RESULTS AND DISCUSSION

IV. RESULTS AND DISCUSSION

Effect of intercropping patterns, orientation of maize plants and nitrogen fertilizer levels and their interactions on peanut and maize crops:

A. Peanut.

1. Growth traits:

a. Effect of intercropping patterns:

Results in Table (1) indicate clearly that intercropping pattern had a significant effect on growth habit of peanut plants. Plant height of peanut increased with increasing maize ratio in the intercrop up to the highest density (67% of full stand). Differences were significant among the treatment imposed. These results were valid in both seasons. Increasing maize percent in the association of (1:2) pattern resulted in increased intra as well as inter-specific competition between both crops in the association. Plants of peanut develop its growth in a complex and irregular manner. They must grow in spaced to optimize light interception and gas exchange. In heavy dense maize plots (1:2) light penetration into lower leaves of the canopy decreased and there was less light available for peanut plants. Peanut plants compensated by increasing internode length which led to increase plant height. **Kayhan *et al* (1999)**, found that even when soybean was grown alone at low, normal and high density plants did not catch up in height with soybean associated with maize in the intercrop. However, these results were concordant with those obtained by **Hussein, Samira (2005)** and **Sherif, Sahar *et al* (2005)** who reached same results and conclusion

Table (1): Effect of intercropping patterns on some growth traits of peanut in 2003 and 2004 seasons.

Treatments \ Traits	Plant height (cm)	No. of branches/plant
Inter. patterns Peanut : Maize	First season 2003	
100% : 33% (2:1)	56.62 C	5.07 A
100% : 50% (1:1)	58.43 B	4.71 B
100% : 67% (1:2)	61.21 A	4.33 C
	Second season 2004	
100% : 33% (2:1)	49.70 B	4.56 A
100% : 50% (1:1)	50.93 B	4.22 B
100% : 67% (1:2)	52.69 A	3.91 C

when peanut was intercropped with maize under different cropping patterns.

Results on the average number of branches/plant of peanut as influenced by the intercropping patterns with different maize percents in the associations indicated regular trend in both seasons but reverse to plant height, i.e., the average number of peanut branches per plant decreased gradually and consistently with increasing maize percents in the associations. The reductions were also significant. These results are in accordance with those obtained by **Kayhan *et al* (1999), Ibrahim, Sahar**

(2000), Hussein, Samira (2005), and **Sherif, Sahar *et al* (2005).** Many vegetation and yield variables are potentially influenced by the competition of the plant with a second crop in an intercrop system and by competition with other plants of different species or same species. The structure of plant vegetation and its geometric elements combined with total amount of leaf area determine the distribution of light within the canopy. In adequate irradiance, peanut plants can array their foliage in space to optimize light interception and gas exchange and the geometric structure of the canopy can have a great impact on the ability of plants to intercept light, a cogent interpretation for higher branching with less shading of the understory crop.

b. Effect of orientation of maize plants:

Results in Table (2) also indicate that orientation of maize plant (the shade crop) had significant effects on growth of peanut. Spacing maize plants at 35cm. and leaving one plant/hill resulted in higher peanut plants than spacing maize at 70cm. and leaving two plants/hill. These results were true in both seasons. Increases in plant height with narrowing distances between maize hills and leaving one plant/hill over increasing maize spacing to 70cm. between hills and leaving two plants/hill was due to less light penetration that led to more intra specific competition for light intercepted by foliage. Thence, in these intercrop pattern light penetration into lower levels of the canopy (peanut foliage) decreased particularly as maize developed. To optimize light interception and gas exchange, the geometric structure of the canopy had a great impact on the ability of plants

Tabl (2): Effect of orientation of maize plants on some growth traits of peanut in 2003 and 2004 seasons.

Traits / Treatments	Plant height (cm)	No. of branches/plant
Orient. of maize plants	First season 2003	
35 cm (one plant/hill)	64.90 A	3.87 B
70 cm (two plants/hill)	52.60 B	5.53 A
	Second season 2004	
35 cm (one plant/hill)	56.45 A	3.48 B
70 cm (two plants/hill)	45.76 B	4.99 A

to intercept light resulting in increased plant height by enlengthing stem internodes. **(Baker, 1979)**. These results are also in agreement with those obtained by **Hussein, Samira *et al* (2002), Hussein, Samira (2005)** and **Sherif, Sahar *et al* (2005).**

The geometrical distribution of maize plant in the intercrop plots had a reversed trend on peanut branching. Results indicated that the wider spacing system, coupled with two maize plants/hill has led to more branching. These results were valid in both seasons. Further, differences were also significant. It seemed that shading also was the cause and effect. These results are also in accordance with those obtained by **Kayhan *et al* (1999)** and **Ibrahim, Sahar (2000)**. The former concluded that leaf area per plant, number of leaves/plant and branching showed a strong positive correlation with Fractional Dimension (FD) of individual legume plant over time, whereas light penetration (% per plant) was negatively correlated with FD.

c. Effect of nitrogen fertilizer levels:

Results in Table (3) indicate that there were gradual and positive increases in both plant height and the average number of branches/plant of peanut with increasing nitrogen fertilizer level. The increases in plant height with the increase in nitrogen fertilizer application from 60 to 90 and 120 Kg N/fed. were 9.34 and 11.54cm. respectively in the first season whereas these increases were 8.15 and 10.10cm. in the second one.

Concerning number of branches/plant the increases in this trait due to the increase in nitrogen fertilizer level were 0.55 and 0.68 in the first season and 0.49 and 0.60 in the second season, respectively.

Table (3): Effect of nitrogen fertilizer levels on some growth traits of peanut in 2003 and 2004 seasons.

Traits / Treatments	Plant height (cm)	No. of branches/plant
N fert. levels (Kg/fed.)	First season 2003	
60	51.79 C	4.29 C
90	61.13 B	4.84 B
120	63.33 A	4.97 A
	Second season 2004	
60	45.02 C	3.87 C
90	53.17 B	4.36 B
120	55.12 A	4.47 A

Furthermore, the statistical analysis revealed significant differences among the treatment imposed. These results were true in both seasons.

Sison and Pava (1990), reported that nitrogen application significantly reduced nodule weight in the intercropped peanuts. Application of 60 Kg N/ha significantly increased growth and delayed flowering. **Abd El-Motaleb and Yousef (1998)** also indicated that the erect cultivar Giza 5 responded to increasing nitrogen fertilizer level from 40 to 80 Kg N/fed. positively and significantly while the semi-spread Giza 4 responded negatively. **Hussein, Samira (2005),** also, found that tallest peanut plants were obtained when the intercrop system received 165 Kg N/fed. Whereas, highest values of number of branches/plant were obtained when half of nitrogen fertilizer dose for maize (62.5 Kg N/fed.) + full dose of N fertilizer for peanut (40Kg N/fed.) were added to the intercrop systems in sandy soil. It seemed that when soil is poor of natural populations of soil rhizobia peanut responded positively to the added nitrogen fertilizer, a condition which is coincided with the soil of the experimental plots in our study.

d. Effect of interactions:

d_1. Interaction effect between intercropping patterns and orientation of maize plants (a × b):

Interaction effect of intercropping pattern and orientation of maize plants on plant height and average number of peanut branches (Table, 4) was significant.

Table (4): Interaction effect between intercropping patterns and orientation of maize plants on some growth traits of peanut in 2003 and 2004 seasons.

Treatments / Traits		Plant height (cm)	No. of branches/plant
Inter. patterns Peanut : Maize	Orient. of maize plants	First season 2003	
100% : 33% (2:1)	35 cm (one plant/hill)	62.53 B	4.22 D
	70 cm (two plants/hill)	50.70 D	5.92 A
100% : 50% (1:1)	35 cm (one plant/hill)	64.52 B	3.88 E
	70 cm (two plants/hill)	52.33 D	5.53 B
100% : 67% (1:2)	35 cm (one plant/hill)	67.65 A	3.50 F
	70 cm (two plants/hill)	54.77 C	5.15 C
		Second season 2004	
100% : 33% (2:1)	35 cm (one plant/hill)	54.90 B	3.80 D
	70 cm (two plants/hill)	44.50 D	5.32 A
100% : 50% (1:1)	35 cm (one plant/hill)	56.25 B	3.47 E
	70 cm (two plants/hill)	45.60 CD	4.98 B
100% : 67% (1:2)	35 cm (one plant/hill)	58.20 A	3.16 F
	70 cm (two plants/hill)	47.17 C	4.67 C

It is also evident that the interaction effect followed the same pattern of change as the main two variables behaved individually. Increases in height of peanut plants were paralleled with increases in maize percent in the association (up to 1:2) pattern and within each intercrop pattern, the narrow spaced maize treatment coupled with one plant/hill had higher peanut plants. On other hand, the trend of the interaction effect on branching followed reversed trend in both seasons and differences were also significant. Interpretation could be explained as to the combined effect of both main variables. However, the interaction effect in both seasons revealed that maximum peanut branching (5.92 and 5.32) was whenever, peanut plants were grown under maize spaced at 70cm. and two plants were kept per hill with least maize density in the (2:1) association (33%).

d_2. Interaction effect between intercropping patterns and nitrogen fertilizer levels (a × c):

Results presented in Table (5) evidenced paralleled gradient and consistent increases in plant height and average number of branches/plant of peanut when maize plant percent increased in the association up to (1:2) pattern (67% of full stand of maize) and in the same time at an increasing level of nitrogen fertilizer level up to 120 Kg N/fed. This trend was valid in both seasons.

