicates an overall advantage of intercropping system.

Table 2: Total land equivalent ratio (LER) of maize (Lm) and soybean (Ls) determined on (grain + seed) yields basis of both components as affected by FYM and N- fertilization in both seasons and their combined analysis.

Main effects and interaction	2009			2010			Combined		
	Lm	Ls	LER	Lm	Ls	LER	Lm	Ls	LER
FYM levels (F): (m^3/fed.)									
Without	0.82	0.89	1.71	0.82	0.83	1.66	0.82	0.86	1.69
20	0.77	0.88	1.65	0.81	0.83	1.65	0.79	0.85	1.66
40	0.79	0.81	1.60	0.82	0.86	1.68	0.80	0.83	1.65
F-test			N.S			N.S			N.S
LSD05			--			--			
N-fertilization N: (kg N/fed.)									
Without	0.71	0.83	1.54	0.84	0.76	1.61	0.77	0.79	1.58
45	0.80	0.86	1.66	0.78	0.86	1.64	0.79	0.86	1.66
90	0.82	0.89	1.71	0.82	0.86	1.69	0.82	0.87	1.71
135	0.84	0.85	1.69	0.83	0.87	1.71	0.83	0.86	1.70
F-test			**			N.S			**
LSD05			0.093			--			0.061
Interaction:									
F x N			N.S			*			**

NS , * and ** meaning; not significant, significant at 0.05 level and highly significant at 0.01 level, respectively. FYM: farmyard manure, Feddan= 0.42 hectare

It was observed from these data that addition of FYM did not have any significant effect on LER in both seasons and their combined analysis.

But, adding N fertilizer have significant effect on LER (grain + seed yields per fed.) in the 1st season and the combined analysis. However, although the intercrop yield of maize (Lm) as well as soybean (Ls) component crop in the maize – soybean cropping system was decreased in mixed relative to pure stands, the combined intercrop yield of both component crops (LER) yielded more than their respective pure stand yields are given in Table (2). Indeed, intercropping of maize and soybean was more productive than sole cropping with regard to total LER values which were greater than 1.0 at all treatments of FYM and N levels. These results were true for all cases of LER determinations. Since, intercropping of soybean with maize resulted in LER determined from grain + seed yields between 1.69,1.66 and 1.65 when increased FYM from zero to 20 up to 40 m3 per fed., respectively (Table 2) as shown in the combined analysis. These LERs indicate that 69, 66 and 65% more land would require to planting the sole crop to produce the same quantities of intercropping maize and soybean. This means that all treatments showed advantages, showed efficient utilization of land resource by growing the crops together. As shown in the combined analysis, LER values calculated for grain + seed yields per fed. averaged 1.71 at 90 kg N per fed. decreased to 1.58 at without addition of N. In the meantime, the intercropped maize yielded at the highest dose of N (135 kg per fed.) i.e. Lm = 0.83, whereas value of Ls = 0.87 at 90 kg N per fed. This indicates the greater advantage in the grain + seed yields per fed. of maize – soybean intercrop when low N fertilizer level was applied. This may have been due to increased shading of soybean by maize at the highest N level. In this trial, the increase of the yield advantage was more than 10% due to low interspecific competition or strong facilitation indicating that the advantage of using intercropping was wide extension. These results are in line with the conclusion of Khan *et al.* (1999) , Gulzar *et al.* (2001) , Agbaje *et al.* (2002) Ghosh *et al.* (2004), Abera *et al.* (2005) , Asmat *et al.* (2007) Muoneke *et al.* (2007) ,Metwally *et al.* (2009), Addo-Quaye *et al.* (2011) and Solank *et al.* (2011) noted that land equivalent ratio LER for intercropping system was greater than the sole cropping system. In meantime, **Vandermeer (1989)** noted that both competition and facilitation take place in many intercropping systems, and that is possible to obtain the net result of (LER), an indicator of intercropping advantage, > 1 where, the complementary facilitation is contributing more to the interaction than the competitive interference. Thus, LER > 1 could result from low interspecific competition or strong facilitation. According to the combined analysis of the two seasons, the FYM x N interaction affected on LER determinated on grain + seed yields of maize – soybean intercropping system is shown in Table (2-a).

