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Effect of Maize Plants Distribution and Nitrogen Fertilization Levels in Peanut-Maize Intercrop

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TWO FIELD trials were carried out at Ismailia Agricultural Research Station, Agricultural Research Center in 2003 and 2004 summer seasons in sandy soil, to study the interaction effect of intercropping patterns, peanut: maize (2:1), (1:1) and (1:2); orientation of maize plants (the shade crop): spacing maize plants at 35cm apart and leaving one plant/hill , spacing maize plants at 70cm apart and leaving two plants/hill and nitrogen fertilizer levels 60, 90 and 120 kg N/fed. Pure stand plots of both peanut and maize were included in each replicate for land equivalent ratio (LER) and net return essays. Treatments were assigned randomly in factorial Randomized Complete Block Design (RCBD) and replicated for four times. Peanut cv. Giza 5 (Main crop – understory crop) was planted on 23*rd* and 25*th* May in 2003 and 2004 seasons, respectively, whereas maize cv. single cross 10 (Shade crop – overstory crop) was planted on 13*th* and 15*th* June in 2003 and 2004 seasons, respectively. Peanut was planted with intra spacing of 10cm apart on one side of the ridges with population of 70000 plants/fed when intercropped or in pure stand.

Results revealed that intercropping peanut grown 50% of full maize stand (2.4 plants/m^2) in (1:1) pattern under orientated at 70cm apart leaving two plants/hill and adding 120 kg N/fed for the two components resulted in maximum net return of 1851.71 and 2214.95 L.E. with maximum LER of 1.44 and 1.41 in first and second season, respectively.

Keywords: Intercropping, Peanut, Maize, Intercropping patterns, Nitrogen fertilizer.

In sandy soil of Egypt, where peanut is considered the main summer crop, intercropping is popular now among the small holders in Egypt. A reason for this popularity is built on profit and resource maximization and efficient water utilization. However, to determine the processes which lead to the advantages and to maximize benefits, it is necessary to evaluate best intercropping patterns. Since, peanut is the main understory crop, preferably, occupying the whole cultivated area of sandy soil, the geometrical distribution of maize (The shade crop) is expected to play an important role to maximize production and gross income of the intercrop per unit area of land.

Intercropping peanut with maize attracted the attention of some investigators as Mandimba *et al*. (1993), Liphadzi *et al*. (1997), Abd El-Motaleb & Yousef (1998) and Metwally *et al*. (2005).

Studies on maize densities whether maize spacing or number of maize plant/hill which remain after thinning and the fertilization rate and the intercropping pattern seemed to be of prime importance in optimizing the association. Hussein, *et al.* (2002), Hussein *et al*. (2005), Sherif, *et al.* (2005) and Abd El-Motaleb & Yousef (1998) found that peanut responded positively to increasing N level from 40 to 80kg N/fed.

Hussein *et al*. (2005) recorded that highest yield of peanut was obtained when peanut was intercropped with maize on ridges (60 cm width) and received 102.5 kg N/fed.

Several years have been devoted on elaborative research in order to figure out the most productive intercropping pattern. However, the appropriate decision and the correct choice of the most biologically efficient pattern of peanut-maize association have not been reached. Therefore, the objective of the present study is to investigate the interrelationship of peanut-maize intercropping patterns, the geometric and plant density of maize (the shade crop) in sandy soil compared with sole planting of the two crops and the effect of various levels of nitrogen fertilization.

Materials and Methods

Two field trials were carried out at Ismaillia Agricultural Research Station, Agricultural Research Center (2003 and 2004 seasons) in the sandy soil, to study the interaction effect of intercropping patterns, orientation of maize plants and nitrogen fertilization levels on yield and yield component traits of peanut and maize in the intercrop and assay land equivalent ratio (LER) and net return between both components in the intercrop. Eighteen treatments were the combinations of: 1- Three intercropping patterns (Peanut was grown on all ridges and maize was grown on the other side of: a- The third ridge in (2: 1) pattern - 100% peanut and 33% maize, b- The second ridge in (1: 1) pattern - 100% peanut and 50% maize and c- The second and third ridges in (1: 2) pattern - 100% peanut and 67% maize), 2- Two orientation of maize plants (Maize thinned to: a- One plant/hill and 35cm apart. and b- Two plants/hill and 70cm apart.) and 3- Three nitrogen fertilization levels (60, 90 and 120 kg N/fed). Pure stand plots of both peanut and maize were included in each replicate for land equivalent ratio (LER) and net return essays. Both treatments were not involved in the statistical analysis.