The statistical analysis also indicated significant differences. The interaction effect of nitrogen fertilizer level and intercropping patterns revealed that the number of branches of peanut was positively and significantly affected in sandy soils. **(Hussein, Samira *et al* 2002).** It could be concluded that height of peanut plants increased up to the highest (65.93 and 56.80cm.) when maize the shade crop was at its heaviest density (67%) in

Table (5): Interaction effect between intercropping patterns and nitrogen fertilizer levels on some growth traits of peanut in 2003 and 2004 seasons.

Treatments: Inter. patterns Peanut : Maize	N fert. levels (Kg/fed.)	Plant height (cm)	No. of branches/plant
		First season 2003	
100% : 33% (2:1)	60	49.90 F	4.63 C
	90	58.90 D	5.23 A
	120	61.05 B-D	5.35 A
100% : 50% (1:1)	60	51.50 EF	4.30 E
	90	60.78 CD	4.85 B
	120	63.00 BC	4.98 B
100% : 67% (1:2)	60	53.98 E	3.95 F
	90	63.73 AB	4.45 D
	120	65.93 A	4.58 CD
		Second season 2004	
100% : 33% (2:1)	60	43.78 E	4.16 CD
	90	51.71 C	4.70 A
	120	53.62 BC	4.81 A
100% : 50% (1:1)	60	44.87 DE	3.86 E
	90	52.96 BC	4.35 BC
	120	54.94 AB	4.46 B
100% : 67% (1:2)	60	46.41 D	3.58 F
	90	54.85 AB	4.02 DE
	120	56.80 A	4.14 D

the intercrop of the (1:2) association and received 120 Kg N/fed., whereas minimum heights of peanut plants (49.90 and 43.78cm.) were obtained when the maize plots received the lowest dose of

N (60 kg N/fed.) and maize density was at the least (33%) in (2:1) pattern for the two seasons, respectively.

Maximum branching of peanut (5.35 and 4.81) was observed when plots received 120 Kg N/fed. and maize was at the lowest density in (2:1) pattern whereas, minimum branching (3.95 and 3.58) was evident when maize received the lowest dose of N and grown at the heaviest density 67% in (1:2) pattern. It is also interesting to note that peanut branching when plots received the medium dose with lowest density of the shade crop was slightly and insignificantly less than that when the plot received the highest N dose with same maize density indicating the unnecessity of increasing the nitrogen dose to 120 Kg N/fed. to reach the maximum branching.

d_3. Interaction effect between orientation of maize plants and nitrogen fertilizer levels (b × c):

The combined effect of both nitrogen fertilizer level and orientation of maize plant intercropped with peanut on growth of peanut seemed to follow the general tendency of both main variables when they behaved individually (Table 6). The trends were regular and consistent and differences among the treatment imposed were significant, except in case of the average number of branches/plant in the first season and second season when received 90 or 120 Kg N/fed. and maize spaced at 35cm. and one plant/hill was remained. Within each type of maize orientation in the intercrop, values of plant height tended to increase with increasing the level of nitrogen fertilizer up to the highest level (120 Kg N/fed.). Results also revealed that the narrow spaced

Table (6): Interaction effect between orientation of maize plants and nitrogen fertilizer levels on some growth traits of peanut in 2003 and 2004 seasons.

Treatments \ Traits		Plant height (cm)	No. of branches/plant
Orient. of maize plants	N fert. levels (Kg/fed.)	First season 2003	
35 cm (one plant/hill)	60	57.20 C	3.53 E
	90	67.52 B	3.98 D
	120	69.98 A	4.08 D
70 cm (two plants/hill)	60	46.38 E	5.05 C
	90	54.75 D	5.70 B
	120	56.67 CD	5.85 A
		Second season 2004	
35 cm (one plant/hill)	60	49.72 C	3.18 D
	90	58.73 B	3.58 C
	120	60.90 A	3.67 C
70 cm (two plants/hill)	60	40.32 E	4.56 B
	90	47.62 D	5.13 A
	120	49.34 CD	5.27 A

maize, couples with leaving one plant/hill was always associated with higher plants of peanut, rather than the wide spaced maize plants with two plants/hill under the same respective level of nitrogen fertilizer.

On other hand, values of the average number of branches/plant followed reversed trend. The wide spaced maize and leaving two plants/hill had more average number of peanut branches/plant as compared with peanut grown in the intercrop under the narrow spaced maize plants and leaving one plant/hill under the same respective level of nitrogen fertilizer. The interaction results also indicate that maximum peanut branching (5.85 and 5.27) was observed when wide spaced maize plant at 70cm. received the heaviest nitrogen dose, whereas, the minimum value (3.53 and 3.18) was observed when the shade crop was spaced at 35cm. apart and plots received the lowest dose of nitrogen (60 Kg N/fed.).

d_4. Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels ($a \times b \times c$):

The combined effect of the three main variables i.e., intercropping patterns, orientation of maize plant and nitrogen fertilizer levels on both plant height and average number of branches/plant of peanut were also governed by the effect of the three main variables when behaved individually (Table 7). These results were true in both seasons. However, the statistical analysis also revealed significant differences among the treatment imposed.

It is evident that within each intercropping pattern, values of plant height and average number of branches/plant of peanut increased consistently and markedly with increasing the level of nitrogen fertilizer up to the highest level, i.e., 120 Kg N/fed.

These observations hold true in both traits in both seasons. It is also evident, that in case of plant height wide spaced maize plant with two plants/hill was ever lower than the narrow spaced maize plants with one plant/hill within each

Table (7): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on some growth traits of peanut in 2003 and 2004 seasons.

Treatments / Traits			Plant height (cm)	No. of branches/plant	Plant height (cm)	No. of branches/plant
Inter. patterns	Orient. of maize plants	N fert. levels Kg/fed	First season 2003		Second season 2004	
100% : 33% (2:1)	35 cm (one plant/hill)	60	55.10 F-G	3.85 HI	48.36 D-F	3.49 J-L
		90	65.05 C	4.35 F	57.10 C	3.91 HI
		120	67.45 BC	4.45 F	59.24 BC	4.00 H
	70 cm (two plants/hill)	60	44.70 H	5.40 C	39.20 G	4.84 D-F
		90	52.75 G	6.10 A	46.31 F	5.49 AB
		120	54.65 FG	6.25 A	47.99 D-F	5.63 A
100% : 50% (1:1)	35 cm (one plant/hill)	60	56.90 D-F	3.55 J	49.57 D-F	3.16 M
		90	67.10 BC	4.00 GH	58.50 B-C	3.58 JK
		120	69.55 AB	4.10 G	60.68 AB	3.67 IJ
	70 cm (two plants/hill)	60	46.10 H	5.05 D	40.18 G	4.56 F
		90	54.45 FG	5.70 B	47.43 EF	5.12 CD
		120	56.45 D-G	5.85 B	49.20 D-F	5.26 BC
100% : 67% (1:2)	35 cm (one plant/hill)	60	59.60 D	3.20 K	51.24 D	2.88 N
		90	70.40 AB	3.60 J	60.59 AB	3.26 LM
		120	72.95 A	3.70 IJ	62.78 A	3.35 K-M
	70 cm (two plants/hill)	60	48.35 H	4.70 E	41.57 G	4.28 G
		90	57.05 D-F	5.30 C	49.10 D-F	4.79 EF
		120	58.90 DE	5.45 C	50.83 DE	4.93 DE

intercrop pattern, whereas in case of peanut branching the reverse was true in both seasons.

The interaction effect also revealed that peanut height reached maximum when maize was grown at 67% of its full stand in (1:2) pattern, growing maize at 35cm. apart leaving one plant/hill and received 120 Kg N/fed. in both seasons, whereas, minimum height of peanut plants were observed when plots received lowest N dose and the shade crop was orientated at 70cm. apart leaving two plants/hill in (2:1) pattern.

In case of peanut branching, maximum values were obtained when maize was orientated at 70cm. apart with two plants/hill in (2:1) pattern having lowest maize density (33%) with least dose of nitrogen whereas, lowest branching was observed when maize was at its highest density (67%) spaced at 35cm. apart leaving one plant/hill in (1:2) pattern.

2. Yield and yield component traits:

a. Effect of intercropping patterns:

Results in Table (8) indicate clearly that all yield components of peanut were significantly affected by intercropping pattern. The results indicate clearly that highest values of pod number/plant, the average weight of pods/plant, filling percent, weight of seeds/plant and weight of 100-seed were evident when peanut was grown under 33% of full density of maize in (2:1) pattern. These results were true in both seasons.

The results also evidenced that the values of these traits when peanut was grown under maize in the association of (1:1)

Table (8): Effect of intercropping patterns on yield and yield component traits of peanut in 2003 and 2004 seasons.

