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RESPONSE OF GRAIN SORGHUM AND COW PEA TO SOME INTERCROPPING SYSTEMS.

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ABSTRACT

Two field experiment were carried out in randomized complete block design for two successive seasons of 2006 and 2007 at the Experimental Farm of Faculty of Agriculture, Al-Azhar University, Assuit Governorate, Egypt, to study the response of grain sorghum [*sorghum bicolor* (L.) Monech] c.v Dorado as main crop with cow *pea [vigna unguiculata* (L.) Walp] cv. Carem-1 as a secondary crop at seven different intercropping systems: intercropping cow pea at the other side of all grain sorghum ridges. Grain sorghum + cow pea (planting two plants/hill of cow pea at 10, 15 and 20 cm apart), were compared with the pure stands for both grain sorghum and cow pea as a recommended on growth, earliness, yield and its components, competitive relationships and the economic return.

The results of both seasons indicated that different intercropping systems had significant effects on growth, yield and its components, competitive relationships as well as economic return. Intercropping cow pea on ridge sorghum at 20 cm between hills significantly increased plant height compared with the other intercropping patterns, while number of leaves/plant decreased by all intercropping systems. Leaf area index LAI was increased at all intercropping systems as compared with pure stand. Flowering of grain sorghum was significantly earlier by all intercropping systems, while 1000–grain weight, grain yield/plant and grain yield/fed. were reduced significantly by all intercropping systems, since the maximum reduction was at P_5 system. Plant height and leaf area index at all intercropping

systems were increased significantly compared with pure stands while number of leaves/plant were decreased at all intercropping systems compared with pure stands of cow pea. The pure stands of cow pea plants produced the maximum forage yield/fed. compared with the other intercropping systems during both seasons. Meanwhile, cow pea grown under P_6 intercropping system produced the highest values of plant yield/fed compared with the other intercropping patterns during both seasons.

The plant protein ratio of cow pea decreased significantly by intercropping as compared with pure stand treatments. Intercropping system of P_7 gave the lowest protein, while P_5 produced the maximum protein ratio/plant compared with all the other intercropping patterns. Results indicated that P_7 system was the best for land utilization from land equivalent ratio LER and the most efficient intercropping system from relative crowding coefficient RCC, although, it was more aggressive on grain sorghum. All intercropping patterns of cow pea with grain sorghum achieved higher economic return than pure grain sorghum, and the most profitable system was P_7.

INTRODUCTION

The need for an intensive cropping system to raise the production per unit of land area is a great target. Intercropping is becoming one of the most popular phenomena among small farmers in Egypt. Reasons for this popularity resulted from more profit and resource maximization and efficient water and soil utilization. Among the many intercropping companions adopted successfully are those of sorghum and bean varieties. Because of the importance of legumes in human and animal nutrition, in summer, we have no land to grow any of these legumes. Hitherto intercropping was the most suitable guide in cow pea cultivation with sorghum in summer season. Abdel-Shafy (1984) reported that intercropping sorghum with cow pea in different patterns had no effect on plant height and number of leaves of sorghum plants, however, seedling rates of sorghum had significant effect on plant height. Land equivalent ratio LER and relative crowding coefficient RCC of sorghum were higher than of cow pea and increased by increasing sorghum rows from 1 to 2.He also found that sorghum was a dominate intercrop compound and cow pea was dominated. Aggressiveness of sorghum increased by increasing

number of sorghum rows from 1 to 2. Gawad *et al.* (1991) indicated that cow pea plant height, number of branches and leaves/plant, LAI and fresh yields were greater in pure stands than in intercrops. Sorghum grain yields, number of grains/head, grain weight/head and 1000–grain weight were higher in intercrops than in pure stands for both cultivars. Land equivalent ratio (LER) of sorghum was greater than that of cow pea cropping pattern. Selim (1996) stated that the low plant density 140000 plants/fed. surpassed the high plant density 186000 plants/fed. in number of branches, number of seeds/pod, number of pods/plant and seed weight/plant but the high plant density gave the tallest plants and the highest mean value of seed yield/fed. Obou *et al.* (1998) studied four intra–row spacing 10, 20, 30 and 40 cm of each crop were used with one local cow pea cultivar (Seredo) grown as sole crops and intercrops. They found that land equivalent ratio LER was between 1.41 and 1.76, indicating high yield advantages from intercropping. Ram and Singh (2001) found that sorghum intercropped with cow pea recorded significantly higher yield and quality than forage sorghum intercropped with cluster bean. Forage and crude protein yields of sorghum were significantly increased when harvesting was done at 75 days after sowing over harvesting at 45 days. Azraf *et al.* (2006) showed that forage sorghum appeared to be the dominant crop, as indicated by the highest values of relative crowding coefficient and competitive ratio and positive sign of aggressiveness.