Plot area was 12.6 m^2 and consisted of 6 ridges, each was 3.5m in length and 0.6m in width.

The soil was sandy textured (67.98% coarse sand, 24.56% fine sand, 3.13% silt and 4.33% clay), with 7.8 pH, 0.47% organic matter content, 18.21 ppm available N, 2.19 ppm available P and 73.98 ppm available K. (Average of the two seasons).

Peanut cv. Giza 5 (Main crop – understory crop) was seeded on 23*rd* and 25*th* May in 2003 and 2004 seasons, respectively, whereas maize cv. single cross 10 (Shade crop – overstory crop) was seeded on 13*th* and 15*th* June in 2003 and 2004 seasons, respectively. Two sprinkler irrigations were carried out every week. Peanut was seeded with intra spacing of 10cm apart on one side of the ridges with population of (70000 plants/fed) when intercropped or in pure stand. Whereas, maize was planted according to the treatment imposed. Phosphatic fertilization was added during land preparation at the rate of 30 kg P_2O_5/fed in the form of Calcium Super Phosphate (15.5% P_2O_5). Nitrogen fertilization was applied at the rates of 60, 90 and 120 kg N/fed in the form of Ammonium Sulphate (20.5% N)/fed. Application of nitrogen fertilizer was in three equal split up doses. The first dose was after four weeks from peanut planting date, the second dose was after three weeks from first dose and the third dose was after three weeks from the second dose. Potassic fertilization was applied at the rate of 24 kg K_2O/fed in the form of Potassium Sulphate (48% K_2O) with the second dose of nitrogen fertilization. Harvesting of peanut was after 120 days from seeding peanut and maize was after 120 days from seeding maize in both seasons.

Data Recorded

At harvest (after 120 days from planting) a sample of ten plants were taken at random, from the pure stand from intercropped plots of peanut and maize. The following data were recorded:

Peanut

- Number of pods/plant, weight of pods/plant (gm), weight of seeds/plant (gm), 100-seed weight (gm).
- Pod and straw yields/fed (ton) were determined on the plot basis.

Maize

- Ear length (cm), ear diameter (cm), ear weight (gm), weight of kernels/ear (gm), 100-grain weight (gm).
- Grain and straw yields/fed (ton) were determined on the plot basis.

Land equivalent ratio (LER)

LER determined as the sum of the fractions of the yield of the intercrops relative to their sole crop yields according to the following formula (Willey, 1979): LER = $[(Y_{ab}/ Y_{aa}) + (Y_{ba}/ Y_{bb})]$

where: • Y_{aa} and Y_{bb} means: Pure stand yield of crop (a) and (b), respectively.

• Y_{ab} and Y_{ba} means: Intercrop yield of crop (a) and (b), respectively.

Net return fed^{-1}

Net return was calculated for each treatment in the Egyptian pounds LE fed^{-1} for peanut and maize in intercropping or in pure stand according to Economic Affairs Sector EAS (2004 and 2005) for both years.

Statistical analysis

Data were analyzed using ANOVA in factorial Randomized Complete Block Design (RCBD) with four replications. MSTAT-C (1988) was used for statistical computations.

Results and Discussion

Peanut.

Effect of intercropping patterns

Results in Table 1 indicate clearly that highest values of yield and its component traits were evident when peanut was grown under 33% of full density of maize (1.6 plant/m^2) in (2:1) pattern. These results were true in both seasons. Several investigators support these results such as Mandimba *et al*. (1993), Liphadzi *et al*. (1997), Abd El-Motaleb & Yousef (1998) and Metwally *et al*. (2005).

TABLE 1. Effect of intercropping patterns on yield and yield component traits of peanut in 2003 and 2004 seasons.

