MAIZE GRAIN YIELD RESPONSE TO INTERCROPPING WITH THREE LEGUME FODDER CROPS

ABOU-KERISHA, M. A., SAHAR A. SHERIF AND WAFAA KH. MOHAMED

Crop Intensification Research Department, Field Crops Research Institute, ARC, Giza

(Manuscript received 24 January 2010)

Abstract

Two field trials were carried out at Shandaweel Agriculture Research Station (Sohag Governorate) during 2008 and 2009 summer seasons to study response of maize grain yield to intercropping with three legume fodder crops under three sowing dates (simultaneous maize and intercropped crops sowing and sowing at 3 and 5 weeks after maize). A split plot design with three replicates was used. The main plots were devoted to the three legume crops, and the sub plots were allocated to sowing dates of legume crops. The data obtained indicate that all studied characters of maize, cowpea; guar and soybean were reduced as compared with solid crops. This reduction was higher in legume crops than maize. The intercropping system resulted in maize plant height especially when the intercropped crops were planted at the same of maize planting date. Maize grain yield character and its components were significantly affected by intercropped crops and sowing date. The reduction in maize characters was higher when intercropped with guar than with cowpea or soybean, and at simultaneous (T_1) than delay sowing (T_2) or (T_3).The forage green yield of cowpea, guar and soybean were affected by intercropping system and sowing dates. The forage green yield at late planting dates (3 or 5 weeks after maize) was more decreased than those sown at the same date of maize. The results also showed that maize grain yield crop was dominant while intercropped crops were dominated , where the highest land equivalent ratio (LER) recorded 1.15 and monetary 776.96 when maize intercropped with soybean, sown at 5 weeks after maize followed by cowpea sown at the same maize planting date .While total actual grain yield loss (AYL) was positive with cowpea in the three sowing dates with range from o.13 to o.23 , indicating increase in grain yield by 13 to 23 %compared with solid crop .While AYL was negative with guar at the first and second sowing dates which indicate decreased in yield with this system. It could be concluded that intercropping maize with cowpea at the same date or with soybean at delayed sowing (5 weeks after maize) had favored the growth and yield of both crops.

Key words: intercropping , planting date, summer fodder, maize, guar, soybean, cowpea

INTRODUCTION

Cultivated area of summer forage crops in Egypt is not sufficient for meat animals requirements. Farmers used to defoliate maize plants as green fodder for

cattle which resulted in reducing maize yield. Hence, intercropping of forage crops with cereal crops (maize, sorghum, millet) reduce the green fodder gab in summer.

Many studies were carried out on intercropping cereal crops with some legume crops such as bean, cowpea, guar, soybean, vetch.... by several investigators. These studies noted that crop species or cultivar selection, sowing date, cropping system, seeding ratio may affect the growth and yields of the crops used in intercropping systems. They found, also, that the yield of each crop in the intercrop was lower than the total yield of its respective pure stand, but the combined yield from the intercrop was higher than the total yield of these crops as pure stands. The yield reduction of intercropped maize ranged from 10-15% of pure stand, while the intercropped crops, cowpea or bean were reduced by 45-67%, (Ofori and Stern (1986), Fininsa (1997) and Abou Keriasha (2009)). Whereas, Reddy, *et al* (1992), Lima (2000), Okpara (2000), Khan, *et al* (2002), Dasaraddi *et al* (2002) and Yilmaz *et al* (2007) showed that maize, soybean and millet grain yield were either increased or not affect by intercropping system compared with the sole crop, but that of legume crops (cowpea either been) were decreased by 50%. Okpara (2000) showed that intercropping significantly increased maize plant height and grain yield in one season and reduced in the other season, while cowpea yield was reduced in the two seasons.

The intercropping arrangements were more productive and profitable than sole cropping (Reddy *et al* (1992); Aleman (2000), Padhi (2001), Khan *et al*, (2002), Pramod *et al*, (2003) and Reddy *et al* (1992)) showed that Land equivalent ratios (LER) were 1.48,1.43 and 1.08 for intercropping millet with cowpea sown 1,2 and 8 weeks after millet. Padhi (2001) found that intercropping maize with runner bean (phasoelus vulgaris) in 2:2 gave the highest values for equivalent yield, production efficiency, land equivalent ratio, net returns and monetary advantage index. Adipala *et al* (2002) showed that time of planting cowpea within maize significantly affected both growth and yield of cowpea. Simultaneous planting generally showed a yield advantage (land equivalent ratio (LER) for cowpea /maize intercropping systems was higher than one but LER declined when time of introducing cowpea into maize was delayed being as low as 0.75 when cowpea was planted four weeks after maize. Ghosh (2004), Yilmaz *et al* (2007) and Abou Keriasha *et al* (2009) found that when LER, Ag and CR were higher there is also significant economic benefit expressed with higher MAI values

Sowing date had a major effect on yield and yield components of both intercropped crops. Tariah and Wahual (1985) found that sowing cowpea 2 weeks after maize reduced yields and favoured the intercropped maize. Fininsa (1997) showed that delayed maize sowing and simultaneous bean and maize sowing improved bean seed yield. With simultaneous sowing, bean yield was increased by 48%.while delayed bean sowing increased maize grain yield and reduced bean seed yield. Reddy and Visser (1997) noted that delaying sowing from simultaneous sowing cowpea with the millet to 7 weeks after millet led to significant lower grain yield (1110 to 100 kg.h.) Okpara (2000) showed that plant height ,leaf area index, dry matter and pod yield of vegetable cowpea as well as seed yield of maize were decreased significantly due to delay in the introduction of each crop in the mixture, while the component crop that was planted earlier in the mixture gave stiffer growth and yield values. Adipula *et al* (2002) noted that the reduction in the growth and yield was noticed when cowpea was introduced in the fourth week. Therefore to achieve yield benefit simultaneous planting of maize and cowpea as recommended. The aim of this objective was to study maize grain yield response to intercropping with three legume fodder crops at three sowing dates.