These suggested that forage sorghum grown in association with forage legumes (mung bean, cluster bean, cow pea and sesbania) utilized the resources more aggressiveness. Among the forage intercrops, cow pea was more competitive than the other legume intercrops under all planting patterns thus, intercropping of cow pea with forage sorghum the most efficient among the intercropping system. Ibrahim *et al.* (2006) studied the effect of different seed ratios of maize and cow pea on growth, yield and quality of maize fodder (*Zea mays* L.).

The results showed that the highest yield of green fodder 68.30 t/ha was obtained by sowing the crops in a ratio of 75:25 mixtures crude protein 18.10% was produced by the cow pea sown alone and

minimum from the maize plots sown alone 2.50%. Ahmad *et al.* (2007) showed that legume associations decrease the forage sorghum yield than pure stand of sorghum. However, intercropping of forage sorghum with legumes in the pattern of 45 cm. spaced double – row strips appeared to be more productive and profitable than the mono cropped sorghum. Oroka *et al* (2007) found that increased number and weight of pods/plant of cow pea in sole stands. Land equivalent ratios exceeding unity were obtained, indicating an improved resource use by the crop mixture. Relative crowding coefficient and aggressiveness indices showed cow pea to be the dominant crop, with Rice being dominated.

The present work aimed to find out the most effective system of intercropping grain sorghum (as the main cereal crop in Upper Egypt) with the cow pea (as legume crops) for increasing total productivity per unit area in the same unit time. The materials included grain sorghum as the main crop and the cow pea as a companion crop.

MATERIALS AND METHODS

The present study was carried out at the Agriculture Experimental Farm of Al–Azhar University, Assiut Governorate, Egypt during 2006 and 2007 summer seasons to study the effect of intercropping of grain sorghum {*Sorghum bicolor* (L.) Monech} cv. Dorado as main crop with cow pea *[Vigna unguiculata* (L.) Walp] cv. Carem-1 as secondary crop on growth, earliness, yield, yield components, competitive relationships and the economic return. The soil texture of experimental farm was clay loam. Mechanical and chemical analysis of the experimental sites are shown in Table1. The preceding crop was field bean {*Vicia faba*, (L.)} in the two seasons. Two experiments in each season were conducted to study the effect of intercropping grain sorghum as a main crop with cow pea. Each one of separate experiment contained seven treatments. Intercropping cow pea at the other side of all grain sorghum ridges. (planting two plants/hill of cow pea at 10, 15 and 20 cm apart).

Table 1: Mechanical and chemical analysis of soil field experiments.

Season		2006	2007
Physical analysis	Sand%	28.31	28.85
	Silt%	38.05	37.58
	Clay%	33.64	33.57
	Soil texture	Clay loam	Clay loam
Chemical analysis	Organic matter %	0.99	1.07
	Available N (ppm)	67.20	73.60
	Available P (ppm)	10.14	10.20
	Available K (ppm)	341.31	354.00
	pH (sp 68.7)	7.87	8.02
	E.C (dsm-1)	1.14	1.16
	Total Ca CO3%	2.66	2.50

Intercropping patrons:

1 .pure stand grain sorghum (P_1).
2. pure stand cow pea at 10 cm on ridge (P_2).
3. pure stand cow pea at 15 cm on ridge (P_3).
4. pure stand cow pea at 20 cm on ridge (P_4).
5. intercropping cow pea at 10 cm on ridge sorghum at 20 cm between hills (P_5).
6. intercropping cow pea at 15 cm on ridge sorghum at 20 cm between hills (P_6).
7. intercropping cow pea at 20 cm on ridge sorghum at 20 cm between hills (P_7).

Calcium super phosphate (15% P_2O_5) was added during seed bed preparation at the rate of 150 kg/fed. The recommended rate of nitrogen fertilizer was added for both solid plot of grain sorghum and intercropped grain sorghum with cow pea at the rate of 100 kg. N/fed. as Urea (46.5 % N), while in pure stand cow pea, nitrogen was applied at the rate of 40 kg N / fed. The amount of nitrogen fertilizer was divided into two equal doses, the first was applied 20 day from planting and the second one was applied 60 days from planting.