It is obvious from Table (2-a) that, each N increment resulted in a significant increase in LER determinated on grain + seed yields at the low FYM level whereas, data recorded conclude that, plants nutriched with 40 m3 FYM + 45 kg N per fed. produced the highest LER (1.74) or without addition of FYM + 135 kg N per fed. produced the highest LER (1.76) determinated on grain + seed yields.

Table (2-a): LER determinated on grain + seed yields of maize – soybean intercropping system as affected by the interaction between FYM x N (combined analysis)

N levels and FYM	without	N fertilizer level kg per fed.		
		45	90	135
FYM levels (F): (m^3/fed.):				
Without	D 1.61b	C 1.63b	B 1.74a	A 1.76a
20	C 1.64a	D 1.59c	A 1.71b	B 1.67b
40	C 1.49c	A 1.74a	B 1.66c	B 1.67b

2-Area:time equivalent ratio (ATER): Data pertaining the effect of FYM and N fertilizer level on area: time equivalent ratio (ATER) determined for grains and seeds yield per fed. of the maize – soybean intercrop are shown in Table (3).Firstly, it is known that, area :time equivalent ratio (ATER),is the ratio of area: time required in monoculture to area: time used in the intercrop to produce identical quantities of each of the components. Thus, ATER provides the means for evaluating intercrops on a yield – per – day basis. Again, as in LER, ATER criterion was observed that addition of FYM did not have any significant effect on LER in both seasons and their combined analysis. But, adding N fertilizer have significant effect on LER (grain + seed yields per fed.) in the 1st season and the combined analysis. However, intercropping of maize and soybean, again, was more productive than growing them separately, as can be observed from the ATER values which were greater than unity at three FYM and four N fertilizer levels. In the meantime, when time factor is considered, as with the ATER, yield advantages obtained from maize – soybean intercrop lowered those achieved by LER index. Since, the results indicate that a 49, 47 and 46% grain seed yields advantages (ATER = 1.49, 1.47 and 1.46) when increased FYM from 0 to 20 and up to 40 m3 per fed. as above - mentioned, the corresponding grain and seed yields per fed. advantages achieved by LER was 69, 66 and 65% (Table 2). Thus, the reduction yield advantage determined from 115 days maize and 135 days soybean intercrop reached about 40% when time factors are considered, as with average mean of ATER (47%) compared to that of LER (66%). To provide a more real estimate of land use efficiency, the average values of the LER and ATER are considered. Thus, in the combined analysis, the rational estimate of the land use efficiency by maize soybean intercrop (135 days) reached 58, 56 and 54 for grain and seed yields per fed. when both LER and ATER were determined for aforementioned, respectively are shown in Table (4). Regarding N fertilization, as above – mentioned of LER, yield advantage tended to increase with increasing N level with significant differences among ATER values only in 1st season and the combined analysis for grain + seed yields per fed. Where, the highest values of ATER would be obtained at 90 kg N per fed. as shown from the combined analysis, the highest ATER value was 1.51 for grain + seed yields at 90 kg N per fed. This indicates that, the greater advantage, as in LER when adding N fertilizer levels up to 90 kg N per fed. Therefore, as in the combined analysis, intercropping efficiency as expressed in the average of both LER and ATER of maize – soybean intercrop tended to increase by N level from 0 to 45 or 90 kg N per fed. from 48 to 56 or 60% increasing.

According to the combined analysis of the two seasons, the FYM x N interaction affected on ATER which determinated on grain + seed yields of maize – soybean intercropping system is shown in Table (3-a). It is obvious from Table (3-a) that, each N increment resulted in a significant increase in ATER which determinated on grain + seed yields at the low FYM level whereas, data recorded conclude that, plants nutriched with 40 m3 FYM produced the highest ATER (1.54) when receiving 45 kg N per fed. or without addition of FYM + 90 kg N per fed. produced the highest ATER (1.53) which determinated on grain + seed yields. advantages were calculated for grain + seed yields in respective order (Table 4). These results are in line with the conclusion of Aditiloye *et al.* (1983) and Egbe (2010).

Table 3: Area-time equivalent ratio (ATER) of maize (Lm) and soybean (Ls) determined on (grain + seed) yields basis of both components as affected by FYM and N- fertilization in both seasons and their combined analysis.