Treatments / Traits	No. of pods/plant	Weight of pods/plant (g)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
Inter. patterns	First season 2003									
100% : 33% (2:1)	17.45 A	21.51 A	76.13 A	16.32 A	66.68 A	1060 A	1000 A	2060 A	45.38 A	19.05 A
100% : 50% (1:1)	15.60 B	20.41 B	72.23 B	14.69 B	65.78 B	1010 B	950 B	1960 B	45.36 B	19.03 AB
100% : 67% (1:2)	11.50 C	17.32 C	61.25 C	10.57 C	63.27 C	860 C	800 C	1660 C	45.10 C	18.86 B
	Second season 2004									
100% : 33% (2:1)	15.05 A	18.48 A	75.23 A	13.85 A	60.54 A	910 A	850 A	1760 A	45.03 A	18.83 A
100% : 50% (1:1)	13.44 B	17.54 B	71.37 B	12.47 B	59.48 B	850 B	800 B	1650 B	44.84 B	18.70 AB
100% : 67% (1:2)	9.87 C	14.88 C	60.48 C	8.97 C	58.07 C	720 C	670 C	1390 C	44.68 C	18.60 B

pattern i.e., 100% peanut and 50% maize density ranked the second. Whereas, least values of these traits were found when peanut was grown under 67% of maize density in (1:2) pattern.

It is also note worthy mentioning that these values when peanut was grown under highest density of maize in (1:2) pattern were abruptly and sharply decreased as compared when maize the shade crop increased from 33% in (2:1) pattern to 67% in (1:2) pattern.

The effect of intercropping pattern on pod, straw and biological yields/fed. behaved the same as influenced by the intercropping pattern in both seasons. Further the statistical analysis also revealed significant differences among the treatment imposed in both seasons.

Pod yield/fed. when peanut plants were shaded by one third of full maize density (1.6 plant/m^2) was higher than peanut shaded under half of the full density of maize plants (2.4 plant/m^2) by 4.95 and 7.06% in 2003 and 2004 seasons, respectively, and was higher than peanut shaded under the heaviest shading treatment, (two third of full maize density 3.2 plant/m^2) by 23.26 and 26.39% in 2003 and 2004 seasons, respectively. Several investigators support these results such as **Mandimba *et al* (1993)**, **Abd El-Motaleb and Yousef (1998), Metwally *et al* (2005).**

Sherif, Sahar *et al* (2005) examined some intercropping pattern 100% peanut + 25% or 50% or 75% maize. They found that 25% and 50% intercropped maize treatment increased number of pods per peanut plant. Similar trend was observed concerning the effect of these intercropping patterns on weight of seeds of peanut per plant as well as 100-seed weight. Peanut pod yield/fed. was not significantly affected by intercropping maize at 25% of its pure stand while intercropping maize with peanut at 75% of its pure stand affected negatively the pod yield/fed.

Hang *et al* (1984), found that peanut may have one or more period during development when low solar radiation intensity is particularly detrimental to high yield. They studied the effect of shade on vegetative growth, partitioning of assimilates and yield components of peanut. They found that shade during the flowering period reduced the number of flowers per plant and inhibited peg formation, during the pegging and podding phases, reduced total peg and pod number and reduced pod dry weight, whereas, shade during the maturing phase reduced seed fill as shown by reduced filling percent and lower number of fruits. They concluded that on average basis, over all stages, 75% reduction of light intensity decreased the growth rate of vegetative parts by 85%, the reproductive growth rate by 67% and total biomass growth rate by 67%.

Moreover, intercropping considerably improved the Fe nutrition of peanut, partly as a result of an increase in the length and number of lateral roots, the development of rhizodermal transfer cells and an increase in root hair formation in the sub-apical zone of root. Intercropping also maintained the duration of high Fe III reducing capacity in peanut and reduced the number of microorganisms present capable of decomposing either the wacous layer of the root cell surface or the phytosiderophores produced by maize. **(Zuo YuanMei *et al,* 1998).**

The effect of intercropping pattern on oil and crude protein contents followed the general tendency of the treatment effect. There were gradual and consistent decreases with increasing maize density within the intercropping pattern, up to (1:2) pattern. These results were true in both seasons. The treatment effects on oil and crude protein contents were also significant in both seasons. However, interpretation for reduction yields of peanut plants with increasing maize density in the intercrop up to the heaviest (1:2) pattern is feasible as might be due to decreases in assimilation rate as due to increases in shad effect with increasing maize density.

b. Effect of orientation of maize plants:

Results in Table (9) indicate that maize orientation including maize spacing and number of plant/hill had significant effects on yield component traits in both seasons. Values of these traits when maize plants were spaced at 70cm. apart and 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.

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 and Weil (1988)**, support the conclusion that the within-row maize spacing treatments significantly affected light availability to peanut plants. They added that the relationship of shading percent to within-row maize spacing was close and linear, with

Table (9): Effect of orientation of maize plants on yield and yield component traits of peanut in 2003 and 2004 seasons.

Traits / Treatments	No. of pods/plant	Weight of pods/plant (g)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
	First season 2003									
Orient. of maize plants										
35 cm (one plant/hill)	11.87 B	17.35 B	72.67 A	12.73 B	58.54 B	830 B	780 B	1610 B	44.99 B	18.79 B
70 cm (two plants/hill)	17.83 A	22.15 A	67.07 B	14.99 A	71.94 A	1120 A	1050 A	2170 A	45.57 A	19.17 A
	Second season 2004									
35 cm (one plant/hill)	10.22 B	14.90 B	71.80 A	10.81 B	53.27 B	0.71 B	660 B	1370 B	44.57 B	18.53 B
70 cm (two plants/hill)	15.36 A	19.03 A	66.25 B	12.72 A	65.46 A	0.95 A	890 A	1840 A	45.13 A	18.89 A

shading varying from 39% at the 34cm. within-row spacing to 73% at the 13cm. within-row spacing.

In addition **Hardy and 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 peanut. **Nambiar *et al* (1983)**, also found a reduction of 50% or more in the nitrogenase activity of peanut by intercropping peanut with maize planted at 16cm. within-row spacing. Reduction percent diminished with widening distances between maize plants.

The treatment effects on pod, straw and the biological yields/fed. resembled the effect on yield components traits. Moreover, the statistical analysis revealed significant differences in both seasons. The excesses in pod yield/fed. when maize plants were spaced at 70cm. and leaving two plants/hill over those spaced 35cm. and leaving one plant/hill were amounted to 34.94 and 33.80% in 2003 and 2004 seasons, respectively.

Since yield/fed. is a reliable index for the yield component traits, interpretation for superiority of yield with widening distances between hills of the overstory crop might be due to diminishing the adverse effect of shading.

Ibrahim, Sahar (2000) and **Sherif, Sahar *et al* (2005)** reported that the crop yield was also significantly affected by the geometric distribution of the shade crop. The more the shade offered by the overstory crop the less the value of the crop yield. **Liu and Midmore (1990)**, indicated that modification of shade crop population and geometry did influence the spatial variability of solar irradiance intercepted by the understory crop foliage.

The trends and the course of significancy when oil and crude protein percents of peanut seeds were also influenced by the geometric distribution of maize (the shade crop). Wide spacing and growing two maize plants/hill had favorable effects on oil and crude protein in seeds of peanut rather than the narrow spacing and leaving one plant/hill indicating that heavier shading might reduce the photosynthetic metabolites in peanut leaves and consequently metabolites translocation during the seed formation.

c. Effect of nitrogen fertilizer levels:

Results presented in Table (10) indicated that peanut in the intercrop was responsive to nitrogen fertilizer. Moreover, there were ever increases in the values of yield component traits, yields/fed. and crude protein percents in peanut seeds with increasing the level of nitrogen fertilizer. These results were true in both seasons. Furthermore, the statistical analysis revealed significant differences in all these traits. The percent increases in the average number of pod/plant, weight of pod/plant, filling percent, weight of seeds/plant and weight of 100-seed when intercrop plots received 120 Kg N/fed. over those received 60 Kg N/fed. only were estimated to 10.49, 12.53, 5.74,19.01 and 4.98% in the first year and were 10.62, 12.56, 5.88, 19.09 and 4.99% in the second year indicating that the response of the average weight of pods/plant to increases in the level of nitrogen

Table (10): 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)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
N fert. levels (Kg/fed)	First season 2003									
60	14.11 C	18.35 C	67.72 C	12.47 C	63.65 C	900 C	850 C	1750 C	45.73 A	18.69 C
90	14.85 B	20.25 B	70.29 B	14.28 B	65.25 B	1000 B	940 B	1940 B	45.28 B	18.98 B
120	15.59 A	20.65 A	71.61 A	14.84 A	66.82 A	1020 A	960 A	1980 A	44.83 C	19.27 A
	Second season 2004									
60	12.15 C	15.76 C	66.86 C	10.58 C	57.92 C	770 B	720 B	1490 B	45.30 A	18.43 C
90	12.77 B	17.39 B	69.43 B	12.12 B	59.37 B	850 A	800 A	1650 A	44.85 B	18.71 B
120	13.44 A	17.74 A	70.79 A	12.60 A	60.81 A	870 A	810 A	1680 A	44.40 C	18.99 A

fertilizer was highest, whereas, the average number of pods/plant ranked the second in both seasons.