The experimental design was randomized complete blocks with four replicates.

Area of each plot was 10.5 m^2 (3.5 m. length and 0.6 m. width), the plot consisted of 5 ridges spaced 60 apart.

Characters examined:

Growth characters:

During the two growing season; growth characters were estimated at 45 and 90 days after planting. Sample of five plants in marked plot were taken to determine the following characters:

1. Grain sorghum:

(1) Plant height in cm, was measured from soil surface to the top of the plant.
(2) Number of leaves/plant.
(3) Leaf area index (LAI) was calculated according to Kirby and Atkins (1968).
(4) Days to 50 % flowering .

2. Cow pea:

(1) Plant height, in cm, was measured from soil surface to the top of the plant.
(2) Number of leaves/plant.
(3) Leaf area index (LAI) as recorded for cow pea by disk method of Johanson (1967).

Yield and yield components:

1. Grain Sorghum:

At harvesting, the panicles were harvested from the middle ridge of each plot in the two seasons and the following data were recorded:

(1) 1000-grain weight (g).
(2) Grain weight/plant (g).
(3) Grain yield (Ardab/fed): ardab = 140 kg.

2.Cow pea :

(1) Forage yield (ton/fed) Cutting 1 (45 day from sowing)
(2) Forage yield (ton/fed) Cutting 2 (80day from sowing)
(3) Forage yield (ton/fed) Cutting 3 (110 day from sowing)

Intercropping systems

Competitive relationships and yield advantages of intercropping:

1- Land Equivalent Ratio (LER) was determining according to Willey (1979).

2 Relative crowding coefficient (RCC) was calculated as described by Hall (1974).

3 Aggressiveness was determined according to Mc-Gilchrist (1965).

Economic return by L.E. was calculated according to the yield prices and practices cost fixed by the Ministry of Agricultural during 2006/2007.

Data of the studies characters (except for competition parameters) during both seasons were statistically analyzed according to methods by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The effect on grain sorghum crop:

A- Growth Characters:

Data in Table 2 show the effect of grain sorghum and cow pea intercropping systems on plant height, number of leaves per plant and leaf area index of grain sorghum at the plant ages of 45 and 90 days during 2006 and 2007 seasons. Results revealed that intercropping systems significantly affected plant height of grain sorghum at 45 and 90 days of plant ages in both seasons. The tallest plants were obtained from P_5 intercropping system and the lowest values of plant height were obtained from P_7 intercropping system at the tow plant ages in both seasons. These results might be due to the severe competition between grain sorghum and cow pea plants under closer intercropping system of P_5 as compared with P_7 intercropping system.

It is clear from Table 2 that intercropping system had a significant effect on number of leaves/plant at ages of 45 and 90 day during 2006 and 2007 seasons. The lowest number of leaves/plant was obtained from P_5 intercropping system at all ages during both seasons, while the highest number of leaves per plant was almost equal to that of pure stand and the P_7 intercropping system.

Table 2 also shows that intercropping systems significantly affected grain sorghum LAI during both seasons at all plant ages. LAI increased significantly when grain sorghum plants were intercropped with cow pea under various intercropping systems compared with pure stand treatments. The greatest LAI was obtained from P_7 and P_6 intercropping systems, while, the lowest LAI values from planting under intercropping systems of P_5. Similar results were also supported by Abdel–Shafy (1984), , Harb (1994), Osman *et al.* (1998), Muwanga *et al.*(2005) and Toaima (2006).

B- Yield and yield components:

Results in Table 3 show that intercropping systems had significant effect on number of days from sowing to 50 % flowering, 1000–grain weight, grain yield/plant and grain yield/fed. during the two seasons. Intercropping system of P_7 had significant effect on flowering dates compared with pure stand of grain sorghum. On the other hand, grain sorghum plants intercropped with cowpea under the systems of P_5 and P_6 encouraged grain sorghum plants to flowering earlier by 3.33 and 2.50 days and 2.67 and 1.50 days during 2006 and 2007 seasons, respectively. These results may be due to the competition from the high plant population densities per unit area in these intercropping systems.