MATERIALS AND METHODS

Two field trials were carried out at Shandaweel Agricultural Research Station, Sohag Governorate (Upper Egypt) during 2008 and 2009 summer seasons. A split plot design with three replicates was used. The main plots were devoted to the three legume crops i.e. cowpea (Cream), guar (Local variety) and soybean (Giza 111). Whereas, the sub plots were allocated for three planting dates of legume crops as followed:

1. Intercropped crops and maize (T.W.C.310) were sown at the same time.
2. Intercropped crops were sown after three weeks from maize planting date.
3. Intercropped crops were sown after five weeks from maize planting date.

Solids of legume crops were sown on one side of ridge with two plants/hil,30 cm. apart and 60cm. between ridges and when intercropped with maize were sown on the other side of all maize ridges with the same plant density of solids (100% + 100%) Whereas, solid of maize was grown on one side of ridge with one plant/hill, 30cm. and 60cm. between ridges. The area of each sub plot was

3m.long and 7m. width, consisting of 12 ridges .Maize and intercropped crops were sown (solid) in the first week of June in the two seasons. During seed bed preparation, 30 kg.P_2O_5/fad. in the form of calcium superphosphate (15.5% P_2O_5) was added. Nitrogen fertilizer for maize was used at the rate of 120kg.N./fad.in the form of ammonium nitrate (33.5%) in three doses. The first dose was added after thinning directly, the second dose at two weeks after thinning and the third dose at four weeks thinning. Nitrogen fertilizer for legume crops was added at the rate 30 kg. N./fad. after thinning. Potassium fertilizer was added at the rate 24kg.K_2O/fad.

Cutting of cowpea, guar and soybean was done after two months (solid or intercropped) while the second cut (solid only) was after two months late. Green forage yield/fad. was estimated from green forage yield/ plot. Maize grain yield harvesting in both seasons was during the second week of October. Samples of ten plants were taken for each sub plot and the following data were recorded on growth and yield components .

Plant height, ear length, ear diameter, number of rows/ear, number of kernels/row, kernels weight/ear, weight of 100 grain, shilling percentage and grain yield/ fad. (estimated from grain yield /plot).

Competitive relationships:

1- Land equivalent ratio (LER)

LER is determined as the sum of the fractions of the yield of intercrops relative to their sole crop yield (Willey and Osiru 1972). Land equivalent ratio LER was determined according to the following formula:

$$LER = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Where:

Yaa is pure stand yield of crop a, Ybb is pure stand yield of crop b, Yab is mixture yield of a (when combined with b) and Yba yield of B (when combined with a).

2- Aggressivety (Agg.)

This was proposed by Mc-Gilichrist (1960) and was determined according to the following formula:

$$A_{ab} = \frac{Y_{ab}}{Y_{aa} \times Z_{ab}} - \frac{Y_{ba}}{Y_{bb} \times Z_{ba}}$$

Where:

Z_{ab} = Sown proportion of species a (in a mixture with b).

Z_{ba} = Sown proportion of species b (in a mixture with a).

Aggressivety value of zero indicates that the intercropped crops are equally competitive. For any other situation both crops will have the same numerical value., but, the sign of the dominate crop will be positive and the dominated negative. The greater the numerical value of (Agg), the higher the difference between actual and expected yields.

3- Competitive ratio (CR) was calculated by the following formula as advocated by **Willey and Rao (1980)**

$$CR = CRa + CRb \qquad CRa = \frac{LERa}{LERb} \times \frac{Zba}{Zab}$$

Where:

LERa and LERb represent relative yield of a and b intercrops, respectively. Since the CR values of the two crops will be the reciprocals of each other. CRa, CRb are the competitive ratio for intercrop where Zab represents the sown proportion of intercrop a (legume crops) in combination with b (maize) and Zba the sown proportion of intercrop b (maize) in combination with a (legume crops).

4- Actual yield loss (AYL) was calculated according to **(Banik, 1996) as follows:**

$$AYL = AYLa = \frac{(Yab/Zab)}{(Yaa/Zaa)} - 1 + \frac{(Yba/Zba)}{(Ybb/Zbb)} - 1 + AYLb$$

Where:

AYLa and AYLb are the partial yield loss of intercrop legume crops (cowpea) and maize, respectively. Yab represents the yield of intercrop a (cowpea) in combination with b (maize) in combination with a (cowpea).

5- Monetary advantage index (MAI)

Suggests that the economic assessment should be in terms of the value of land saved; this could probably be most assessed on the basis of the rentable value of

this land. MAI was calculated according to the formula, suggested by Willey (1979).

$$MAI = \frac{\text{Value of combined intercrops x LER -1}}{\text{LER}}$$

The average market prices of the two seasons for green forage yield and maize were 90 LE /ton of green forage yield and 220 LE /ardab of maize.