In case of pod, straw and biological yields/fed., the percent increases were estimated to 13.33, 12.94 and 13.14% in first season, whereas they were estimated to 12.99, 12.50 and 12.75% in second season. The response in yield components traits and yield/fed. were supported by several investigators such as **Sison and Pava (1990), Abd El-Motaleb and Yousef (1998), Zhan WeiHua *et al* (1999), Hussein, Samira (2005) and Lanier *et al* (2005).**

Abd El-Motaleb and Yousef (1998), indicate that the erect peanut cultivar Giza 5 responded to increasing N level from 40 to 80 Kg N/fed. positively and significantly. **Zhan WeiHua et al (1999)**, also reported that peanut yield increased with increasing rate of nitrogen from 5.35 to 6.33 t/ha. when maize and peanuts were given 0, 225, 450 or 675 Kg N/ha.

Hussein, Samira (2005) also revealed that maximum yield of peanut pods were obtained when half of nitrogen fertilizer dose for maize (62.5 Kg N/fed.) + full dose of N-fertilizer for peanut (40 Kg N/fed.) were added to intercrop systems.

Lanier *et al* (2005) also reported that pod yield increased linearly as N-rate increased in these experiments.

Lack of significant quadratic and cubic functions suggests that higher rate of nitrogen fertilizer increased yield above the maximum observed than those applied in these experiments (0, 23, 70, 115, 160 and 210 Kg N ha^{-1}). They concluded that additional research is needed to more accurately define yield response to supplemental nitrogen fertilizer and to determine the source of variation in response to both applied N and inoculation the seeds with N-fixing bacteria. **Patra and 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 and 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 and Ratnasinghe (1993) and Senaratne and Gunasekera (1994).**

The results also indicate that there were gradual and consistent increases in crude protein percent in the seed of peanut up to the highest level (120 Kg N/fed.), while the reverse was true in oil percent trait. It is also evident that statistical analysis revealed significant differences for both traits in both seasons. The results were also supported by **Abd El-Motaleb and Yousef (1998)** in case of oil content.

d. Effect of interactions:

d_1. Interaction effect between intercropping patterns and orientation of maize plants (a × b):

Results in Table (11) revealed that the interaction effect of both intercropping pattern and orientation of maize plants on yield and yield component traits of peanut followed the general tendency of the treatment effect of both main variables, when they behaved individually i.e., with diminishing maize percent in association, significant increases in the values of these traits were observed. From another angle of results, values of these traits when growing maize (the shade crop) at 70cm. apart and leaving two plants/hill were always higher than when maize plants were orientated at one plant/hill at 35cm. apart. However, the results obtained also revealed that values of number of pods/plant, weight of pods/plant, weight of seeds/plant and weight of 100-seed/plant reached their maximals when maize percent in the intercrop diminished to one third of its full stand (2:1) and maize was orientated at two plants/hill. On other hand, these values reached their minimals when maize plants increased to maximum in the association and plants were orientated at one plant/hill at 35cm. apart in (1:2) pattern. Little deviation was only observed in filling percent, where the value of this trait was maximized with least percent of maize in the association, but maize was thinned at one plant/hill and maize was spaced at 35cm. apart. These observations were true in both seasons.

Pod, straw and biological yields/fed. behaved the same as peanut yield components were influenced by the interaction treatments. The excesses in pod, straw and biological yields/fed.

Table (11): Interaction effect between intercropping patterns and orientation of maize plants on yield and yield component traits of peanut in 2003 and 2004 seasons.

Treatments: Inter. patterns	Orient. of maize plants	No. of pods/plant	Weight of pods/plant (g)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
		First season 2003									
100% : 33% (2:1)	35 cm (one plant/hill)	14.22 C	18.93 D	79.27 A	15.02 C	59.83 D	900 D	850 D	1750 D	45.09 C	18.86 BC
	70 cm (two plants/hill)	20.68 A	24.10 A	72.99 C	17.61 A	73.52 A	1210 A	1140 A	2350 A	45.67 A	19.24 A
100% : 50% (1:1)	35 cm (one plant/hill)	12.53 D	17.95 E	75.17 B	13.51 D	59.03 E	860 E	810 E	1670 E	45.07 C	18.84 BC
	70 cm (two plants/hill)	18.67 B	22.88 B	69.29 D	15.87 B	72.52 B	1150 B	1080 B	2230 B	45.65 A	19.22 A
100% : 67% (1:2)	35 cm (one plant/hill)	8.87 E	15.18 F	63.56 E	9.66 F	56.77 F	730 F	680 F	1410 F	44.81 D	18.68 C
	70 cm (two plants/hill)	14.13 C	19.46 C	58.93 F	11.49 E	69.77 C	980 C	920 C	1900 C	45.39 B	19.04 AB
		Second season 2004									
100% : 33% (2:1)	35 cm (one plant/hill)	12.24 C	16.26 D	78.35 A	12.75 C	54.31 D	770 D	720 CD	1490 CD	44.75 D	18.64 B-D
	70 cm (two plants/hill)	17.86 A	20.71 A	72.12 C	14.95 A	66.77 A	1040 A	980 A	2020 A	45.31 A	19.02 A
100% : 50% (1:1)	35 cm (one plant/hill)	10.80 D	15.42 E	74.30 B	11.47 D	53.38 E	730 D	690 D	1420 D	44.56 E	18.52 CD
	70 cm (two plants/hill)	16.08 B	19.65 B	68.43 D	13.47 B	65.58 B	970 B	910 B	1890 B	45.12 B	18.88 AB
100% : 67% (1:2)	35 cm (one plant/hill)	7.63 E	13.04 F	62.76 E	8.20 F	52.11 F	620 E	570 E	1190 E	44.39 F	18.42 D
	70 cm (two plants/hill)	12.12 C	16.72 C	58.20 F	9.74 E	64.02 C	830 C	770 C	1600 C	44.97 C	18.78 A-C

when maize plants diminished to the least (33% of its full stand) in 2:1 pattern grown at 70cm. apart and two maize plants/hill were left over pod yield/fed. of peanut plants when maize (the shade crop) increased to 67% of its full stand in (1:2) pattern grown at 35cm. apart with one plant/hill were estimated to 65.75, 67.65 and 66.67% and 67.74, 71.93 and 69.75% in first and second season, respectively.

The interaction effects on oil and crude protein contents in peanut seeds were the same as on yield components of peanut. Interpretation for these symmetric trends as influenced by the interaction effects are mainly confined to the adverse effects of shading which were associated with maize percent in the associations as well as maize orientation as a shade crop in the associations (maize spacing and number of plants/hill). Moreover, **Patra and Poi (1998)** also demonstrated that increasing shading reduced the legume nodulation and N-fixation.

These results are also coincided with observations experienced by our farmers, who noted decreases in peanut yield and yield components with increasing plant density and maize orientation as the overstory crop. On other hand, the statistical analysis revealed significant interaction effects on all yield component traits and peanut yields/fed. in both seasons.

Differences due to the interaction effects on oil and crude protein percents in peanut seeds were also significant in both seasons.

d_2. Interaction effect between intercropping patterns and nitrogen fertilizer levels (a × c):

Results in Table (12) indicate that the interaction effects on yield and yield component of peanut plants were governed by both main variable trend (nitrogen fertilizer level and intercropping pattern) when they affected these traits alone.

Within each intercrop pattern values of the average number of pods/plant, weight of pods/plant, filling percent, weight of seeds/plant and weight of 100-seed gradually increased with increasing the level of nitrogen fertilizer up to 120 Kg N/fed. From another angle of results, values of these traits decreased with increasing maize percent in intercropping pattern (up to 1:2 pattern). These results were true in both seasons. In addition, the trends of the treatment effect on these traits were regular in both seasons and differences among the treatment imposed were significant. The highest values for the above mentioned traits were 18.35, 22.48, 77.94, 17.43 and 68.14, respectively in the first season and 15.79, 19.31, 77.08, 14.81 and 61.87, respectively in the second season. These values were realized when maize was intercropped with peanut by 33% maize in (2:1) pattern and the intercrop plots received 120 Kg N/fed. The interaction effects on pod, straw and biological yields/fed. behaved the same as on the yield component traits, in addition, differences reached the 5% level of significance in both seasons.

However the results showed that maximum yield of pod/fed., straw yield/fed. and the biological yield/fed. were also obtained when peanut received 120 Kg N/fed. when the shading crop

Table (12): Interaction effect between intercropping patterns and nitrogen fertilizer levels on yield and yield component traits of peanut in 2003 and 2004 seasons.