Table 3 also shows that 1000-grain weight was significantly affected by intercropping systems during 2006 and 2007 seasons. The maximum reduction occurred at P_5 and P_6 systems; at which the competition between cow pea and grain sorghum was high because of close distances between cow pea. As the number of increased cow pea hills, the competition was not too much to reduce 1000-grain weight of grain sorghum. Hence the intercropping pattern of P_7 did not reduce 1000-grain weight and had the same weight as that of solid grain sorghum.

Table 4 indicates that all intercropping patterns significantly affected grains weight/plant of grain sorghum during 2006 and 2007 seasons. However, the exerted treatment P_5 which reduced number of leaves per plant and LAI also tended to reduce the grain per plant as compared with other intercropping systems and pure stand during

Table 2: Effect of cow pea–grain sorghum intercropping systems on growth characters of grain sorghum at different ages during 2006 and 2007seasons.

Intercropping systems	Plant height (cm)				Number of leaves/plant				Leaf area index (LAI)			
	45 day		90 day		45 day		90 day		45 day		90 day	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Pure stand	114.76	113.40	151.03	152.26	8.12	7.95	12.03	12.45	5.98	6.05	8.51	8.84
P_5	121.63	122.96	162.63	161.26	7.20	6.98	11.59	11.38	9.94	10.16	14.33	13.92
P_6	117.83	119.36	155.33	154.20	7.53	7.07	11.41	11.55	10.76	10.46	14.77	15.72
P_7	111.80	113.10	159.26	156.73	7.83	7.92	11.65	11.06	10.50	10.70	15.45	15.84
LSD at 5%	2.58	2.14	2.61	2.96	0.32	0.51	0.50	0.56	0.48	0.38	0.32	0.55

Table 3: Effect of cow pea–grain sorghum intercropping systems on yield and yield components of grain sorghum during 2006 and 2007 seasons.

Intercropping systems	50% flowering (days)		1000-grain weight (g)		grains weight /plant (g)		grain yield (ardab/fed)	
	2006	2007	2006	2007	2006	2007	2006	2007
Pure stand	67.33	66.83	47.97	48.60	91.65	91.92	23.74	23.95
P_5	64.00	64.33	44.24	45.48	60.86	61.94	20.46	20.59
P_6	64.66	65.33	45.94	46.40	75.64	72.18	21.59	22.08
P_7	66.33	66.00	47.77	47.32	85.52	86.00	21.97	22.19
LSD. at 5%	1.10	0.76	0.34	0.44	9.13	6.38	0.57	1.15

Table 4: Effect of cow pea–grain sorghum intercropping systems on plant height (cm), number leaves/plant, Leaf area index (LAI) and forage yield (ton/fed) of cow pea at different ages during 2006 and 2007 seasons.

characters / Intercropping	Plant height (cm)						Number of leaves / plant					
	Cutting (1)		Cutting (2)		Cutting (3)		Cutting (1)		Cutting (2)		Cutting (3)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Pure stand 10 cm	76.90	75.53	59.51	58.80	48.76	48.06	35.33	35.76	28.53	27.93	18.66	19.53
Pure stand 15 cm	72.83	73.96	57.67	57.67	46.12	45.00	40.53	39.90	31.28	32.13	21.13	21.33
Pure stand 20 cm	67.96	69.40	55.03	54.53	41.95	43.06	43.16	42.16	34.16	33.56	24.06	23.20
P_5	87.50	85.63	67.77	68.80	56.77	55.83	27.10	26.73	17.86	17.90	13.43	13.26
P_6	83.96	84.33	62.96	64.06	53.46	54.08	29.46	28.86	20.66	19.83	15.20	14.76
P_7	81.43	79.66	61.43	61.76	51.81	52.80	33.10	33.36	22.80	21.46	16.56	17.16
LSD at 5%	2.92	1.38	1.68	1.67	1.67	1.97	1.83	0.94	1.49	1.36	0.77	1.30
characters / Intercropping	Leaf area index (LAI)						forage yield (Ton / fed)					
	Cutting (1)		Cutting (2)		Cutting (3)		Cutting (1)		Cutting (2)		Cutting (3)	
Pure stand 10 cm	1.68	1.66	1.44	1.41	1.35	1.34	13.611	13.693	11.002	10.965	7.691	7.716
Pure stand 15 cm	2.92	2.89	2.49	2.47	2.09	2.08	14.323	14.362	12.074	12.136	8.069	8.133
Pure stand 20 cm	4.44	4.40	3.75	3.73	3.10	3.13	12.550	12.521	10.122	10.008	6.94	7.041
P_5	2.40	2.35	1.97	1.91	1.66	1.65	10.084	10.149	7.661	7.597	3.42	3.375
P_6	4.58	4.25	3.19	3.13	2.89	2.86	11.370	10.997	8.488	8.488	3.660	3.630
P_7	6.14	6.14	4.73	4.68	4.37	4.31	9.674	9.645	7.267	7.267	3.094	3.160
LSD at 5%	0.12	0.11	0.11	0.08	0.15	0.31	0.93	0.81	0.11	0.09	0.08	0.08