Data for each experiment were analyzed by MSTATC (1980) software for comparison of the mean values of the two seasons by LSD test at the 5% level. Response equations were calculated according to Snedecor and cochran (1988).

RESULTS AND DISCUSSION

A-Maize:

A-1- Effect of intercropped crops:

Data in Table (1) show significant differences in all of the studied characters except ear length in the combined, ear diameter in second season and ear rows number in both seasons and combined analysis. The results clear that intercropping system resulted in taller maize plants than in solid planting. The highest value of maize plant height was observed when intercropped with guar followed by cowpea in the first ,second season and the combined of the two seasons .The results, also proved that maize grain traits yield and its components were decreased under intercropping condition .The maximum values of yield components(ear length, ear diameter, no. of kernels/row ,wt. of kernels /ear and wt. of 100 kernels) were observed when maize intercropped with cowpea .Whereas, the minimum values were observed with Guar plants. The reductions in maize yield components when intercropping with cowpea were 5.0,7.0 and 6.0% for ear length,1.0,0.4 and 0.7% for ear diameter, 0.1,0.7 and 0.4% for no. of kernels/row,0.2,4.0 and 2.6%forwt. of kernels/ear and 0.9, 1.7 and 1.1%for wt. of 100-kernles.While, the reduction with guar were 11.0, 10.2 and 10.6% for ear length, 5.1, 1.8 and 3.4% for ear diameter,

Table 1. Intercropped crops effect on maize grain yield and its components in the two seasons and combined data.

Traits / Crops	Plant height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels /row	Wt. of kernels /ear	Wt. of 100 kernels	Shelling %	Grain yield (ard/fad)
	First season								
Cowpea	205.3	20.13	4.26	12.71	46.76	187.6	34.78	82.11	22.64
Guar	207.9	18.87	4.08	12.33	43.09	160.7	32.00	82.00	20.63
Soybean	205.1	19.36	4.17	12.44	45.51	184.7	33.44	83.89	22.28
LSD	0.82	0.91	0.05	NS	0.16	1.61	0.30	0.31	0.25
Solid	198.00	21.20	4.30	12.80	46.80	188.00	35.10	80.00	23.82
	Second season								
Cowpea	204.0	20.56	4.34	13.44	46.44	219.2	34.60	82.33	22.90
Guar	211.4	19.76	4.28	12.91	44.87	190.2	33.67	82.89	18.41
Soybean	197.4	20.31	4.27	13.42	46.84	196.2	33.90	81.67	22.10
LSD	1.14	0.40	NS	NS	0.35	3.80	0.44	0.40	0.55
Solid	196.00	22.00	4.36	13.60	46.80	229.00	35.20	81.00	24.75
	Combined								
Cowpea	204.65	20.34	4.30	13.07	46.60	203.0	34.70	82.22	22.77
Guar	209.56	19.31	4.18	12.62	44.00	175.55	32.80	82.44	19.52
Soybean	201.25	19.83	4.22	12.93	46.17	190.45	33.67	82.78	22.13
LSD	1.16	NS	0.07	NS	0.32	3.41	0.44	0.42	0.50
Solid	197.00	21.60	4.33	13.20	46.80	208.50	35.10	81.50	24.28

7.9,4.1and 6.0% for no. of kernels/row,14.5,16.8 and 15.6% for wt. of kernels /ear and 8.8,4.3 and 6.6% for wt. of 100-kerneld in first, second season and the combined of the two seasons respectively.

The maximum values of maize grain yield were observed when intercropped with cowpea, whereas, the minimum values were recorded with guar. The reductions in grain yield with cowpea were 5.0,7.4 and 6.2%,whil with guar was 13.4,25.6and 19.5% compared with solid planting in first, second season and the combined, respectively.

The different effects of the three intercropped crops (cowpea, guar and soybean) may be attributed to the difference in canopy size. Guar had large canopy with taller plants (150 cm.) compared with cowpea and soybean plants (70-90 cm.) , therefore, guar plants were highly competitive with maize plants than the other crops. Similar results were recorded by Fininsa (1997), and Abou – Keriasha (2009)

A-2-Effect of sowing dates of intercropped crops:

Data in Table (2) showed that sowing dates of intercropped crops had significant effect on all of characters maize grain yield in both seasons and the combined analysis except ear length, ear diameter and no. of rows/ear in first season.

Table 2. Effect of sowing date of intercropped crops on yield and yield components of maize in the two seasons and the combined data.

Traits / Crops	Plant height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels /row	Wt. of kernels /ear	Wt. of 100 kernels	Shelling %	Grain yield (ard/fad)
	First season								
T1	214.9	18.82	4.10	12.23	41.33	151.6	31.56	82.67	19.74
T2	209.2	19.76	4.18	12.41	44.07	179.8	33.22	81.44	21.23
T3	194.2	19.78	4.22	12.84	49.96	201.6	35.44	83.89	24.58
LSD	1.87	NS	NS	NS	1.28	6.45	1.00	1.19	0.93
Solid	198.00	21.20	4.30	12.80	46.80	188.00	35.10	82.00	23.82
	Second season								
T1	214.0	19.42	4.11	12.60	44.18	186.3	32.40	81.44	18.88
T2	203.7	20.22	4.31	13.16	46.00	196.7	34.40	82.33	20.21
T3	195.2	20.98	4.47	14.02	47.98	222.9	35.37	83.11	24.32
LSD	2.66	0.91	0.23	2.2	1.20	5.48	0.94	1.61	0.77
Solid	196.00	22.00	4.36	13.6	46.80	229.00	35.20	81.00	24.75
	Combined								
T1	214.4	19.12	4.11	12.42	42.76	168.9	31.98	82.06	19.31
T2	206.4	19.99	4.24	12.78	45.03	188.2	33.81	81.89	20.72
T3	194.7	20.38	4.34	13.43	48.97	212.2	35.41	83.50	24.45
LSD	1.54	0.65	0.12	0.42	0.83	4.01	0.65	0.95	0.57
Solid	197.00	21.6	4.33	2.1	46.80	208.50	35.15	81.50	24.28