Main effects and interaction	2009			2010			Combined		
	Lm	Ls	ATER	Lm	Ls	ATER	Lm	Ls	ATER
FYM levels (F): (m^3/fed.)									
Without	0.82	0.89	1.50	0.82	0.83	1.46	0.82	0.86	1.49
20	0.77	0.88	1.47	0.81	0.83	1.46	0.79	0.85	1.47
40	0.79	0.81	1.42	0.82	0.86	1.50	0.80	0.83	1.46
F-test			N.S			N.S			NS
LSD05			--			--			
N-fertilization N: (kg N/fed.)									
Without	0.71	0.83	1.37	0.84	0.76	1.41	0.77	0.79	1.39
45	0.80	0.86	1.47	0.78	0.86	1.46	0.79	0.86	1.47
90	0.82	0.89	1.51	0.82	0.86	1.50	0.82	0.87	1.51
135	0.84	0.85	1.51	0.83	0.87	1.51	0.83	0.86	1.51
F-test			**			N.S			**
LSD05			0.089			--			0.056
Interaction:									
F x N			N.S			*			*

NS , * and ** meaning; not significant, significant at 0.05 level and highly significant at 0.01 level, respectively. FYM: farmyard manure, Feddan= 0.42 hectare

Table (3-a): ATER determinated on grain + seed yields of maize – soybean intercropping system as affected by the interaction between FYM x N (combined analysis)

N levels and FYM	without	N fertilizer level kg per fed.		
		45	90	135
FYM levels (F): (m³/fed.)				
	B	B	A	A
Without	1.41a	1.44b	1.53a	1.55a
	AB	B	A	AB
20	1.45a	1.41b	1.52a	1.48a
	B	A	A	A
40	1.31b	1.54a	1.47a	1.49a

According to the combined analysis of the two seasons, the FYM x N interaction affected on average of LER and ATER which determinated on grain + seed yields of maize – soybean intercropping system is shown in Table (4-a).It is obvious from Table (4-a) that, each N increment resulted in a significant increase in average of LER and ATER which determinated on grain + seed yields at the low FYM level whereas, data recorded conclude that, plants nutriched with 40 m3 FYM produced the highest average of LER and ATER (1.64) when receiving 45 kg N per fed. or without addition of FYM + 90 kg N per fed. produced the highest average of LER and ATER (1.61) which determinated on grain + seed yields.

Table 4: Average of area-time equivalent ratio (ATER) and (LER)of maize (Lm) and soybean (Ls) determined on (grain + seed) yields basis of both components as affected by FYM and N-fertilization in both seasons and their combined analysis.

Main effects and interaction	Average of LER and ATER		
	2009	2010	combined
FYM levels (F):(m³/fed.)			
Without	1.60	1.56	1.58
20	1.56	1.55	1.56
40	1.51	1.58	1.54
F-test	NS	NS	N.S
LSD05	----	----	--
N-fertilization N: (kg N/fed.)			
Without	1.45	1.51	1.48
45	1.56	1.55	1.56
90	1.61	1.59	1.60
135	1.59	1.61	1.60
F-test	**	NS	**
LSD05	0.087	-----	0.057
Interaction:			
F x N	NS	**	**

NS , * and ** meaning; not significant, significant at 0.05 level and highly significant at 0.01 level, respectively. FYM: farmyard manure, Feddan= 0.42 hectare

Table (4-a): Average of area-time equivalent ratio (ATER) and (LER) of maize (Lm) and soybean (Ls) components determined on (grain + seed) yields as affected by the interaction between FYM x N (combined analysis)

N levels and FYM	without	N fertilizer level kg per fed.		
		45	90	135
FYM levels (F): (m^3/fed.)				
Without	B 1.50a	B 1.54b	A 1.63a	A 1.65a
20	AB 1.54a	B 1.50b	A 1.61a	AB 1.57a
40	B 1.40b	A 1.64a	A 1.55a	A 1.58a

3-Land Equivalent Co-efficient (LEC): Total land productivity in terms of LEC and its fractions of maize (Lm) and soybean (Ls) obtained from grains and seeds yield per fed., ears and pods and biological yields per fed. of the maize – soybean intercrop as influenced by FYM and N- fertilizer levels in both seasons and their combined analysis are given in Table (5). It is known that land equivalent coefficient (LEC), a measure of interaction concerned with the strength of relationship. For a two- crop mixture the minimum expected productivity coefficient (P C) is 25% that is a yield advantage is obtained if LEC exceeds 0.25. It is evident, from these data (Table 5) that, land equivalent coefficient (LEC),values for maize – soybean intercrop. was not significantly affected by adding of FYM during both seasons and the combined analysis. and significantly affected by N fertilizer levels on grain + seed yields per fed. these results were true for all cases of intercropping system.