Traits / Treatments	No. of pods/plant	Weight of pods/plant (g)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (ton/fed)	Straw yield (ton/fed)
Inter. patterns	**First season 2003**					
100% : 33% (2:1)	17.45 A	21.51 A	16.32 A	66.68 A	1.06 A	1.00 A
100% : 50% (1:1)	15.60 B	20.41 B	14.69 B	65.78 B	1.01 B	0.95 B
100% : 67% (1:2)	11.50 C	17.32 C	10.57 C	63.27 C	0.86 C	0.80 C
	Second season 2004					
100% : 33% (2:1)	15.05 A	18.48 A	13.85 A	60.54 A	0.91 A	0.85 A
100% : 50% (1:1)	13.44 B	17.54 B	12.47 B	59.48 B	0.85 B	0.80 B
100% : 67% (1:2)	9.87 C	14.88 C	8.97 C	58.07 C	0.72 C	0.67 C

Effect of orientation of maize plants

Results in Table 2 indicate that yield and its component traits were influenced by the geometric distribution of maize. Values of these traits when maize plants were spaced at 70 cm apart with leaving two plants per each hill were ever superior to those spaced at 35cm and leaving one plant/hill, except, the filling percent where the trend was truly reversed.

TABLE 2. Effect of orientation of maize plants on yield and yield component traits of peanut in 2003 and 2004 seasons.

Traits / Treatments	No.of pods/plat	Weight of pods/ plant (g)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (ton/fed)	Straw yield (ton/fed)
Orient. of maize plants	**First season 2003**					
35cm apart (one plant/hill)	11.87 B	17.35 B	12.73 B	58.54 B	0.83 B	0.78 B
70 cm apart (two plants/hill)	17.83 A	22.15 A	14.99 A	71.94 A	1.12 A	1.05 A
	Second season 2004					
35 cm apart (one plant/hill)	10.22 B	14.90 B	10.81 B	53.27 B	0.71 B	0.66 B
70 cm apart (two plants/hill)	15.36 A	19.03 A	12.72 A	65.46 A	0.95 A	0.89 A

Pod and straw yield of peanut spaced at 70 cm and leaving two plants per hill surpassed that spaced at 35 cm and leaving one plant per hill by 0.29 and 0.27 ton/fed, respectively in the first season as well as 0.24 and 0.23 ton/fed in the second one. These results are in agreement with those obtained by Sherif *et al.* (2005).

In explicit, these results evidenced that reductions in values of these traits were tenaciously bounded with narrowing maize spacing which resulted in more shading. Calavan & Weil (1988), support the conclusion that the within-row maize spacing treatments significantly affected light availability to peanut plants.

In addition Hardy & Havelka (1973), reported that shading reduces the rate of peanut photosynthesis and affects the amount of assimilates available for the competing processes of N_2 fixation and reproductive dry matter accumulation. They also found that peanut root nitrogenase activity was 30 to 46% lower for intercrop than for sole crop.

Effect of nitrogen fertilizer levels

Results presented in Table 3 indicated that peanut in the intercrop was responsive to nitrogen fertilizer. Moreover, there were ever increases in the values of yield and its component traits with increasing the level of nitrogen fertilizer up to 120 kg N/fed. These results were true in both seasons. This result may be due to the role of nitrogen element in enhancing the meristmatic activity of plant tissues which contributes to the production of new organs as well as to the role of nitrogen in stimulating the metabolic activity which are used in building up plant organs such as tillers flowers and pods. The response in yield components traits and yield/fed were supported by several investigators such as Abd El-Motaleb & Yousef (1998), Hussein, Samira (2005) and Lanier *et al.* (2005).

TABLE 3. Effect of nitrogen fertilizer levels on yield and yield component traits of peanut in 2003 and 2004 seasons.

Traits / Treatments	No.of pods/ plant	Weight of pods/ plant (g)	Weight of seeds / plant (g)	Weight of 100-seed (g)	Pod yield (ton/fed)	Straw yield (ton/fed)
N fert. levels	**First season 2003**					
60 kg/fed	14.11 C	18.35 C	12.47 C	63.65 C	0.90 C	0.85 C
90 kg/fed.	14.85 B	20.25 B	14.28 B	65.25 B	1.00 B	0.94 B
120 kg/fed	15.59 A	20.65 A	14.84 A	66.82 A	1.02 A	0.96 A
	Second season 2004					
60 kg/fed	12.15 C	15.76 C	10.58 C	57.92 C	0.77 B	0.72 B
90 kg/fed	12.77 B	17.39 B	12.12 B	59.37 B	0.85 A	0.80 A
120 kg/fed	13.44 A	17.74 A	12.60 A	60.81 A	0.87 A	0.81 A

Patra & Poi (1998) revealed that intercropping caused the number of nitrogen fixing nodules on the legume crop roots to decrease due to shading. When legume was intercropped with cereals, legume nodulation was poor and less nitrogen fixation took place. On this basic ground, it could be concluded that First: intercropping peanut with maize might stimulate the peanut plant response to increased levels of nitrogen fertilizer rather than growing peanut in mono culture due to the inhibitory effect of maize shading on peanut nodulation, (Senaratne & Ratnasinghe, 1993). Second: that the poor natural population of rhizobia in the sandy soil was offset by high response of peanut to increased nitrogen fertilizer level might explain different response to the nitrogen fertilizer level. These conclusions were also explained by Senaratne & Ratnasinghe (1993).