The results prove that simultaneous maize and intercropped crops sowing (T_1) recorded taller maize plants compared to the other sowing dates. The increase in plant height values when simultaneous maize and intercropped crops were 8.5,9.2 and 8.8%,whereas, the increase when intercropped crops were sown after 3weeks maize (T_2) were 5.6,4.0 and 4.7% compared with solid planting in first, second season and the combined of the two seasons, respectively. The long life period of both components of the intercrop together (60 days) simulated maize

stems internodes to elongate as a result of more shading seemed to be a feasible explanation for stem elongation of intercropped crops. The results showed also, that maize grain yield components i., e no. of row/ear, no. of kernels/row, wt. of kernels/ear and wt. of 100-kernels were affected by sowing date of intercropped crops. The best treatment was observed when intercropped crops were sown 5 weeks after maize (T_3),where it surpassed solid planting. The increases in delayed sowing (T_3) were 1.7% for no. of rows/ear, 4.6% for no. of kernels/row,1.7% for wt. of kernels/ear.o,7%for wt. of 100kernels and 2.4%for shilling percentage compared with solid planting (combined of the two seasons).Whereas, the minimum values were observed when simultaneous maize and intercropped crops was performed (T_1) .The reductions in this treatment were 5.0% for ear diameter,6.0% for no. of rows/ear ,8.6% for no. of kernels/roe,18.9% for wt. of kernels/ear and 9.0% for wt. of 100-kernels compared with solid planting (combined of the two season).

Intercropped maize grain yield was reduced when intercropped crops was sown in the same date (T_1) or after 3 weeks from maize (T_2) by 20.4% and 14.6% respectively, while when sown after 5 weeks from maize (T_3) there was insignificant increase in grain yield (0.7%) as compared with solid planting. The reduction in grain yield and its components was due to increased shading effect of intercropped crops, hence high competition for intercepted light especially when simultaneous maize and intercropped crops was performed. These results are in agreement with those obtained by Tariah and Wahual, (1985), Raddy and Visser (1997) and Okpara (2000).

A-3-The interaction effect of intercropped crops and their sowing dates:

The interaction effect of intercropped crops and their sowing dates on growth, maize grain yield and its components were significant for all maize traits except no. of rows/ear in combined analysis (Table 3).The plant height of maize reached the maximum value (218.65 cm.) at simultaneous maize and guar sowing (T_2). Whereas, the minimum value (165.8 cm) were observed when intercropped with cowpea and sown after 5 weeks from maize (T_3).

The maximum values of yield components (ear length, ear diameter, no. of row/ ear, no. of kernels/row and wt. of kernels/ear) were observed when intercropping with cowpeas and sown 5 weeks after maize sowing (T_3), whereas, the minimum values were observed when intercropped with guar and sown at the same date of maize (T_1).While maize + soybean gave the maximum value of wt. of 100-kernels when soybean was sown 5 weeks after maize.

The results showed also, that the maximum value of grain yield (25.01 ardab /fad.) was observed when intercropped with soybean followed by when intercropping with cowpea (24.59) at sown 5 weeks after maize, whereas , the minimum value (16.44) was observed when intercropped with guar and sown at the same date (T_1).

The relationship between maize grain yield and sowing dates of intercropped crops is represented in Figure (1).It is obvious that guar crop was the more responsive to delayed intercropping from sowing at the same date to 5 weeks after maize sowing ,while cowpea was the least responsive. This response amount to 7.31 ardab/fad. with guar and 4.26 ardab /fad. for soybean. Whereas, cowpea was 3.76 ardab/fad. The different responses may be related to that the minimum values of most maize grain yield components were recorded with sowing guar at the same date of sowing maize (T_1), whereas the maximum values were obtained when sowing cowpea after maize by 5 weeks. Therefore guar showed more aggressivety against maize, but cowpea was the least aggressive to maize plants.