It was observed from these data that FYM did not have any significant effect on LEC in both seasons and their combined analysis But, adding N fertilizer have significant effect on LEC (grain + seed yields per fed.) in both seasons and the combined analysis. However, although the intercrop yield of maize (Lm) as well as soybean (Ls) component crop in the maize – soybean cropping system was decreased in mixed relative to pure stands, the combined intercrop yield of both component crops (LEC) yielded more than their respective pure stand yields are given in Table (5). Indeed, intercropping of maize and soybean was more productive than sole cropping with regard to total LEC values which were greater than 0.25 at all treatments of FYM and N levels. These results were true for all cases of LER determinations. Since, intercropping of soybean with maize resulted in LEC determined from grain + seed yields between 0.70,0.69 and 0.67 when tried FYM- increments from zero to 20 up to 40 m3 per fed., in respective order (Table 5) as shown in the combined analysis. This means that all treatments had LEC values above 0.25 suggesting yield advantages. showed efficient utilization of land resource by growing the crops together. As shown in the combined analysis, LEC values calculated for grain + seed yields per fed. averaged 0.73 at 90 kg N per fed. decreased to 0.62 at without addition of N. In the meantime, the intercropped maize yielded at the highest dose of N (135 kg per fed.) i.e. Lm

= 0.83, whereas value of Ls = 0.87 at 90 kg N per fed. This indicates the greater advantage in the grain + seed yields per fed. of maize – soybean intercrop when applied 90 kg N. This may have been due to increased shading of soybean by maize at the highest N level. These results are in line with the conclusion of **Aditi!oye *et al.*,(1983)** and **Egbe (2010).**

Table 5: land equivalent co-efficient (LEC) of maize (Lm) and soybean (Ls) determined on (grain + seed) yields basis of both components as affected by FYM and N- fertilization in both seasons and their combined analysis.

Main effects and interaction	2009			2010			Combined		
	Lm	Ls	LEC	Lm	Ls	LEC	Lm	Ls	LEC
FYM levels (F): (m^3/fed.)									
Without	0.82	0.89	0.72	0.82	0.83	0.68	0.82	0.86	0.70
20	0.77	0.88	0.69	0.81	0.83	0.69	0.79	0.85	0.69
40	0.79	0.81	0.64	0.82	0.86	0.71	0.80	0.83	0.67
F-test			N.S			N.S			N.S
LSD05			--			--			--
N-fertilization N: (kg N/fed.)									
Without	0.71	0.83	0.59	0.84	0.76	064	0.77	0.79	0.62
45	0.80	0.86	0.69	0.78	0.86	0.68	0.79	0.86	0.68
90	0.82	0.89	0.73	0.82	0.86	0.72	0.82	0.87	0.73
135	0.84	0.85	0.71	0.83	0.87	0.73	0.83	0.86	0.72
F-test			*			*			**
LSD05			0.080			0.065			0.050
Interaction:									
F x N			N.S			NS			*

NS , * and ** *meaning*; not significant, significant at 0.05 level and highly significant at 0.01 level, respectively. FYM: farmyard manure, Feddan= 0.42 hectare

As regarding to the combined analysis of the two seasons, the FYM x N interaction affected on LEC which determinated on grain + seed yields of maize – soybean intercropping system is shown in Table (4-a).It is obvious from Table (4-a) that, each N increment resulted in a significant increase in LEC values which determinated on grain + seed yields at the low FYM level whereas, data recorded conclude that, plants nutriched with 40 m^3 FYM produced the highest LEC value (0.76) when receiving 45 kg N per fed. But, without addition of FYM + 90 kg N per fed. or addition 20 m3 of FYM + 90 kg N per fed. produced the highest LEC value (0.75) which determinated on grain + seed yields.

Table (5-a): LEC determinated on grain + seed yields of maize – soybean intercropping system as affected by the interaction between FYM x N (combined analysis).