Interaction effects

A summary of the interaction effects of the three factors is given in Table 4. The highest values of traits studied are given. The letters in brackets represent the sequence in the order of the planting practices (intercropping patterns × orientation of maize plants × nitrogen fertilizer levels). From the table it is clear that the highest values of yield and its components traits were recorded when maize percent in the intercrop diminished to one third of its full stand in (2:1) pattern, when only growing maize at 70cm apart and leaving two plants/hill and received 120 kg N/fed. Similar conclusions were also explained by Abd El-Motaleb & Yousef (1998) and Hussein *et al*. (2002).

TABLE 4. Summary of interaction effects among intercropping patterns (A), orientation of maize plants (B) and nitrogen fertilizer levels (C) on yield and yield component traits of peanut in 2003 and 2004 seasons.

Traits / Treat.	No.of pods/plant	Weight of pods/plant (g)	Weight of seeds / plant (g)	Weight of 100-seed (g)	Pod yield (ton/fed)	Straw yield (ton/fed)
	First season 2003					
A×B	($A_1 \times B_2$) 20.68	($A_1 \times B_2$) 24.10	($A_1 \times B_2$) 17.61	($A_1 \times B_2$) 73.52	*($A_1 \times B_2$) 1.21	($A_1 \times B_2$) 1.14
A×C	($A_1 \times C_3$) 18.35	($A_1 \times C_3$) 22.48	($A_1 \times C_3$) 17.43	($A_1 \times C_3$) 68.14	($A_1 \times C_3$) 1.11	($A_1 \times C_3$) 1.04
B×C	($B_2 \times C_3$) 18.82	($B_2 \times C_3$) 23.14	($B_2 \times C_3$) 16.03	($B_2 \times C_3$) 73.67	*($B_2 \times C_3$) 1.17	($B_2 \times C_3$) 1.09
A×B×C	($A_1 \times B_2 \times C_3$) 21.65	($A_1 \times B_2 \times C_3$) 25.15	($A_1 \times B_2 \times C_3$) 18.79	($A_1 \times B_2 \times C_3$) 75.10	($A_1 \times B_2 \times C_3$) 1.27	($A_1 \times B_2 \times C_3$) 1.19
Second season 2004						
A×B	($A_1 \times B_2$) 17.86	($A_1 \times B_2$) 20.71	($A_1 \times B_2$) 14.95	($A_1 \times B_2$) 66.77	($A_1 \times B_2$) 1.04	($A_1 \times B_2$) 0.98
A×C	($A_1 \times C_3$) 15.79	($A_1 \times C_3$) 19.31	($A_1 \times C_3$) 14.81	($A_1 \times C_3$) 61.87	($A_1 \times C_3$) 0.95	($A_1 \times C_3$) 0.89
B×C	($B_2 \times C_3$) 16.10	($B_2 \times C_3$) 19.88	($B_2 \times C_3$) 13.60	($B_2 \times C_3$) 67.03	($B_2 \times C_3$) 0.99	($B_2 \times C_3$) 0.93
A×B×C	($A_1 \times B_2 \times C_3$) 18.71	($A_1 \times B_2 \times C_3$) 21.60	($A_1 \times B_2 \times C_3$) 15.96	($A_1 \times B_2 \times C_3$) 68.22	($A_1 \times B_2 \times C_3$) 1.09	($A_1 \times B_2 \times C_3$) 1.03

Maize

Effect of intercropping patterns

Results in Table 5 indicate that the values of all yield components decreased with increasing maize density in the intercrop. Consequently maximum values of these traits were obtained with 33% maize in (2:1) pattern, while, the minimum values were obtained in (1:2) pattern with 67% maize density. The results hold true in both seasons. Since plant density was the principal mode of action within the intercrop, responses of maize yield components were mostly due to maize density. The increase in maize yield components values may be due to the decrease in maize density could be due attributed to less competition between plants for light, water, nutrient minerals and place. The similar results were obtained by several investigators. El-Hosary & Salwau (1989), El-Bana & Gomaa (2000) and Ibrahim & Abd El-Maksoud (2001) demonstrated that maize yield component, increased with decreasing maize density in the intercrop.