Treatments: Inter. patterns	N fert. levels (Kg/fed)	No. of pods/plant	Weight of pods/plant (g)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
First season 2003											
100% : 33% (2:1)	60	16.55 C	20.03 C	73.96 C	14.74 E	65.21 E	980 D	930 D	1910 C	45.83 A	18.76 CD
	90	17.45 B	22.04 A	76.50 B	16.78 B	66.68 C	1090 AB	1020 AB	2110 A	45.38 C	19.05 A-C
	120	18.35 A	22.48 A	77.94 A	17.43 A	68.14 A	1110 A	1040 A	2150 A	44.93 E	19.33 A
100% : 50% (1:1)	60	14.77 E	18.96 D	70.00 E	13.20 F	64.30 F	940 E	880 E	1820 D	45.81 A	18.74 CD
	90	15.63 D	20.94 B	72.70 D	15.15 D	65.79 D	1030 C	970 C	2000 B	45.35 C	19.03 A-C
	120	16.40 C	21.34 B	74.00 C	15.72 C	67.24 B	1060 BC	990 BC	2050 B	44.91 E	19.32 A
100% : 67% (1:2)	60	11.00 H	16.05 F	59.21 H	9.46 I	61.44 H	790 G	740 G	1530 F	45.55 B	18.57 D
	90	11.48 G	17.77 E	61.66 G	10.90 H	63.27 G	880 F	820 F	1700 E	45.10 D	18.86 B-C
	120	12.02 F	18.15 E	62.88 F	11.36 G	65.10 E	900 F	840 F	1740 E	44.65 F	19.16 AB
Second season 2004											
100% : 33% (2:1)	60	14.27 C	17.21 C	73.07 C	12.51 D	59.21 D	840 BC	790 BC	1630 BC	45.48 A	18.55 C-E
	90	15.09 B	18.93 A	75.55 B	14.23 B	60.54 B	930 A	870 A	1800 A	45.03 D	18.83 A-C
	120	15.79 A	19.31 A	77.08 A	14.81 A	61.87 A	950 A	890 A	1840 A	44.58 G	19.11 A
100% : 50% (1:1)	60	12.70 E	16.29 D	69.06 E	11.19 E	58.15 E	800 CD	750 CD	1540 CD	45.28 B	18.42 DE
	90	13.46 D	17.99 B	71.84 D	12.86 D	59.49 CD	870 A-C	820 A-C	1690 A-C	44.83 E	18.70 B-D
	120	14.16 C	18.33 B	73.20 C	13.35 C	60.81 B	890 AB	840 AB	1730 AB	44.40 H	18.98 AB
100% : 67% (1:2)	60	9.48 H	13.79 F	58.45 H	8.02 H	56.39 F	670 E	610 E	1280 E	45.13 C	18.32 E
	90	9.77 G	15.26 E	60.90 G	9.25 G	58.07 E	740 D	690 D	1440 D	44.68 F	18.60 C-E
	120	10.38 F	15.59 E	62.09 F	9.64 F	59.74 C	760 D	710 D	1470 D	44.23 I	18.89 A-C

percent in the intercrop was at minimum (33%) in (2:1) pattern. It is also evident that differences between maximum pod yield/fed. obtained from peanut plant received the heaviest dose of nitrogen fertilizer (120 kg N/fed.) coupled with lowest density of maize i.e., 33% maize in (2:1) pattern and minimum yield of pods/fed. when peanut plants received lowest dose of nitrogen fertilizer (60 kg N/fed.) and shaded by 67% of full maize density (1:2 pattern) were 40.51 and 41.79% in 2003 and 2004 seasons, respectively.

The interaction effect on oil and crude protein percents in both seasons followed the general tendency of the treatment effect. It is also evident that differences among the treatment imposed reached the 5% level of significance in both seasons.

It could be concluded that the interaction effects evidenced that the nitrogen fertilizer effect was only confined within each intercrop pattern on yield and yield components of peanut but these traits were tenaciously bounded more by the shading effect. These results were congruent with those obtained by **Abd El-Motaleb and Yousef (1998)** and **Hussein, Samira *et al* (2002)**. The latter, demonstrated the least percent of the shade crop (maize) resulted in highest pod yield/fed. as compared with other intercropping patterns.

d_3. Interaction effect between orientation of maize plants and nitrogen fertilizer levels (b × c):

The interaction effects of maize orientation and nitrogen fertilizer levels on yield and yield components of peanut was also governed by the trend of the main variables (nitrogen fertilizer level and maize orientation: maize spacing and number of plants/hill) as they affected these traits alone (Table, 13). The interaction effect on peanut yield components indicate that the values of number of pods/plant, weight of pods/plant, filling percent, weight of seeds/plant and weight of 100-seed increased consistently and remarkably with increasing the rate of nitrogen fertilizer up to the heaviest dose (120 Kg N/fed.) within each orientation system. On other hand, the values of these traits under spacing maize at 70cm. apart and two plants/hill were always higher than those recorded when maize was spaced at 35cm. with one plant/hill, while the reverse was true in case of filling percent under the same respective dose of nitrogen fertilizer.

Pod, straw and biological yields of peanut trends were affected by the interaction of both main variables in the same trend as on yield components of peanut plant. Maximum values of pod yield, straw yield and biological yield were obtained when peanut plants were grown under maize spaced at 70cm. and two plant/hill and plots received 120 Kg N/fed., whereas minimum values of these traits were obtained when peanut plants were grown under maize spaced at 35cm. with one plant/hill and the plots received only 60 Kg N/fed. The excesses were estimated to 51.95, 51.39 and 51.68% for pod, straw and biological yields/fed., respectively in the first season and 52.31, 52.46 and 52.38% for the same respective traits in the second season.

Table (13): Interaction effect between orientation of maize plants and nitrogen fertilizer levels on yield and yield component traits of peanut in 2003 and 2004 seasons.

Orient. of maize plants	N fert. levels (Kg/fed)	No. of pods/plant	Weight of pods/plant (g)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
First season 2003											
35 cm (one plant/hill)	60	11.18 F	16.08 E	70.44 C	11.43 E	57.11 F	770 E	720 D	1490 E	45.44 C	18.50 E
	90	11.87 E	17.81 D	73.10 B	13.12 D	58.54 E	850 D	800 C	1650 D	44.99 E	18.79 D
	120	12.57 D	18.17 D	74.47 A	13.64 C	59.97 D	870 D	820 C	1690 D	44.54 F	19.08 BC
70 cm (two plants/hill)	60	17.03 C	20.61 C	65.01 F	13.51 C	70.20 C	1040 C	970 B	2010 C	46.02 A	18.88 CD
	90	17.83 B	22.69 B	67.47 E	15.43 B	71.95 B	1140 B	1070 A	2210 B	45.57 B	19.17 B
	120	18.82 A	23.14 A	68.74 D	16.03 A	73.67 A	1170 A	1090 A	2260 A	45.12 D	19.46 A
Second season 2004											
35 cm (one plant/hill)	60	9.64 F	13.81 D	69.51 C	9.69 E	51.96 F	650 D	610 D	1260 D	45.01 C	18.24 E
	90	10.24 E	15.30 C	72.24 B	11.14 D	53.27 E	730 C	680 C	1400 C	44.57 E	18.53 D
	120	10.79 D	15.61 C	73.67 A	11.59 C	54.58 D	740 C	700 C	1440 C	44.12 F	18.81 BC
70 cm (two plants/hill)	60	14.66 C	17.71 B	64.21 F	11.46 C	63.87 C	880 B	820 B	1710 B	45.58 A	18.61CD
	90	15.31 B	19.49 A	66.62 E	13.09 B	65.46 B	970 A	910 A	1880 A	45.13 B	18.89 B
	120	16.10 A	19.88 A	67.92 D	13.60 A	67.03 A	990 A	930 A	1920 A	44.69 D	19.17 A

d$_4$. Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels (a × b × c):

Results presented in Table (14) and Fig. (1) revealed the combined effect of the interaction of the three main variables (intercrop pattern, orientation of the shade crop and the nitrogen fertilizer level) followed the general tendency of the three main variables when behaved alone. These trends were evident in both seasons. Values of all yield components traits increased consistently and remarkably with increasing nitrogen fertilizer dose up to the heaviest, i.e., 120 Kg N/fed. within each maize orientation of the shade crop. On other hand, the values of these traits when maize plants were orientated at 70cm. apart with two plants/hill were higher than those when maize plant were spaced at 35cm. and leaving one plant/hill under the same respective dose of nitrogen, while the reverse was true in case of filling percent trait. The third angle of results revealed that the values of these traits were higher in (2:1) pattern, medium in (1:1) pattern and lowest in (1:2) pattern when comparisons were held under same respective orientation level and nitrogen fertilizer level.

Pod, straw and the biological yields followed the same pattern of change as influenced by the combined interaction of the three main variables.

Crude protein percent in peanut seeds followed also the same pattern of change while oil percent values increased with diminishing nitrogen fertilizer level and when maize plants were spaced at 70cm. apart with leaving two plants/hill.

Table (14): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on yield and yield component traits of peanut in 2003 and 2004 seasons.