both seasons, for example in 2006 and 2007 seasons the intercropping system of P_5 decreased number of leaves per plant and LAI, also decreased grains weight/plant as compared with pure stand, P_7 and P_6 intercropping systems.

Grain yield per fed., was significantly affected by intercropping systems during 2006 and 2007 seasons. The pure stand of grain sorghum had the greatest grain yield /fed. in both seasons, while the treatment of P_5 reduced the grain yield/fed sharply compared with the other intercropping systems and pure stand in both seasons. However, P_7treatments which contained the plant population density of grain sorghum plants 70000 plants/fed. combined with 70000 plants/fed. of cow pea plants produced the maximum grain yield/fed compared with other intercropping patterns during both seasons.

Generally, the results in Table 3 clearly show that grain sorghum planting under the intercropping P_5 which contain the plant population density of grain sorghum 70000 plants/fed. combined with 140000 plants/fed. of cow pea plants led to a decrease in the values of grain weight (1000–grain weight), grain yield/plant and grain yield/fed., while P_7treatment resulted to greatest values of grain weight (1000–grain weight), grain yield/plant and grain yield/fed during both seasons compared with other intercropping patterns. These results are in agreement with Kamel *et al* (1992), Harb (1994), Obou *et al.* (1998), Nalatwadmath *et al.* (2002), Khalil and Nawar (2004), and Toaima (2006).

The effect on cow pea crop:

A - Growth characters:

Results in Table 4 show the effect of applied intercropping systems on average plant height, number of leaves per plant and leaf area index, of cow pea plants at plant ages of 45 cutting (1), 80 cutting (2) and 110 cutting (3) days from sowing during 2006 and 2007 seasons. Intercropping systems had a significant effect on cow pea plant height at all plant ages during 2006 and 2007 seasons. Cow pea grown under P_5 intercropping system which contained the population density of grain sorghum plants 70000 plants/fed. combined with 140000 plants/fed. of cow pea had the tallest plant

compared with the pure stands or other intercropping patterns during all plant ages of cutting in both seasons.

Regarding the number of leaves per plant results indicated that all intercropping systems significantly affected number of leaves per plant of cow pea during all plant ages during 2006 and 2007 seasons. Generally, it is clear that number of leaves per cow pea plant tended to decrease starting from 45,80 and 110 day of three cutting plant ages when it grown under the different intercropping systems compared with the pure stands. Sowing cow pea under P_7 intercropping system which contained the population density of grain sorghum plants 70000 plant/fed. combined with 70000 plants/fed. of cow pea had the highest number of leaves per plant at all plant ages compared with the other intercropping patterns during 2006 and 2007 seasons. On the other hand, P_5 intercropping system resulted in the lowest number of leaves/plant compared with other intercropping systems.

Concerning the effect of the applied intercropping systems on leaf area index results in Table 5 showed that, a significant effect on the leaf area index LAI at all cow pea plant ages during 2006 and 2007 seasons.

P_7 intercropping system which contained the population density of grain sorghum plants 70000 plants/fed. combined with 70000 plants/fed. of cow pea plants produced the greatest values of LAI compared with pure stands or other intercropping systems during both seasons. P_5 intercropping system which contained the population density of grain sorghum plants 70000 plant/fed. combined with 140000 plants/fed. of cow pea plants led to a reduction in the LAI of cow pea at all ages compared with other intercropping patterns during 2006 and 2007 seasons. The exerted intercropping system P_7 produced values of LAI at all ages because of more land area that was occupied for each plant. These results are in agreements with those obtained by Abd-El Gawad *et al.* (1990) and Gawad *et al.* (1991).