Results on grain and straw yields/fed followed reversed trends of the pattern treatment effect on maize yield components.

The results indicate maximum yield with increasing maize density in the pattern, with (67% maize density) whilist minimum yield was associated with pattern (2:1) with 33% maize density indicating that the yields were associated with maize density in the intercrop rather than any other factor. These results are in agreement with those obtained by several investigators such as Lucas (1986) and El-Bana & Gomaa (2000).

TABLE 5. Effect of intercropping patterns on yield and yield component traits of maize in 2003 and 2004 seasons.

Traits / Treatments	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Weight of kernels / ear (g)	100-kernel weight (g)	Grain yield (ton/fed)	Straw yield (ton/fed)
Inter. patterns Peanut : Maize	**First season 2003**						
100% : 33% (2:1)	17.74 A	3.85 A	219.99 A	179.23 A	32.18 A	1.17 C	0.87 C
100% : 50% (1:1)	16.66 B	3.67 A	197.05 B	157.67 B	31.43 B	1.54 B	1.15 B
100% : 67% (1:2)	15.58 C	3.31 B	178.84 C	142.59 C	30.28 C	1.86 A	1.36 A
	Second season 2004						
100% : 33% (2:1)	18.48 A	3.90 A	251.53 A	201.86 A	34.80 A	1.33 C	0.98 C
100% : 50% (1:1)	17.13 B	3.75 A	224.24 B	176.68 B	33.98 B	1.75 B	1.31 B
100% : 67% (1:2)	15.78 C	3.42 B	197.96 C	155.46 C	32.88 C	2.05 A	1.54 A

Effect of orientation of maize plants

Results in Table 6 indicate that maize yields and its components were significantly influenced by maize orientation in the intercrop in both seasons, except, ear diameter, differences failed to reach the 5% level in both seasons. The results indicate that values of all yield and its components traits when maize was spaced at 35cm apart with one plant/hill except in case of 100-kernel weight were always higher than those recorded when maize was spaced at 70cm apart with two plants/hill. These observations were valid in both seasons.

TABLE 6. Effect of orientation of maize plants on yield and yield component traits of maize in 2003 and 2004 seasons.

Traits / Treatments	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Weight of kernels / ear (g)	100-kernel weight (g)	Grain yield (ton/fed)	Straw yield (ton/fed)
Orient. of maize plants	**First season 2003**						
35 cm apart (one plant/hill)	17.12 A	3.65 A	204.74 A	166.12 A	30.79 B	1.58 A	1.18 A
70 cm apart (two plants/hill)	16.21 B	3.57 A	192.51 B	153.55 B	31.80 A	1.47 B	1.07 B
	Second season 2004						
35 cm apart(one plant/hill)	17.40 A	3.72 A	235.88 A	188.49 A	33.01 B	1.80 A	1.34 A
70 cm apart (two plants/hill)	16.86 B	3.66 A	213.28 B	167.51 B	34.76 A	1.63 B	1.21 B

These results seemed distinctive and did not coincide with light penetration theory only which over dominated most of the results. Interpretation might be due the diminishing effect as a result of plant to plant competition when two plants were left per hill and maize was orientated at 70 cm spacing. Hussein *et al*. (2002) and Sherif *et al.* (2005) came to similar results.

Effect of nitrogen fertilization levels

Results in Table 7 obtained that there were increases in all yield and its components traits with increasing nitrogen fertilizer dose up to 120 kg N/fed. Increases were significant among the treatment imposed in both seasons, except, in case of ear diameter where differences failed to reach 5% level of significance. The increases in yield and its components of maize with increasing N level are mainly due to role of N in stimulating metabolic activity which contributed to the increase in metabolites amount most of which is used building yield and its components. These results were in agreement with several investigators such El-Douby *et al*. (2001), Shams (2002) and Hussein (2005).

TABLE 7. Effect of nitrogen fertilizer levels on yield and yield component traits of maize in 2003 and 2004 seasons.