N levels and FYM	without	N fertilizer level kg per fed.		
		45	90	135
FYM levels (F): (m³/fed.)				
Without	B 0.63a	B 0.66b	A 0.75a	A 0.76a
20	AB 0.67a	B 0.64b	A 0.74a	AB 0.70a
40	B 0.55b	A 0.76a	A 0.69a	A 0.70a

4-Aggressivity (A): Data presented in Table (6) indicate the effect of FYM and N fertilization on aggressivity values (A) of maize (Ams) and soybean (Asm) calculated for grains + seeds. It is known that an aggressivity value of zero indicates that, both component crops are equally competitive. For any other situation, two crops will have the same numerical value by positive for the dominant crop and negative for the dominated one. The greater the numerical value, the larger the differences in competitive abilities. It is evident, from these data, that aggressivity values for maize (Ams) as well as for soybean (Asm) calculated from any yield determination per fed. was not significantly affected by FYM levels during both seasons and the combined analysis and was significantly. ffected by tried N fertilizer levels at 1st season for grain + seed grain affected by tried N fertilizer levels at 1st season for grain + seed grain yields per fed. , during both seasons. However, Ams as well as Asm calculated for each of grain +seed grain , ear + pod and biological yields per fed. (Table 6) responded to FYM addition, but with no clear trend. Furthermore, in most of cases, soybean component was the dominant crop, whereas, the maize was dominated one. In the meantime, aggressivity value for the associated soybean (Asm) intercropped with maize recorded for aforementioned trait was 0.03, 0.06 and 0.03 for soybean component and it was -0.03, -0.06 and -0.03 for maize component, in respective order indicating equally competitive among the intercrops on the requisites. Moreover, as shown in the combined analysis, though the significant effect of N addition on Ams as well as Asm determined, generally, for all yield determinations per fed., the highest value of Ams as well as the lowest one of Asm was found at 90 for grain + seed yields per fed. However, the negative sign for maize and the positive one for soybean may be due to the ability of the shorter component to compete with the taller component for available nutrients, especially N in this respect. This further, emphasizes that soybean is able to acquired more resources than that maize in the maize – soybean intercropping. These results are in line with the conclusion of **Long** *et al.*,(2001) , Ghosh *et al.*, (2006) and Egbe (2010). However, Ghosh *et al.*, (2004) further explained that because of the differences in canopy height of soybean and maize, the two species not only competed for nutrient and water but also for sunlight. Our results indicate that, land use of the maize/soybean intercropping was more efficient than sole cropping, which may be due to a more rational use of environmental resources in intercropping situations.

Table 6: Agressivity of maize (Lm) and soybean (Ls) determined on (grain + seed) yields basis of both components as affected by FYM and N- fertilization in both seasons and their combined analysis.

Main effects and interaction	2009		2010		Combined	
	Ams	Asm	Ams	Asm	Ams	Asm
FYM levels (F):(m^3/fed.)						
Without	-0.07	0.07	-0.01	0.01	-0.03	0.03
20	-0.10	0.10	-0.03	0.03	-0.06	0.06
40	-0.02	0.02	-0.04	0.04	-0.03	0.03
F-test	N.S	N.S	N.S	N.S	N.S	N.S
LSD05	--	--	--	--	---	---
N-fertilization N: (kg N/fed.)						
Without	-0.12	0.12	0.07	-0.07	-0.02	0.02
45	-0.05	0.05	-0.07	0.07	-0.06	0.06
90	-0.08	0.08	-0.04	0.04	-0.06	0.06
135	-0.01	0.01	-0.04	0.04	-0.03	0.03
F-test	*	*	NS	NS	NS	NS
LSD05	0.07	0.07	----	----	----	----
Interaction:						
F x N	NS	N.S	NS	NS	NS	NS

NS , * and ** meaning; not significant, significant at 0.05 level and highly significant at 0.01 level, respectively. FYM: farmyard manure, Feddan= 0.42 hectare

Conclusion: Grain and seed yields of maize and soybean components significantly reduced by intercropping compared to the pure stand yield, However, the relative yield of those two components was 82 and 85% for maize and soybean ,respectively. Thus, intercropping efficiency i.e. economic yield advantage of the combined intercrop yield reached 67% in the maize – soybean intercrop. grain and seed yields of maize and soybean components were significantly increased due to FYM application up to 40 m3 and N up to 135 kg N per fed. (combined analysis). LER, ATER and its average, LEC and Agressivity (A) criterions were observed that addition of FYM did not have any significant effect on aforementioned traits in both seasons and their combined analysis But, adding N fertilizer have significant effect on that traits (combined analysis). However, intercropping of maize and soybean, again, was more productive than growing them separately, as can be observed from the LER, ATER and its average values which were greater than unity and from the LEC values which were greater than 0.25 and from sign of agressivity values which were positive for soybean component and negative for maize at three FYM and four N fertilizer levels.