B- Yield and yield components:

The effect of applied intercropping systems on yield and yield components of cow pea grown with grain sorghum during 2006 and 2007 seasons is presented in Table 4.

Pure stands of cow pea plants produced maximum plant yield /fed. (Ton) compared with other intercropping systems during both seasons. Meanwhile, cow pea grown under P_6 intercropping system that had plant population density 70000 plants/fed. of grain sorghum plants combined with 93333.3 plants/fed of cow pea plants produced the highest values of plant yield per fed/ton compared with the other intercropping patterns in both seasons. On the other hand, cow pea plant grown under P_7 intercropping system which had plant population density 70000 plants/fed. of grain sorghum plants combined with 70000 plants/fed. of cow pea plants tended to decrease plant yield/fed compared with pure stands and other intercropping systems during both seasons. Similar results were obtained by Moursi et al. (1980), Abd-El Gawad *et al.* (1990), Gawad *et al.* (1991), Ibrahim *et al.* (2006) and Oroka *et al* (2007).

Concerning protein ratio/plant of cow pea, results in Table 5 reveal that this character decreased significantly by intercropping compared with pure stands treatment during the two seasons. Cow pea grown under P_5 intercropping system which contained the population density of grain sorghum 70000 plants/fed. combined with 140000 plant/fed. of cow pea had the lowest system as compared with all other intercropping patterns during all plant ages cutting during both seasons. On the other hand, P_7intercropping system which contained the population density of grain sorghum 70000 plants/fed. combined with 70000 plants/fed of cow pea produced the lowest value of protein ratio/plant. Similar results were obtained by Moursi *et al.* (1980), Narwal and Malik (1985) and Ibrahim *et al.* (2006).

Table 5: Effect of intercropping systems cow pea with grain sorghum on Protein ratio / plant of cow pea at different ages in 2006 and 2007 seasons.

Intercropping systems			Cutting (1)		Cutting (2)		Cutting (3)	
			2006	2007	2006	2007	2006	2007
P_2	Pure stand 10 cm		23.18	23.45	25.30	24.98	26.19	26.16
P_3	Pure stand 15 cm		22.25	22.30	24.51	24.25	25.32	25.69
P_4	Pure stand 20 cm		21.70	21.70	22.92	23.51	25.45	25.09
P_5	Sorghum 20 cm	Cow pea10 cm	20.26	20.25	21.32	21.28	21.10	21.27
P_6	Sorghum 20 cm	Cow pea 15 cm	19.59	19.59	21.12	21.60	19.98	20.18
P_7	Sorghum 20 cm	Cow pea 20 cm	19.29	19.51	20.13	20.47	18.90	19.38
L. S. D at 5 % level			0.77	0.81	0.42	0.45	0.49	1.02

Competitive relationships of intercropping cow pea with grain sorghum:

A. Land Equivalent Ratio (LAR):

Results in Table 6 show that there was a considerable yield advantage as a results of intercropping cowpea with grain sorghum during 2006 and 2007 seasons. Land equivalent ratio LER was increased over one by intercropping cow pea with grain sorghum in different patterns during both 2006 and 2007 seasons.

The highest LER value was obtained by intercropping system of P_7 at which population density of grain sorghum was 70000 plants/fed combined with 70000 plants/fed of cow pea during both seasons. These results are in agreement with those obtained by Narwal and Malik (1985), El-Aref (1995), Azraf *et al.*(2006) Toaima (2006) and Oroka *et al* (2007).

Table 6: Competitive relation ships and yield advantage of sorghum and cow pea (cutting-1, cutting-2 and cutting-3) during 2006 and 2007 seasons.