Traits / Treatments	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Weight of kernels / ear (g)	100-kernel weight (g)	Grain yield (ton/fed)	Straw yield (ton/fed)
N fert. levels	**First season 2003**						
60 kg/fed	15.84 C	3.56 A	179.11 C	143.51 C	30.03 C	1.37 C	1.03 B
90 kg/fed	16.71 B	3.58 A	199.29 B	160.31 B	31.63 B	1.53 B	1.13 A
120 kg/fed	17.43 A	3.70 A	217.47 A	175.68 A	32.23 A	1.67 A	1.21 A
	Second season 2004						
60 kg/fed	16.29 C	3.63 A	211.00 C	166.59 C	32.85 C	1.60 C	1.19 C
90 kg/fed	17.17 B	3.65 A	226.19 B	179.30 B	34.08 B	1.72 B	1.28 B
120 kg/fed	17.93 A	3.79 A	236.55 A	188.10 A	34.73 A	1.81 A	1.36 A

Interaction effects

A summary of the interaction effects of the three experimental factors is given in Table 8. The highest values of traits studied are given. The letters in brackets represent the sequence in the order of the planting practices (intercropping patterns× orientation of maize plants × nitrogen fertilizer levels).

It is clear that the highest values of yield components traits were recorded when maize percent in the intercrop diminished to 33% of its full stand in (2:1) pattern when only growing maize at 35cm apart, leaving one plant/hill and received 120 kg N/fed while grain and straw yields/fed reached maximum when maize percent in the intercrop increased to 67% of its full stand in (1:2) pattern when only growing maize at 35cm apart and leaving one plant/hill and received 120 kg N/fed. These results coincide with those explained by Eliseu & Freire (1992) and Metwally *et al*. (2005).

TABLE 8. Summary of interaction effects among intercropping patterns (A), orientation of maize plants (B) and nitrogen fertilizer levels (C) on yield and yield component traits of maize in 2003 and 2004 seasons.

Traits / Treat.	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Weight of kernels / ear (g)	100-kernel weight (g)	Grain yield (ton/fed)	Straw yield (ton/fed)
	First season 2003						
A×B	$(A_1 \times B_1)$ 18.23	$(A_1 \times B_1)$ 3.89	$(A_1 \times B_1)$ 231.75	$(A_1 \times B_1)$ 191.51	$(A_1 \times B_2)$ 32.65	$(A_3 \times B_1)$ 1.87	$(A_3 \times B_1)$ 1.39
A×C	$(A_1 \times C_3)$ 18.58	$(A_1 \times C_3)$ 3.95	$(A_1 \times C_3)$ 243.02	$(A_1 \times C_3)$ 198.82	$(A_1 \times C_3)$ 33.22	$(A_3 \times C_3)$ 2.02	$(A_3 \times C_3)$ 1.46
B×C	$(B_1 \times C_3)$ 17.92	NS. $(B_1 \times C_3)$ 3.74	$(B_1 \times C_3)$ 224.29	$(B_1 \times C_3)$ 182.75	$(B_2 \times C_3)$ 32.82	$(B_1 \times C_3)$ 1.73	$(B_1 \times C_3)$ 1.27
A×B×C	$(A_1 \times B_1 \times C_3)$ 19.10	$(A_1 \times B_1 \times C_3)$ 3.99	$(A_1 \times B_1 \times C_3)$ 256.17	$(A_1 \times B_1 \times C_3)$ 212.48	$(A_1 \times B_2 \times C_3)$ 33.84	$(A_3 \times B_1 \times C_3)$ 2.04	$(A_3 \times B_1 \times C_3)$ 1.50
	Second season 2004						
A×B	$(A_1 \times B_1)$ 18.77	$(A_1 \times B_1)$ 3.93	$(A_1 \times B_1)$ 271.81	$(A_1 \times B_1)$ 221.03	$(A_1 \times B_2)$ 35.60	$(A_3 \times B_1)$ 2.08	$(A_3 \times B_1)$ 1.57
A×C	$(A_1 \times C_3)$ 19.35	$(A_1 \times C_3)$ 4.00	$(A_1 \times C_3)$ 263.36	$(A_1 \times C_3)$ 212.14	$(A_1 \times C_3)$ 35.73	$(A_3 \times C_3)$ 2.18	$(A_3 \times C_3)$ 1.64
B×C	$(B_1 \times C_3)$ 18.22	NS. $(B_1 \times C_3)$ 3.82	$(B_1 \times C_3)$ 247.54	$(B_1 \times C_3)$ 198.61	$(B_2 \times C_3)$ 35.68	$(B_1 \times C_3)$ 1.89	$(B_1 \times C_3)$ 1.43
A×B×C	$(A_1 \times B_1 \times C_3)$ 19.65	$(A_1 \times B_1 \times C_3)$ 4.03	$(A_1 \times B_1 \times C_3)$ 283.12	$(A_1 \times B_1 \times C_3)$ 231.11	$(A_1 \times B_2 \times C_3)$ 36.59	$(A_3 \times B_1 \times C_3)$ 2.19	$(A_3 \times B_1 \times C_3)$ 1.67