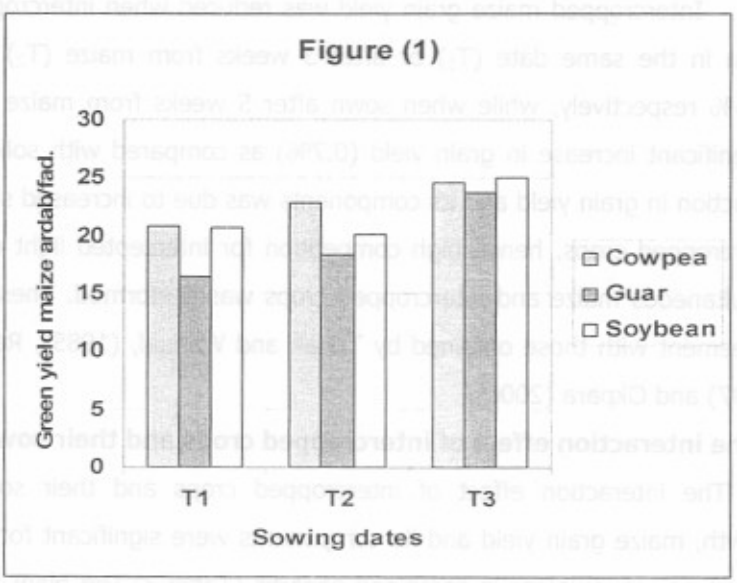

Figure (1): The relationship between maize grain yield and sowing dates of intercropped crops

Table 3. The interaction effect of intercropped crops and sowing dates on yield and yield components of maize (combined of the two seasons).

Traits	Plant height (cm)			Ear length (cm)			Ear diameter (cm)		
Crops / Sowing dates	Cowpea	Guar	soybean	Cowpea	Guar	soybean	Cowpea	Guar	soybean
T1	212.50	218.65	212.15	19.33	17.90	19.93	4.21	4.00	4.10
T2	206.35	210.80	202.30	20.37	19.73	19.87	4.25	4.23	4.20
T3	195.8	199.80	199.30	21.13	20.30	19.70	4.38	4.30	4.35
LSD	2.67			1.12			0.21		
Traits	No. of rows/ear			No. of kernels /row			Wt. of kernels /ear		
Crops / Sowing dates	Cowpea	Guar	soybean	Cowpea	Guar	soybean	Cowpea	Guar	soybean
T1	12.90	12.08	12.25	43.13	41.10	43.91	185.15	144.65	177.00
T2	12.70	12.76	1300	46.60	43.83	44.66	201.35	184.00	179.30
T3	13.63	13.20	13.50	50.10	47.00	49.80	223.70	198.00	215,00
LSD	NS			1.44			6.95		
Traits	Wt. of 100 kernels			Shelling %			Grain yield (ard/fad)		
Crops / Sowing dates	Cowpea	Guar	soybean	Cowpea	Guar	soybean	Cowpea	Guar	soybean
T1	33.10	31.50	31.34	82.00	82.15	82.00	20.83	16.44	20.75
T2	35.32	32.37	33.82	81.67	81.60	82.45	22.90	18.39	20.08
T3	35.66	34.63	35.94	83.00	83.00	83.30	24.59	23.75	25.01
LSD	1.13			1.64			0.99		

B-Intercropped crops:

Intercropping and planting dates effects on intercropped crops green forage yield.

Data in Table (4) showed that green forage yields of the legume crops (cowpeas, guar and soybean) were significantly affected by sowing dates under the studies intercropping systems in both seasons and indicated the combined. The results that the legume green forage yield crops were more affected with sowing dates compared with solid planting. The green forage yields of the legume crops were decreased relative to maize grain yield when sown at the same date with maize 25% for cowpea, 23% for Guar and 18% for soybean compared with solid planting (combined data). Whereas, when delayed sowing to 3 or 5 weeks after maize, the green forage yields were decreased by 12and 8% for cowpea, 11 and 7% for guar

and 16 and 12% for soybean respectively ,compared with solid planting. These results clear that the reduction green forage yield of the three legume crops in delay sowing date 3 or 5 weeks was higher than those sown at the same date of maize (T1).This reduction in growth or yield of cowpea, guar and soybean was due to increased shading from the maize plants, hence low amount of intercepted light, especially when intercropped crops were sowing at 5 weeks after maize. Similar results were observed by Reddy and Visser (1997), Okpara (2002), Adipala *et al* (2002) and Abou Keriasha (2009).

The relationship between green forage yields and sowing dates are presented in Figure (2). It was clear that cowpea plants was more affected by delay sowing dates followed by guar plants, while soybean plants were the least effect under late planting. This effect was observed with the reductions in green forage yields by 9.15 ton/fad. for cowpea and 6.32 ton/ fad. For guar, whereas soybean was reduced by 2.68 ton/fad.(combined of the two seasons).

The results also, clear that cowpea green forage yield was the highest followed by guar when planted at the same maize planting date (T1). The soybean crop recorded the lowest value. Whereas, green forage yield of soybean in delay sowing times (T2 and T3) was higher than both crops, cowpea and guar. Similar results were recorded by Okpara (2000).

Table 4. Sowing date effect on green forge yield (ton/fad.) of intercropped crops (cowpea, guar and Soybean) in first, second and the combined

	Cowpea	Guar	Soybean
	First season		
T1	12.79	8.50	7.30
T2	5.79	4.63	6.80
T3	4.25	2.66	4.60
Solid	51.35	39.19	40/20
LSD	3.16	1.20	0.37
	Second season		
T1	14.43	9.68	8.15
T2	6.83	4.12	6.90
T3	4.67	2.91	5.50
Solid	55.50	39.66	45.24
LSD	0.95	1.65	0.53
	Combined		
T1	13.61	9.09	7.73
T2	6.31	4.37	6.85
T3	4.46	2.79	5.05
Solid	53.44	39.42	42.72
LSD	1.47	1.07	0.37