Inter. patterns	Orient. of maize plants	N fert. levels Kg/fed	No. of pods/plant	Weight of pods/plant (g)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
			First season 2003									
100% : 33% (2:1)	35 cm (one plant/hill)	60	13.40 H	17.58 I	77.02 C	13.54 G	58.48 M	830 J	790 IJ	1620 J	45.54 D	18.57 EF
		90	14.20 G	19.40 FG	79.64 B	15.45 E	59.83 K	930 GH	870 GH	1800 GH	45.09 H	18.86 B-F
		120	15.05 F	19.80 EF	81.16 A	16.07 D	61.17 I	950 G	890 G	1840 G	44.64 K	19.15 A-D
	70 cm (two plants/hill)	60	19.70 C	22.48 C	70.91 H	15.94 DE	71.94 E	1130 D	1060 D	2190 D	46.12 A	18.96 B-E
		90	20.70 B	24.68 A	73.36 F	18.11 B	73.53 C	1240 AB	1170 AB	2410 AB	45.67 C	19.24 A-C
		120	21.65 A	25.15 A	74.71 E	18.79 A	75.10 A	1270 A	1190 A	2460 A	45.22 FG	19.52 A
100% : 50% (1:1)	35 cm (one plant/hill)	60	11.75 J	16.64 J	72.90 G	12.13 H	57.70 N	800 JK	750 JK	1550 JK	45.52 D	18.55 EF
		90	12.55 I	18.42 H	75.62 D	13.93 FG	59.03 L	880 I	830 HI	1710 I	45.07 H	18.84 B-F
		120	13.30 H	18.78 GH	77.00 C	14.46 F	60.35 J	900 HI	850 GH	1750 HI	44.62 K	19.13 A-D
	70 cm (two plants/hill)	60	17.80 E	21.28 D	67.10 J	14.28 F	70.90 F	1070 E	1010 E	2080 E	46.11 A	18.93 B-E
		90	18.70 D	23.46 B	69.78 I	16.37 D	72.54 D	1180 C	1110 V	2290 C	45.64 C	19.22 A-C
		120	19.50 C	23.90 B	71.00 H	16.97 C	74.13 B	1210 BC	1130 BC	2340 BC	45.20 G	19.51 A
100% : 67% (1:2)	35 cm (one plant/hill)	60	8.40 M	14.02 L	61.40 M	8.61 J	55.14 P	670 M	630 M	1300 M	45.26 F	18.39 F
		90	8.85 L	15.60 K	64.04 L	9.99 I	56.77 O	750 L	700 L	1450 L	44.81 J	18.68 D-F
		120	9.35 K	15.92 JK	65.25 K	10.39 I	58.40 M	760 KL	720 KL	1480 KL	44.36 L	18.97 B-E
	70 cm (two plants/hill)	60	13.60 H	18.08 HI	57.01 P	10.31 I	67.75 H	910 G-I	850 GH	1760 G-I	45.84 B	18.74 C-F
		90	14.10 G	19.94 EF	59.27 O	11.82 H	69.77 G	1010 F	940 F	1950 F	45.39 E	19.04 A-E
		120	14.70 F	20.37 E	60.52 N	12.33 H	71.79 E	1030 EF	960 F	1990 F	44.94 I	19.34 AB

Table (14): Continued.

Inter. patterns	Orient. of maize plants	N fert. levels Kg/fed	No. of pods/plant	Weight of pods/plant (g)	Filling (%)	Weight of seeds/ plant (g)	Weight of 100-seed (g)	Pod yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
			Second season 2004									
100% : 33% (2:1)	35 cm (one plant/hill)	60	11.57 HI	15.10 J	76.09 C	11.49 G	53.10 J	710 H-K	670 G-J	1380 G-J	45.20 E	18.35 F-H
		90	12.27 G	16.66 GH	78.64 B	13.10 E	54.31 H	790 F-I	740 F-H	1530 F-H	44.75 I	18.64 C-H
		120	12.88 F	17.01 FG	80.30 A	13.66 D	55.52 G	810 E-H	760 E-G	1570E-G	44.30 M	18.93 A-E
	70 cm (two plants/hill)	60	16.97 C	19.31 D	70.05 H	13.53 DE	65.31 D	970 B-D	910 B-D	1890 B-D	45.76 A	18.75 B-F
		90	17.92 B	21.20 AB	72.45 F	15.36 B	66.77 B	1060 AB	1010 AB	2070 AB	45.31 D	19.02 A-D
		120	18.71 A	21.60 A	73.86 E	15.96 A	68.22 A	1090 A	1030 A	2110 A	44.86 H	19.29 A
100% : 50% (1:1)	35 cm (one plant/hill)	60	10.14 K	14.29 K	71.82 G	10.27 H	52.17 K	680 I-K	640 H-J	1310 H-J	45.00 G	18.24 GH
		90	10.83 J	15.83 IJ	74.82 D	11.84 FG	53.38 IJ	750 G-J	710 F-J	1450 F-I	44.56 K	18.52 D-H
		120	11.44 I	16.13 HI	76.27 C	12.30 F	54.59 H	770 F-I	720 F-I	1490 F-H	44.12 N	18.80 A-F
	70 cm (two plants/hill)	60	15.27 E	18.28 E	66.30 J	12.12 F	64.12 E	910 C-E	860 C-E	1780 C-E	45.57 B	18.60 C-H
		90	16.10 D	20.15 C	68.87 I	13.88 D	65.59 CD	990 A-C	930 A-C	1920 A-C	45.11 F	18.88 A-E
		120	16.88 C	20.53 BC	70.12 H	14.40 C	67.03 B	1020 A-C	950 A-C	1970 A-C	44.68 J	19.16 AB
100% : 67% (1:2)	35 cm (one plant/hill)	60	7.22 N	12.04 M	60.61 M	7.30 J	50.61 L	570 L	520 K	1090 K	44.84 H	18.14 H
		90	7.61 M	13.40 L	63.25 L	8.47 I	52.11 K	640 J-L	590 JK	1230 JK	44.39 L	18.42 E-H
		120	8.05 L	13.68 KL	64.43 K	8.81 I	53.61 I	640 J-L	610 I-K	1250 I-K	43.94 O	18.70 B-G
	70 cm (two plants/hill)	60	11.75 HI	15.53 IJ	56.29 P	8.74 I	62.17 F	770 F-I	700 F-J	1460 F-I	45.42 C	18.49 E-H
		90	11.92 GH	17.13 FG	58.55 O	10.03 H	64.03 E	850 E-G	790 EF	1640 EF	44.97 G	18.78 B-F
		120	12.70 F	17.50 F	59.76 N	10.46 H	65.86 C	870 D-F	810 D-F	1680 D-F	44.52 K	19.07 A-C