Land equivalent ratio (LER) and net return

Land equivalent ratio values in Table 9 indicated clearly that all values obtained under the treatment imposed exceeded the unit indicating yield advantage as compared when each component was grown alone. These results were true in both seasons. The only exception, was when maize density diminished to 33% (2:1) and peanut was shaded by maize spaced 35cm apart leaving one plant/hill and the plot received lowest nitrogen fertilizer dose (60 kg N/fed) in the first season only where LER was less than the unit with no yield advantage being achieved. Results of the interaction indicate that LER obtained from (1:1) pattern were generally superior to (2:1) or (1:2) pattern either. Moreover, LER values of (1:2) pattern were always higher than in (2:1) pattern under same respective nitrogen fertilizer dose. (2:1) pattern recorded lowest values. LER values also increased with increasing the nitrogen fertilizer level. Within orientation patterns of the shade crop LER of 70cm spaced plants and two plants/hill were left were relatively higher than those spaced at 35cm spaced and one plant/hill, due to increasing light efficiency and decreasing the shading effect on the understory crop.

TABLE 9. Effect of intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on land equivalent ratio (LER) and net return in 2003 and 2004 seasons.

Treatments \ Traits			First season 2003		Second season 2004	
Inter. patterns	**Orient. of maize plants**	**N levels kg/fed**	**LER**	**Net return (L.E.)**	**LER**	**Net return (L.E.)**
100% : 33% (2:1)	35 cm apart (one plant/hill)	60	0.99	908.99	1.03	1372.82
		90	1.10	1141.89	1.13	1588.53
		120	1.17	1203.91	1.16	1590.37
	70 cm apart (two plants/hill)	60	1.16	1444.48	1.18	1730.29
		90	1.28	1692.76	1.27	1904.76
		120	1.34	1754.21	1.30	1955.26
100% : 50% (1:1)	35 cm apart (one plant/hill)	60	1.07	990.86	1.11	1592.44
		90	1.19	1212.29	1.21	1811.92
		120	1.26	1284.14	1.26	1868.52
	70 cm apart (two plants/hill)	60	1.23	1481.80	1.25	1912.24
		90	1.37	1764.14	1.36	2149.69
		120	1.44	1851.71	1.41	2214.95
100% : 67% (1:2)	35 cm apart (one plant/hill)	60	1.06	798.88	1.08	1462.11
		90	1.19	1034.20	1.19	1690.35
		120	1.25	1087.48	1.22	1729.83
	70 cm apart (two plants/hill)	60	1.24	1309.16	1.23	1849.49
		90	1.37	1568.55	1.35	2131.93
		120	1.43	1648.21	1.40	2211.19

- Pure stands were: 1.36, 1.17 ton pods/fed and 1.27, 1.11 ton straw/fed for peanut and 2.97, 3.29 ton grains/fed and 2.37, 2.55 ton straw/fed for maize for 2003 and 2004 seasons, respectively.
- Ton price in 2003 season: (Peanut pods = 2133.33 L.E., foliage = 40.00 L.E.) & (Maize grains = 692.86 L.E., straw = 76.00 L.E.).
- Ton price in 2004 season: (Peanut pods = 2253.33 L.E., foliage = 40.00 L.E.) & (Maize grains = 1035.71 L.E., straw = 76.00 L.E.).

Maximum LER was obtained when the intercrop received 120 kg N/fed and peanut plants were grown under the 50% of maize plants (2.4 plants/m^2) orientated at 70 cm apart and two plants/hill were left in (1:1) pattern.