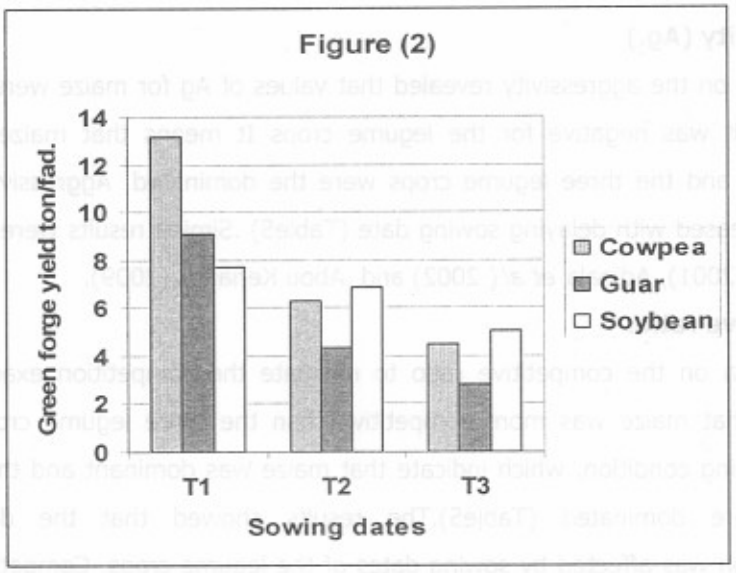

Figure (2): The relationship between green forage yield of intercropped crops and sowing dates

C-Competitive relationships and yield advantages:

1-Land Equivalent Ratio (LER):

Data in Table (5) indicated that land equivalent ratio (LER) showed considerable yield advantage resulting from intercropping maize with the three legume crops i.,e cowpea, guar and soybean in combined data. The results cleared that grain yield of maize and the intercropped crops was affected by sowing dates. The high value of RYm (1.03) was recorded by soybean and sowing at 5 weeks after maize, whereas the lowest values (0.68) was recorded by guar in the first sowing data. While the highest value of RYc (0.25) was recorded by cowpea sown at the same date of maize and the lowest value (0.07) was recorded by guar sown in the same date of maize

Land equivalent ratio(LER) values were greater than one in all treatments expect guar when sown at first and second dates(T1andT2),.It could be concluded that the actual productivity was higher than the expected productivity when intercropping maize with three legume crops. The highest values (1.15) was observed when intercropping maize with soybean followed by cowpea (1.09) and sowing at the same date of maize. While the lowest value (0.87) was observed by guar and sown 3 weeks after maize. LER of cowpea +maize was higher than soybean +maize while LER of guar +maize was less than one (0.94). The results are in agreement with those obtained by Reddy *et al* (1992), Pramod *et al* (2003), Yimaz *et al* (2007)and Abou Keriash (2009).

2- Aggressivity (Ag.)

Data on the aggressivity revealed that values of Ag for maize were positive, whereas it was negative for the legume crops It means that maize was the dominant and the three legume crops were the dominated. Aggressivity values were increased with delaying sowing date (Table5) .Similar results were observed by Paehi (2001), Adipala *et al* (2002) and Abou Keriasha (2009).

3- Competitive ratio:

Data on the competitive ratio to estimate the competition exact degree indicate that maize was more competitive than the three legume crops under intercropping condition, which indicate that maize was dominant and the legume crops were dominated (Table5).The results showed that the degree of competition was affected by sowing dates of the legume crops. Competition ratio of maize was higher with delayed sowing, while competition ratio of the legume crops in delayed sowing was lower. These results were observed by Yimaz *et al* (2007) and Abou Keriasha (2009).

4-Actual yield loss (AYL):

Similar trend to that of LER, Ag and CR was also observed for AYL (Table 5). In particular, AYL values for the three legume crops (cowpea, guar and soybean) which were negative over the three sowing dates, and indicated that yield was disadvantage for legume crops when grown with maize. While AYL for maize was positive when intercropped with cowpea, guar and soybean in the three sowing dates, which indicates an advantage for maize grain yield, probably because of the positive effect of legume crops when grown in association Quantification of yield loss or gain due to association with the three legume crops and three sowing dates could not be obtained through partial LER since partial AYL shows the yield loss or gain by its sign as well as its value. Thus there was AYL for legume crops ranged from -0.49 with cowpea in (T_1) to -0.86 with guar in (T_3), indicating a yield loss from 49 to 86% compared with its solid. Whereas, AYL for maize ranged from +0.35 with guar in (T_1) to + 1.06 with soybean in (T_3) indicating increase in yield by 35 to 106% compared with solid. Total AYL, also was positive when intercropping with cowpea at three sowing dates and, with both guar and soybean at the third sowing date, which indicates that these systems are successful. Thus, there was a gain of 18% with cowpea and 11% with soybean, while it was 12% with guar. The results are in agreement with Ghosh (2004); Yimaz *et al* (2007) and Abou Keriasha (2009).

Table 5. Effect of the three legume crops (cowpea, guar and soybean) and sowing date on the competitive relationships and monetary advantage index(combined data of the two seasons).