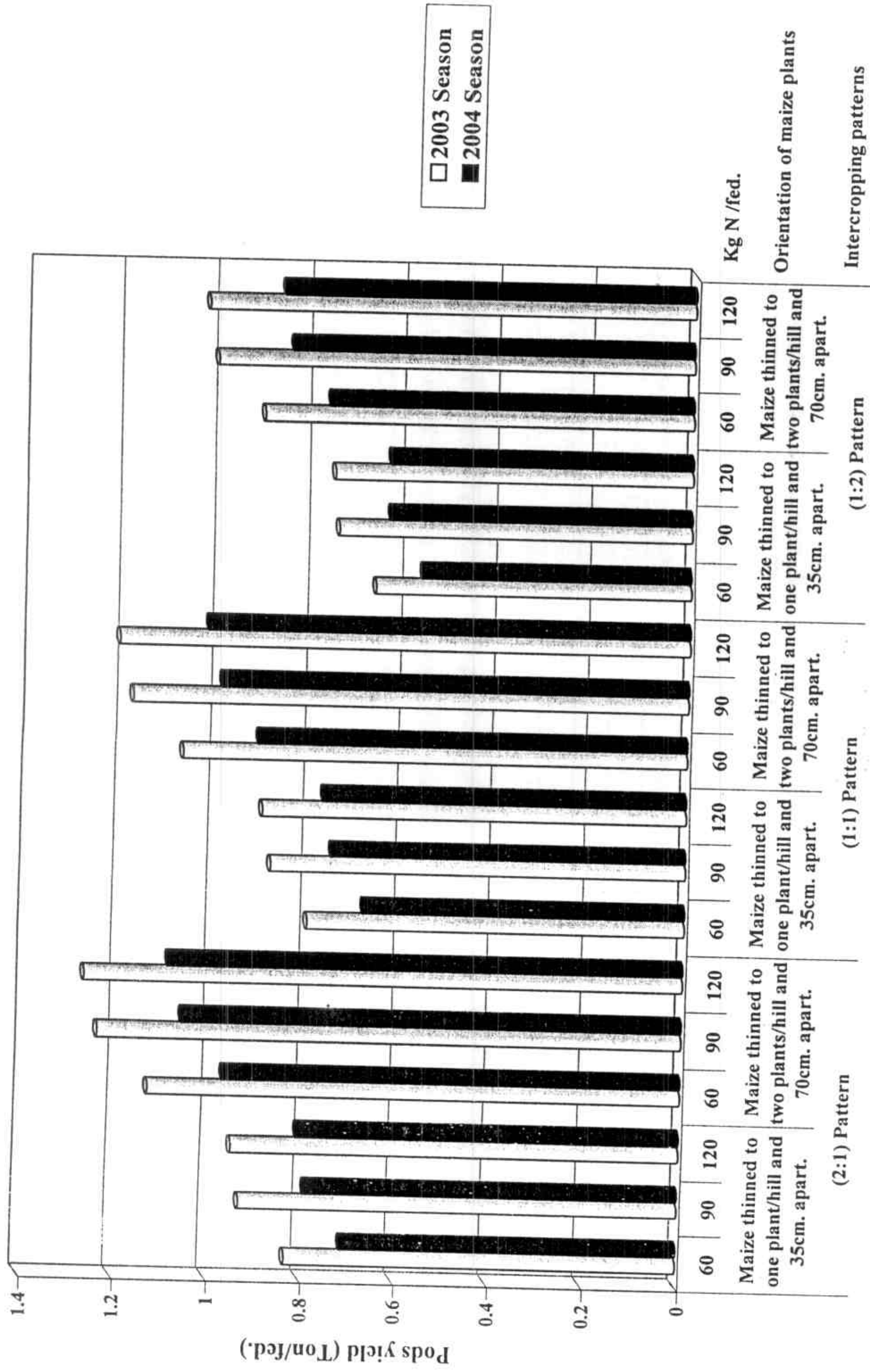

Fig. (1): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on yield of peanut in 2003 and 2004 seasons.

Interaction results revealed that maximum pod, straw and biological yields/fed. were recorded when peanut plants received 120 Kg N/fed. and grown under 33% of full stand maize (as the shade crop) in (2:1) pattern orientated at 70cm. apart leaving two plants/hill, whereas, minimum yields were obtained when peanut plants received lowest nitrogen fertilizer dose (60 Kg N/fed.) and grown under heaviest maize density (67% of full stand) in (1:2) pattern where maize plants were oriented at 35cm. apart leaving one plant/hill. Excesses in these traits namely, pod, straw and biological yields over the lowest value were estimated to 89.55, 88.89 and 89.23% in the first season and 91.23, 98.08 and 93.58% in the second season, respectively.

B. Maize.

1. Growth traits:

a. Effect of intercropping patterns:

Results in Table (15) indicate that both tasseling and silking (measured as the average number of days to 50% tasseling or silking) were slightly affected by the intercrop pattern in both seasons. The results indicate that the average number of days to 50% tasseling or silking tended to increase with increasing maize density in the intercrop. Increasing maize density from 33% in (2:1) pattern to 50% of full stand maize in (1:1) pattern to 67% of full stand maize in (1:2) pattern delayed tasseling and silking traits. Interpretation for the slight delay might owe much to more plant to plant competition **(Intra-specific competition)** with increasing maize density in the intercrop that led to reduction in photosynthetic activity and

Table (15): Effect of intercropping patterns on some growth traits of maize in 2003 and 2004 seasons.

Traits / Treatments	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)
	Tasseling	Silking				
Inter. patterns Peanut : Maize	First season 2003					
100% : 33% (2:1)	60.33 B	62.96 C	215.44 C	92.73 C	1.98 A	594.64 A
100% : 50% (1:1)	60.58 AB	63.63 B	217.80 B	97.39 B	1.89 A	570.89 B
100% : 67% (1:2)	60.83 A	64.46 A	220.16 A	102.05 A	1.80 A	547.14 C
	Second season 2004					
100% : 33% (2:1)	58.83 B	61.46 C	229.21 C	107.85 C	2.02 A	684.08 A
100% : 50% (1:1)	59.08 AB	62.13 B	242.65 B	109.68 B	1.93 A	646.93 B
100% : 67% (1:2)	59.33 A	62.96 A	256.08 A	111.50 A	1.84 A	609.78 C

retardation in plant developing to transfer to the reproductive organs. These interpretations were coincided with those reported by **Shams (2002)**.

At 75 days from planting, maize height increased with increasing maize density in intercrop. Therefore, maize height increased in (1:2) pattern (220.16 and 256.08cm.) where the shade crop grown at 67% of its full density more than in (1:1) pattern (217.80 and 242.65cm.) where maize was grown at 50% of its full density and more than in (2:1) pattern (215.44 and 229.21cm.) where maize was grown at 33% of its full density, respectively in both seasons. It has been demonstrated that plant height increased with increasing plant density. Competition for light among plants intercepted by foliage which in turn resulted in elongation of stem internodes might be the cause and effect. These results and conclusions were in agreement with those obtained by **Kamel *et al* (1990)** and **Shams (2002)**.

Also the effect of intercropping patterns on topmost ear height followed the general trend of maize height. The results indicate that there was gradual increase in the topmost ear height with increasing plant density in the intercrop. Therefore, topmost ear height in (1:2) intercrop pattern (102.05 and 111.50cm.) were more than that in (1:1) pattern (97.39 and 109.68cm.) and (2:1) pattern (92.73 and 107.85cm.), respectively. These observations were valid in both seasons. It seemed that this trait was governed genetically rather than influenced by the environmental factors and eventually was tenaciously associated with maize height in the different intercropping patterns. Several investigators supported these observations such, **Ibrahim, Sahar (2000)**,

Shams (2002), Hussein, Samira (2005) and **Sherif, Sahar *et al* (2005).**

The effect of intercropping pattern on stem diameter was reversed. The results indicate that with increasing maize density in the intercropping pattern gradually tended to decrease stem diameter up to the heaviest maize density in the intercrop (67% of full stand maize in 1:2 pattern). These observations were also true in both seasons. The low irradiance within dense canopy of maize might explain the stimulation of stem to elongate rather than stem diameter to enlarge. These results are in agreement with those obtained by **Abdul-Galil *et al* (1990)** who indicated that high density of maize gave taller and thinner plants with higher first ear than light sown one.

Leaf area of topmost ear was influenced by the intercropping pattern. The trend was similar to the effect on stem diameter. The results indicate that there were gradual declines in leaf area of topmost ear with increasing maize density in the intercrop pattern up to the heaviest density i.e., (1:2) where maize was at 67% of its full stand. These results were true in both seasons and were in accordance with those obtained by **Ibrahim and Abd El-Maksoud (2001)**. The increase in leaf area of topmost ear with low density of maize is expected and could be attributed much to less competition between plants for sun irradiance which in turn led to increases in the photosynthetic surface of leaf.

Maize plant densities in both systems were 23200 plants/fed. Her result revealed that bed method gave the highest values of stem diameter, leaf area/plant. **Sherif, Sahar *et al* (2005)** examined four densities of the shade crop at differing geometric distribution. They reported that dense planting resulted in higher growth and yield of maize whether by narrowing maize spacing or increasing the number of maize plants per hill after thinning. The results also evidenced that rectangularity increased with widening distances between maize plants (from 35cm. apart to 70cm. apart). It seemed that maize geometry per unit area could play an important role in optimizing the favorable condition predisposed by the arrangement. Similar conclusion has been previously reached by **Francis *et al* (1978), Khalil (1994)** and **Ibrahim, Sahar (2000)**. **Olasantan (1988)** also reported that growth and yield of maize increased with squarcity in both intercropping systems due to more irradiance penetration and light intercepted by maize foliage in dense planting.

c. Effect of nitrogen fertilizer levels:

Results in Table (17) indicate that number of days to 50% tasseling and silking was significantly affected by increasing nitrogen fertilizer level added to maize plants. The more the nitrogen fertilizer dose added to maize plant, the less the number of days to both tasseling and silking were. These observations hold true in both seasons. Tasseling was ever earlier than silking under any nitrogen fertilizer level (by three days earlier). Reduction in the values of both traits with increasing nitrogen

Table (17): Effect of nitrogen fertilizer levels on some growth traits of maize in 2003 and 2004 seasons.

Traits / Treatments	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)
	Tasseling	Silking				
N fert. levels (Kg/fed)	First season 2003					
60	62.50 A	65.79 A	206.27 C	88.70 C	1.77 A	526.33 C
90	61.00 B	64.13 B	221.62 B	101.16 B	1.89 A	566.43 B
120	58.25 C	61.13 C	225.50 A	102.31 A	2.01 A	619.92 A
	Second season 2004					
60	61.00 A	64.29 A	230.28 C	99.58 C	1.80 B	590.68 C
90	59.50 B	62.63 B	246.74 B	113.94 B	1.93 AB	641.31 B
120	56.75 C	59.63 C	250.92 A	115.51 A	2.06 A	708.81 A

fertilizer dose up to the heaviest is plausible, since the role of nitrogen in enhancing growth stages is not arguable and has been reported by numerous investigators. However, these results are in agreement with those obtained by **El-Wakil (2002) and Shams (2002)**.