Yield advantage in the intercrop as compared with sole cropping were also supported by Calavan & Weil (1988) who found that peanut-maize intercrop resulted in land equivalent rate ranging from 1.28 to 1.49 and Eliseu & Freire (1992) who also found that peanut-maize intercrop gave yield advantage estimated to 1.20-1.99, particularly in peanut-maize (3:1).

Results on net return presented in Table 9 also indicated that the treatment effect had apparent impose on net return with increases in nitrogen fertilizer level from 60 to 120 kg N/fed under all the intercrop patterns.

The results also evidenced that within any intercrop, net return (on average basis) when peanut plants were grown at 70cm spaced maize plant with two plants/hill were higher than those orientated at 35cm spaced maize plant leaving one plant/hill. Maximum net return was recorded when the intercrop plots received 120 kg N/fed and peanut plants were grown under 50% of full stand of maize plants orientated at 70 cm apart with two plants/hill. Whereas, when the intercrop plot received 120 kg N/fed and peanut was grown under 67% of full stand of maize plants orientated at 70 cm apart with two plants/hill had the second net return indicating that increasing the shade crop density to maximum, 67% (3.2 plants/m^2) had no beneficial effect whether on production per unit of land (measured in LER) or any more economical value (measured in net return).

However, it could be concluded that differences were only appreciable between (1:1) and (1:2) or (2:1) patterns which stimulate the need to more plant density of maize to improve the net return of the intercrop particularly if the price unit of the shade crop increased, *i.e.*, increasing the shade crop up to 67% or decreasing it to 33% of its full stand density is mainly dependant on the price unit of the shade crop.

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تأثير توزيع نباتات الذرة الشامية ومستويات التسميد اليتروجينى عند تحميل الفول السودانى والذرة الشامية

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قسم بحوث التكثيف المحصولى – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية–الجيزة و *قسم المحاصيل –كلية الزراعة بمشتهر – جامعة بنها – بنها – مصر.

أقيمت تجربتان حقليتان في محطة بحوث الاسماعيلية في موسمي ٢٠٠٣ ، ٢٠٠٤ على أرض رملية وذلك لدراسة التفاعل بين النسق التبادلية للفول السودانى : الذرة الشامية (٢ :١) ، (١ :١) ، (١ :٢) ، ونظام توزيع نباتات الذرة الشامية (محصول الظل – المحصول الفوقى) والذى تضمن الزراعة فى جور على أبعاد ٣٥سم مع ترك نبات واحد بالجورة أو ابعاد ٧٠سم والخف على نباتين بالجورة ، وإختبار ثلاث مستويات من التسميد النيتروجينى ٦٠ ، ٩٠ ، ١٢٠ كجم نيتروجين/فدان. كما تضمنت المعاملات قطع للمقارنة من كل من الفول السودانى والذرة الشامية بزراعتها منفردة فى كل مكررة وذلك لتقدير معدل إستغلال الأرض وصافى العائد من التحميل مقارنه بالزراعة المنفردة. وزعت المعاملات عشوائيا فى تجربه عامليه وذلك فى تصميم القطاعات الكاملة العشوائية فى أربع مكررات. وزرع الفول السودانى صنف جيزه ٥ (وهو يمثل المحصول الرئيسى- المحصول التحتى) فى ٢٣ ، ٢٥ مايو بينما زرع محصول الذرة الشامية هجين فردى ١٠ (وهو يمثل المحصول الفوقى) فى ١٣، ١٥ يونيو من عامى ٢٠٠٣، ٢٠٠٤. وقد زرع الفول السودانى على مسافات ١٠سم بين الجور وعلى جانب واحد من الخط بكثافة نباتية قدرها ٧٠ ألف نبات/فدان سواء فى معاملات التحميل أو الزراعة المنفردة.

خلصت الدراسة إلى أن تحميل الفول السودانى تحت ٥٠% من الكثافة الكاملة للذرة الشامية فى نسق ١:١ أى ١٠٠% فول سودانى : ٥٠% ذرة شامية (٢،٤ نبات/ م^{٢}) و زراعة الذرة الشامية على مسافات ٧٠سم مع ترك نباتين بالجورة والتسميد بمعدل ١٢٠كجم نيتروجين /فدان أدى إلى الحصول على أعلى صافى عائد ١٨٥١،٧١ ، ٢٢١٤،٩٥ جنيها الناتج عن أعلى معدل استغلال للأرض ١،٤٤، ١،٤١ فى الموسم الأول والثانى على الترتيب.