Intercropping systems	Land equivalent ratio (LER)						Relative crowding coefficient (RCC)						Aggressiveness (A)			
characters / intercropping	2006			2007			2006			2007			2006		2007	
	Sorghum	Cow pea	L.E.R	Sorghum	Cow pea	L.E.R	Sorghum	Cow pea	R.C.C	Sorghum	Cow pea	R.C.C	Sorghum	Cow pea	Sorghum	Cow pea
Cutting-1																
P_5	0.85	0.73	1.58	0.85	0.74	1.59	6.36	2.85	18.12	6.92	2.85	19.72	1.21	1.21	1.19	1.19
P_6	0.90	0.78	1.68	0.91	0.76	1.67	10.15	3.35	34.00	14.49	3.43	49.70	1.39	1.39	1.57	1.57
P_7	0.92	0.76	1.68	0.92	0.77	1.59	12.85	3.36	43.17	15.37	3.35	51.48	1.54	1.54	1.56	1.56
Cutting-2																
P_5	0.85	0.69	1.54	0.85	0.85	1.70	6.36	2.29	14.54	6.92	2.25	5.57	1.65	1.65	1.68	1.68
P_6	0.90	0.69	1.59	0.91	0.91	1.62	10.15	2.43	24.66	14.49	2.35	35.10	1.95	1.95	2.20	2.20
P_7	0.92	0.70	1.62	0.92	0.92	1.64	12.85	2.43	31.22	15.37	2.57	39.50	2.16	2.16	2.06	2.06
Cutting-3																
P_5	0.85	0.44	1.29	0.85	0.43	1.29	6.36	0.79	5.02	6.92	0.84	5.81	4.17	4.17	4.23	4.23
P_6	0.90	0.45	1.35	0.91	0.44	1.35	10.15	0.84	8.52	14.49	0.80	11.59	4.55	4.55	4.52	4.52
P_7	0.92	0.44	1.36	0.92	0.44	1.36	12.85	0.79	10.15	15.37	0.81	12.44	4.80	4.80	4.78	4.78

B. Relative Crowding Coefficient (RCC):

Table 6 shows that the relative crowding coefficient RCC was also influenced by different treatments imposed in a similar trend as land equivalent ratio LER behavior during 2006 and 2007 seasons. The RCC values exceeding unity indicated that net grain in yield was more than accepted from both components. The results also indicated that increasing plant density of grain sorghum and cow pea crops led to an increase in the total RCC, i.e., the highest total RCC was resulted from growing 70000 plants/fed grain sorghum combined with 70000 plants/fed of cow pea at P_7 intercropping system, while the intercropping pattern P_6 ranked the second. These results of P_7 intercropping system achieved the highest LAI, grain weight and yield per plant for grain sorghum. The same trend was obtained by Abdel-Shafy (1984), El-Aref (1995), Azraf *et al.*(2006) Toaima (2006) and Oroka *et a*l (2007).

C. Aggressiveness (A):

Results in Table 6 show that during both growing seasons of study, grain sorghum was dominant at all intercropping systems. Aggressiveness value was the highest when cow pea was intercropped with grain sorghum at P_5 intercropping system. It is also evident that grain sorghum was dominant and cow pea dominated. However, it could be concluded that inter specific competition between grain sorghum and cow pea was pronounced in all intercropping systems because of the differences in the morphology of both crops. Similar results were also reported by, El-Aref (1995), Azraf *et al.*(2006) Toaima (2006) Oroka *et al* (2007).

Economic return per (L.E.)

The economic return evaluation for either intercropping grain sorghum + cow pea and at different intercropping systems compared with each pure stands of the crops are recorded in Table 7. The results of economic return per fed for intercropping cow pea with grain sorghum revealed that all intercropping systems under testing realized more net income than the pure stands of cow pea during the two experimental seasons. In general intercropping system realized more net profit than the pure stand of cow pea during the two seasons.

For example during 2006 and 2007 seasons that all intercropping systems of P_5, P_6 and P_7 achieved (60.74 and 59.46), (73.76 and 71.68) and (62.79 and 62.49) %, higher net profit than pure stands of grain sorghum, respectively.

In general, the comparison between, the intercropping system which realized the greatest grain yield of grain sorghum under intercropping cow pea with grain sorghum P_6 also, realized the highest net income per fed during the two experimental seasons. The results are in agreement with those obtained by Harb (1994), El-Aref (1995) and Bhilar *et al.* (2001).

Table 7: Effect of intercropping systems of cow pea with grain sorghum on the economic return/fed (Egyptian pounds) in 2006 and 2007 seasons.