Intercropped crop	Sowing date	LER			Agg		CR			AYL			MAI
		Lym	Lyc	total	Agm	Agc	CRm	CRc	total	Aylm	Aylc	total	
Cowpea	T1	0.86	0.25	1.11	+0.61	-0.61	3.44	0.29	3.73	+0.72	-0.49	+0.23	575.52
	T2	0.94	0.12	1.06	+0.82	-0.82	7.83	0;13	7.96	+0.89	-0.76	+0.13	317.32
	T3	1.01	0,08	1.09	+0.93	-0.93	12.63	0.08	12.71	+1.03	-0.83	+0.20	479.83
	M.	0.93	0.15	1.08	+0.79	-0.79	7.96	0.16	8.13	+0.88	0.69	+0.18	457.72
Guar	T1	0.68	0.23	0.91	+0.45	-0.45	2.96	0.34	3.30	+0.35	-0.54	-0.19	-438.62
	T2	0.76	0.11	0.87	+0.65	-0.65	6.91	0.14	7.05	+0.51	-0.78	-0.27	-663.31
	T3	0.98	0.07	1.05	+0.91	-0.91	14.0	0.07	14.07	+0.96	-0.86	+0.10	+260.77
	M.	0.81	0.14	0.95	+0.67	-0.67	7.95	0.20	8.14	+0.6	-0.72	-0.12	-280.38
Soybean	T1	0.85	0.18	1.03	+0.67	-0.67	4.72	0.21	4.93	+0.71	-0.64	+0.07	+153.22
	T2	0.83	0.16	0.99	+0.67	-0.67	5.19	0.19	5.38	+0.65	-0.68	-0.03	-50.85
	T3	1.03	0.12	1.15	+0.91	-0.91	8.58	0.12	8.70	+1.06	-0.76	+0.3	+776.96
	M.	0.90	0.15	1.05	+0.75	-0.75	6.16	0.17	6.33	+0.80	-0.69	+0.11	293.11
Mean	T1	0.79	0.22	1.01	+0.57	-0.57	3.70	0.26	3.98	+0.64	-0.63	+0.03	96.70
	T2	0.84	0.13	0.97	+0.71	-0.71	6.64	0.15	6.76	+0.66	-0.74	-0.17	-132.28
	T3	1.00	0.05	1.1	+0.91	-0.91	11.73	0.10	11.82	+1.01	-0.81	+0.20	+505.85

5-Monetary advantage index (MAI):

The MAI, which is an indicator of the economic feasibility of intercropping systems. These values were positive when intercropping maize with the three legume crops at the three sowing dates except for guar at first and second sowing dates and soybean at the second planting date (Table5). The highest MAI value (776.96) was observed when maize was intercropped with soybean and sown after 5 weeks, followed by intercropping with cowpea and sown at the same date of maize (575.52). The lowest value (-663.31) was observed when maize was intercropped with guar and sown, 3 weeks after maize. These findings are in agreement with the results of LER, Ag, CR and AYL found by Ghosh (2004), Yilmaz *et al* (2007) and Abou Keriasha, *et al* (2009).

REFERENCES

1. Abou Keriasha, M.A., M.A. Abd El-Hady, and F. R. Nawar. 2009. Response of some cowpea varieties to intercropping with maize under upper Egypt condition. Egypt, J. of Appl. Sci.24(2B),495-514.
2. Adipala-E., Ocaya-C.P and Osiru-D.S.O. 2002. Effect time of planting cowpea *(Vign unguiculata L. Walp.)* relative to maize *(Zea mays L.)* on growth and yield of cowpea.Tropicultura,20:2, 49-57.
3. Aleman, Z.F. 2000. Studies on bean-maize production system in Nicarayua. Acta-universitatis-Agric.-Sueciae-Agraria, 239, 107 pp.
4. Banik, P. Banik. 1996. Evaluation of wheat *(Triticum aestivum)* and legume intercropping under 1:1 and 2:1 row replacement series system. J. Agron. Crop Sci., 176: 289-294.
5. Dasaraddi, S.V., S.M. Hiremeth and R. H. Patil. 2002. Performance of legumes as inter-crops in maize. J. of Res., Birsa-Agric. Univ. 14:2,241-244.
6. Fininsa-C. 1997. Effects of planting ,relative planting date and inter-row spacing on a haricot bean/maize intercrop. African Crop Science Journal 5:1,15-22.
7. Ghosh, P.K. 2004. Growth, yield, competition and economics of groundnut/ cereal fodder intercropping systems in the semi-arid tropics of India. Field Crops Res., 88: 227-237.
8. Khan, S.M., M.A. Bhat, S. Qayoom, M.H. Shah and M. Sidiggue. 2002. Performance of maize (*Zea mays*) and cowpea (*Vigna unguiculata* L.) intercropping under Kashmir conditions. Plant Archives. 2, 2: 229-231.
9. Lima, filho Jmp. 2000. Physiological responses of maize and cowpea to intercropping. Pesquisa Agropecuaria Brasileire. 35, 5: 915-921.