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تأثير إضافة السماد البلدي و النيتروجيني على كمية المحصول وكفاءة استعمال الأرض تحت نظام تحميل الذرة الشامية وفول الصويا.

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أقيمت تجربتان حقليتان خلال موسمي ٢٠٠٩ و ٢٠١٠ بحقل إرشادي سنهوت -منيا القمح – محافظة الشرقية تحت إشراف قسم المحاصيل – كلية الزراعة – جامعة الزقازيق. واستهدف البحث دراسة تأثير إضافة ثلاث مستويات للسماد البلدي (بدون إضافة – الإضافة بمعدل ٢٠ م٣ – الإضافة بمعدل ٤٠ م٣ للفدان) وأربع مستويات للسماد النيتروجيني (كنترول – ٤٥ – ٩٠ و ١٣٥ كجم ن للفدان) لثلاث نظم زراعية لتحميل فول الصويا مع الذرة الشامية : الزراعة المنفردة للذرة الشامية صنف ٣٢٤ كهجين ثلاثي (٢٣.٣٣٣ نبات للفدان) – الزراعة المنفردة لفول الصويا جيزة ٢٢ (٩٣.٣٣٣ نبات للفدان)– الزراعة المحملة لصنفي فول الصويا مع الذرة الشامية بنظام ٣ : ٣ (أي زراعة الذرة الشامية على ثلاث خطوط على مسافة ٩٠ x ٢٠ سم ونباتين في الجورة بدلا من نبات واحد في حالة الزراعة المنفردة متبادلة مع ثلاث خطوط من فول الصويا على أبعاد ٩٠ x ١٠ سم على جانبي الخط ونباتين بالجورة بدلا من جانب واحد من الخط في حالة الزراعة المنفردة) بينما الأصناف على الجانب الآخر بنفس كثافة الزراعة المنفردة) على كمية المحصول وكفاءة استعمال الأرض.

ويمكن تلخيص أهم النتائج التي تم التوصل إليها على النحو التالي:١- أدى استخدام للتحميل إلى حدوث نقصا معنويا في كمية المحصول للذرة الشامية وفول الصويا بالمقارنة بالزراعة المنفردة ، وكان المحصول النسبي ٨٢% لمكون الذرة الشامية و٨٥% لمكون فول الصويا وكانت هناك ميزة محصولية تقدر ب ٦٥%. زادت كمية المحصولين سواء فى حالة الزراعة المنفردة أو في حالة التحميل عند اضافة ٤٠ م٣ سماد بلدي و ١٣٥ كجم ن للفدان في كلا الموسمين وفى التحليل المشترك.

٢-لم يكن للسماد البلدي اى تأثير معنوي على مقاييس استعمال الأرض ، بينما كان هناك تأثير معنوي للسماد النيتروجينى على تلك المقاييس.

٣-أدى تحميل فول الصويا على الذرة الشامية إلى زيادة محصوليه تفوق الواحد الصحيح فى حالة LER , ATER average of LER and ATER وتفوق ال 0.25 فى حالة LEC و مقارنة بزراعة كل محصول على حدة. وبالنسبة لل Agressivity كانت الإشارة الموجبة لمكون فول الصويا وهذا يعنى انه السائد Dominants crop وكانت الإشارة السالبة لمكون الذرة الشامية وهذا يعنى انه المسود .Dominated crop

ويمكن التوصية بزراعة فول الصويا محملا على الذرة الشامية بنظام ٣:٣ والتسميد بإضافة ٤٠ م٣ سماد بلدي و١٣٥ كجم ن للفدان تحت ظروف المنطقة التي أجريت بها الدراسة .

قام بتحكيم البحث

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