Intercropping	Cow pea with grain sorghum							
	2006			2007			Relative net income	
	Price of the yield	cost	Net income	Price of the yield	cost	Net income	2006	2007
P_1	4273.2	2991.2	1282.0	4311.0	3017.7	1293.3	100.0	100.0
P_2	4845.6	3391.9	1453.7	4876.1	3399.3	1476.8	113.4	114.2
P_3	5169.9	3618.9	1551.0	5194.6	3636.2	1558.3	121.0	120.5
P_4	4443.0	3110.1	1332.9	4447.5	3113.2	1334.2	104.0	103.2
P_5	6857.5	3212.9	3644.6	6874.2	3228.0	3646.3	284.3	281.9
P_6	7424.9	3428.1	3997.0	7400.7	3467.4	3933.0	311.8	304.1
P_7	6956.4	3368.6	3587.8	7005.0	3398.1	3603.9	279.9	287.6

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Intercropping systems

إستجابة الذرة الرفيعة ولوبيا العلف لبعض نظم التحميل

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أقيمت تجربتان حقليتان فى تصميم القطاعات العشوائية الكاملة وذلك بمزرعة كلية الزراعة جامعة الأزهر بأسيوط خلال موسمي ٢٠٠٦, ٢٠٠٧ لدراسة نظم تحميل لوبيا العلف على الذرة الرفيعة وعلاقة ذلك بصفات النمو والمحصول ومكوناته ونسبة البروتين فى لوبيا العلف والعائد الإقتصادي لنظم التحميل المختلفة تحت الدراسة مقارنه بالزراعة المنفردة لكل محصول وكان صنف الذرة الرفيعة (درادو) وصنف لوبيا العلف (كريم - ١). وقد حمل لوبيا العلف على محصول الذرة الرفيعة على جميع خطوط محصول الذرة الرفيعة علي الريشة الثانية بمسافات ١٠ ، ١٥ ، ٢٠ سم بين الجور.

وتتلخص النتائج كالاتى :

أوضحت النتائج في كلا موسمي الدراسة ان جميع أنظمة التحميل المختلفة أثرت معنويا على صفات النمو والمحصول ومكوناته وكذلك العلاقات التنافسية والإقتصادية وأعطى نظام تحميل لوبيا العلف على جميع خطوط الذرة الرفيعة زيادة معنوية فى طول النبات مقارنة بجميع الأنظمة الأخرى بينما مساحة السطح الورقى زادت فى جميع أنظمة التحميل مقارنة بالزراعة المفردة.

زاد معدل التزهير معنويا فى أنظمة التحميل معنويا على الزراعة المنفردة للذرة الرفيعة بينما وزن الألف حبة ومحصول الحبوب للنبات والفدان نقص معنويا فى جميع أنظمة التحميل وكان النقص عاليا فى نظام التحميل لوبيا العلف على مسافة ١٠سم بين النباتات

أظهرت النتائج أن طول النبات ومساحة السطح الورقى زاد معنويا فى جميع أنظمة التحمل المستخدمة مقارنة بالزراعة المفردة للوبيا العلف بينما عدد الأوراق للنبات نقص معنويا فى جميع الأنظمة مقارنة بالزراعة المفردة وحققت الزراعة المفردة

للوبيا العلف أعلى محصول علف أخضر فى كلا موسمى الدراسة مقارنة بالأنظمة الأخرى

زادت النسبة المئوية للبروتين فى الزراعة المنفردة للوبيا العلف معنوياعن نظم التحميل المختلفة وأعطى نظام التحميل ١٠ سم بين نباتات لوبيا العلف أعلى بروتين فى نظم التحميل بينما أعطى نظام تحميل ٢٠سم بين النباتات اقل قيمة للبروتين.

أثبتت النتائج أن تحميل لوبيا العلف على الذرة الرفيعة أدى إلى زيادة كفاءة إستغلال وحدة المساحة (LER) وقد حقق النظام (P7) اكبر إستفادة للحشات الثلاثة مقارنة بزراعة الذرة الرفيعة منفردا بينما نجد نفس الإتجاه سائدا عند تطبيق معامل الحشد النسبى لكلا المحصولين وقد أعطى محصول الذرة الرفيعة اكبر قيم للعدوانية (سائد) بينما أعطى محصول لوبيا العلف اقل قيم للعدوانية (مسود) خلال موسمى االدراسة.

وتوصي الدراسة ان الزراعة المحملة للذرة الرفيعة + لوبيا العلف تحت نظم التحميل المختلفة كانت أكثر تكلفة الا انها حققت أعلى عائد إقتصادي مقارنة بالزراعة المنفردة للذرة الرفيعة وقد حققت الزراعة تحت نظام (P6) و (P7) أعلى عائد إقتصادي مقارنة بالنظام (P5) لنفس المحصولين خلال موسمى الزراعة .