10. Mc- Gillichrist, C.A. 1960. Analysis and competition experiments. Biometrics. 21: 975-985.
11. MSTATC. 1980. A Microcomputer Program of the Design Management and Analysis of Agronomic Research Experiments. Michigan State Univ., USA.
12. Ofori, F. and W.R. Stern 1986. Maize/cowpea intercrop system: effect of nitrogen fertilizer on productivity and efficiency. Field Crops Res., 14, 3: 247-261.
13. Okpara, D. A. 2000. Growth and yield of maize and vegetable cowpea as infuencd by intercropping and nitrogen fertilizer in the low land humid tropics. J. of Sustainable Agric. and the Environment. 2, 2: 188-194.
14. Padhi, A. K. 2001. Effect of vegetable intercropping on productivity, economics and energetics of maize (*Zea mays*). Indian J. of Agron., 46, 2: 204-210.
15. Pramod-Kumar, N.K., N.K. Prasad and P. Kumar. 2003. Biological and economical sustainability of forage maize (*Zea mays*) + cowpea (*Vigna unguiculata*) intercrop. Indian J. of Agron., Sci., 73, 6: 341-342.
16. Reddy, K.C., P. Visser and P. Buckner. 1992. Pear millet and cowpea yield in sol and crop productivity. Field Crop Research 28:4,315-326.
17. Reddy, K.C. and P. Visser. 1997. Cowpea intercrop growth and yield as affected by time of planting relative to millet .African Crop Science Journal 5:4,351-357.
18. Snedecor, G.W. and W.G. Cochran. 1988. Statistical Methods. 7th Ed. Iowa State Univ. Press, Ames, Iowa, USA.
19. Tariah-N.M. and T.A.T. Wahua- 1985. Affects of component populations on land equivalent ratios of intercropped maize and cowpea. Field Crops Research.1,81:81-89.
20. Willey, R.W. 1979. Intercropping its importance and research needs, part 1: Competition and yield advantages. Field Crop Abst., 32: 1-10.
21. Willey, R.W. and S.O. Osiru. 1972. Studies on mixture of maize and beans (*Phaseolus vulgaris*) with particular reference to plant populations. J. Agric. Sci., Camb., 79: 519-529.
22. Willey, R.W. and M.R. Rao. 1980. Competitive ratio for quantifying competition between intercrops. Exp. Agric., 16: 117-125.
23. Yilmaz F., M. Atak and M. Erayman. 2007. Identification of advantages of maize –legume intercropping over solitary cropping through competition indices in the East Mediterrsnean Rwgion.Turk J. Agric. 32:111-119.

استجابة محصول الذرة الشامية للتحميل مع ثلاثة محاصيل أعلاف بقولية

محمد أبو العيون أبو كريشة – سحر على شريف – وفاء خميس محمد

قسم بحوث التكثيف المحصولى -معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة – مصر

أجريت هذه التجربة فى محطة بحوث شندويل – محافظة سوهاج خلال الموسم الصيفى لسنة ٢٠٠٨/٢٠٠٩م وذلك لدراسة استجابة محصول الذرة الشامية للتحميل مع ثلاث محاصيل اعلاف بقولية (لوبيا علف – الجوار – فول الصويا) في ثلاث مواعيد زراعة (زراعة المحصولين في نفس الميعاد – زراعة المحاصيل المحملة بعد ثلاثة أسابيع من الذرة الشامية – زراعة المحاصيل المحمله بعد خمسة أسابيع من الذرة الشامية).

تم استخدام تصميم القطع المنشقة مرة واحدة فى ثلاث مكررات حيث زرعت المحاصيل البقولية الثلاثة فى القطع الرئيسية ومواعيد الزراعة الثلاثة في القطع الشقية .

أوضحت النتائج أن صفات المحصول المدروسة للذرة الشامية والمحاصيل البقولية المحملة انخفضت تحت ظروف التحميل مقارنة بالزراعة المنفردة وهذا الانخفاض كان كبيراً في المحاصيل المحملة (لوبيا العلف – الجوار – فول الصويا) عنه في الذرة الشامية.

التحميل تسبب في استطالة نباتات الذرة الشامية وخصوصاً عندما زرعت المحاصيل المحملة فى نفس ميعاد الذرة الشامية (T1)٠ أيضاً المحصول والصفات المكونه له فى الذرة الشامية تأثرت كثيراً بنوع المحصول المحمل ومواعيد الزراعة- وقد كان النقص قليلا عند التحميل مع لوبيا العلف فى الزراعة المتأخرة بينما الانخفاض فى المحصول ومكوناته كان كبيرا عند التحميل مع الجوار وعندما كانت الزراعة في نفس ميعاد زراعة الذرة الشامية.

انخفض محصول العلف الأخضر للمحاصيل البقولية المحمله كثيرا عند التحميل مع الذرة الشامية في الزراعة المتاخرة (بعد ٣ أو ٥ أسابيع).

أوضحت النتائج أيضاً أن الذرة الشامية كان هو المحصول السائد والمحاصيل البقولية هى المسود. وكانت أكبر كفاءة لاستغلال الارض (١,١٥) ومعدل العائد النقدى (٧٧٦,٩٦) عند تحميل الذرة الشامية مع فول الصويا فى الزراعة فى الميعاد المتأخر(خمسة أسابيع من الذرة الشامية) يليه عند التحميل مع لوبيا العلف وفى نفس ميعاد زراعة الذرة والفقد الحقيقى فى المحصول (AYL) كان موجبا مع لوبيا العلف (٠,١٣ – ٠,٢٣) أى باستخدام لوبيا العلف أعطى زيادة تتراوح بين ١٣% و ٢٣% بينما مع الجوار كان سالبا (وهذا يؤكد أن التحميل مع الجوار يكون غير مفيد).

وأخيراً يمكن التوصية بالتحميل مع لوبيا العلف فى نفس ميعاد زراعه الـــذرة أو مـــع فـــول الصويا فى ميعاد متاخر (خمسة أسابيع تعطى فائدة للتحميل).