The effect of increasing nitrogen fertilizer level on plant height, topmost ear height, stem diameter and leaf area of topmost ear was always positive. All values of these traits increased with increasing nitrogen fertilizer dose up to the highest level. The results also revealed that differences were also significant, except, in case of stem diameter in the first season. The increases in plant height were 15.35 and 16.46cm. and 19.23 and 20.64cm. due to increasing nitrogen fertilizer level from 60 to 90 and 120 Kg N/fed., respectively in the two seasons. They were 12.46 and 14.36cm. and 13.61 and 15.93cm. in topmost ear height and 0.12 and 0.13cm.% and 0.24 and 0.26cm. in stem diameter and 40.10 and 50.63cm^2 and 93.59 and 118.13cm^2 in leaf area of topmost ear for the mentioned nitrogen fertilizer levels, respectively. These results were valid in both seasons and were in agreement with those obtained by **El-Gizawy (2000), El-Douby *et al* (2001) and El-Wakil (2002)**.

d. Effect of interactions:

d_1. Interaction effect between intercropping patterns and orientation of maize plants (a × b):

The interaction effect between intercropping patterns and orientation of maize plants on the average number of days to 50% tasseling and silking followed in general the same trend of both main variables when they are alone. However the results in Table (18) indicate that when maize was orientated at 35cm. apart and one maize plant were left in (1:2) pattern where maize density was at 67% of its full stand, tasseling (61.08 and 59.58 day) and silking (64.83 and 63.33) delayed to maximum, whereas minimum values of these traits were obtained when maize plants were spaced at 70cm. and leaving two plant/hill in (2:1) pattern and maize density was at 33% of its full stand, in both seasons.

Hussein, Samira *et al* (2002) found that reduction in number of days to 50% tasseling was observed when maize population density decreased from 50 to 33% of maize stand. It seemed also, that increasing spacing of the shade crop to 70cm. apart and leaving two plants/hill and diminishing maize density to 33% in (2:1) pattern reduced time taken for developing canopies to intercept all the incoming radiation.

At 75 days from planting, maize plant height was governed by the interaction effect of both main variables when behaved alone. Within each orientation, the narrow spaced maize increased plant height in all the intercrop patterns. On other hand, maize height increased by maize percent increases in the intercrop patterns. These observations seemed conspicuous in both seasons. The reason, in explicit, might owe much to the effect of the degree of shading associated with different intercropping pattern as well as maize orientation. The tallest plants (221.55 and 259.17cm.) were obtained when maize plants were intercropped with peanut under 1:2 pattern with spacing at 35cm. leaving one plant/hill. Topmost ear height followed the

Table (18): Interaction effect between intercropping patterns and orientation of maize plants on some growth traits of maize in 2003 and 2004 seasons.

Treatments: Inter. patterns Peanut : Maize	Orient. of maize plants	No. of days to 50% Tasseling	No. of days to 50% Silking	Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)
First season 2003							
100% : 33% (2:1)	35 cm (one plant/hill)	60.58 BC	63.33 C	216.78 C	93.56 E	2.00 A	612.63 A
	70 cm (two plants/hill)	60.08 D	62.58 D	214.10 D	91.91 F	1.95 A	576.65 C
100% : 50% (1:1)	35 cm (one plant/hill)	60.83 AB	64.00 B	219.17 B	98.26 C	1.91 A	588.27 B
	70 cm (two plants/hill)	60.33 CD	63.25 C	216.42 C	96.52 D	1.87 A	553.52 E
100% : 67% (1:2)	35 cm (one plant/hill)	61.08 A	64.83 A	221.55 A	102.97 A	1.82 A	563.90 D
	70 cm (two plants/hill)	60.58 BC	64.08 B	218.77 B	101.14 B	1.78 A	530.38 F
Second season 2004							
100% : 33% (2:1)	35 cm (one plant/hill)	59.08 A-C	61.83 C	231.98 E	108.88 C	2.05 A	694.30 A
	70 cm (two plants/hill)	58.58 C	61.08 D	226.43 F	106.82 D	1.99 A	673.85 B
100% : 50% (1:1)	35 cm (one plant/hill)	59.33 AB	62.50 B	245.58 C	110.72 B	1.96 A	656.72 C
	70 cm (two plants/hill)	58.83 BC	61.75 C	239.72 D	108.63 C	1.90 A	637.15 D
100% : 67% (1:2)	35 cm (one plant/hill)	59.58 A	63.33 A	259.17 A	112.57 A	1.87 A	619.15 E
	70 cm (two plants/hill)	59.08 A-C	62.58 B	252.98 B	110.43 B	1.81 A	600.42 F

general tendency of the interaction effect on maize height, indicating that both traits were genetically associated. **Hussein, Samira** ***et al*** **(2002)** supported these results.

Stem diameter was also influenced by interaction effect. The trend was distinctive, stem diameter was less when maize was spaced at 70cm. apart leaving two plants/hill than maize spaced at 35cm. and leaving one plant/hill, however, values of stem diameter decreased with increasing plant density of the shade crop up to 67% in pattern (1:2). It is evident that the treatment effect on stem diameter was governed also by maize density.

The results were in accordance with those obtained by **Ibrahim, Sahar (2000) and Hussein, Samira (2005)**.

Leaf area of topmost ear was also influenced by the interaction effect and was associated with maize density by the shade crop. The results indicate that leaf area of topmost ear when maize plants were spaced at 35cm. apart and one plant was left per hill in 2:1 pattern (612.63 and 694.30.68 cm^2) was larger than maize plants were spaced at 70cm. apart and two plants/hill were left in 1:2 pattern (530.38 and 600.42 cm^2), respectively in both seasons. This result might be due to sever competition when leaving two plants/hill. On other hand, values tended to decrease with increasing maize density in the intercrop up to 67% of its full density at the same respective maize orientation. These observations were also true in both seasons.

d_2. Interaction effect between intercropping patterns and nitrogen fertilizer levels (a × c):

Both intercropping pattern and nitrogen fertilizer level had significant effect on the studied growth traits (Table, 19). The interaction results revealed that within each intercropping pattern both tasseling and silking have got earlier with increasing nitrogen fertilizer level up to the highest level (120Kg N/fed.). These results were true in both seasons. Differences among the treatments were also significant in both seasons. On other hand, in almost cases, values of both traits increased consistently with increasing maize density in the intercrop under same respective level of nitrogen fertilizer. The results indicate that last tasseling (62.75 and 61.25 day) and silking (66.63 and 65.13 day) were observed when maize received lowest dose of nitrogen fertilizer in (1:2) pattern where maize was grown at the heaviest density (67% of it full stand) whereas earliest tasseling (58.00 and 56.50 day) and silking (60.38 and 58.88 day) were observed when maize received heaviest dose of nitrogen fertilizer (120 Kg N/fed.) and maize was grown at its lowest density in the intercrop (2:1) i.e., 33% of its full stand.

Plant height, topmost ear height, stem diameter and leaf area of topmost ear increased consistently with increasing nitrogen fertilizer level up to the heaviest within any intercrop pattern. On other hand, values of these traits increased gradually with increasing maize density in the intercrop up to the highest (2:1) <(1:1) <(1:2) except in case of stem diameter and leaf area of topmost ear where they behaved the reverse. These results were true in both seasons. Moreover, differences were ever

Table (19): Interaction effect between intercropping patterns and nitrogen fertilizer levels on some growth traits of maize in 2003 and 2004 seasons.

Treatments / Traits		No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)
		Tasseling	Silking				
Inter. patterns Peanut : Maize	N fert. levels (Kg/fed)	First season 2003					
100% : 33% (2:1)	60	62.25 A	65.13 C	204.04 F	84.46 I	1.85 A	548.50 F
	90	60.75 B	63.38 E	219.22 D	96.32 F	1.98 A	590.03 D
	120	58.00 C	60.38 H	223.05 C	97.41 E	2.11 A	645.40 A
100% : 50% (1:1)	60	62.50 A	65.63 B	206.27 EF	88.68 H	1.77 A	526.33 H
	90	61.00 B	64.13 D	221.62 C	101.17 D	1.89 A	566.43 E
	120	58.25 C	61.13 G	225.50 B	102.31 C	2.01 A	619.93 B
100% : 67% (1:2)	60	62.75 A	66.63 A	208.50 E	92.95 G	1.69 A	504.15 I
	90	61.25 B	64.88 C	224.02 BC	106.00 B	1.80 A	542.85 G
	120	58.50 C	61.88 F	227.95 A	107.21 A	1.92 A	594.43 C
		Second season 2004					
100% : 33% (2:1)	60	60.75 A	63.63 BC	217.53 I	97.93 G	1.88 A	625.35 F
	90	59.25 B	61.88 E	233.08 G	112.03 D	2.02 A	678.20 C
	120	56.50 C	58.88 H	237.03 F	113.60 C	2.15 A	748.68 A
100% : 50% (1:1)	60	61.00 A	64.13 B	230.28 H	99.58 F	1.80 A	590.68 H
	90	59.50 B	62.63 D	246.75 D	113.95 C	1.93 A	641.33 E
	120	56.75 C	59.63 G	250.93 C	115.50 B	2.06 A	708.80 B
100% : 67% (1:2)	60	61.25 A	65.13 A	243.03 E	101.23 E	1.72 A	556.00 I
	90	59.75 B	63.38 C	260.40 B	115.85 B	1.84 A	604.40 G
	120	57.00 C	60.38 F	264.80 A	117.43 A	1.96 A	668.95 D

significant, except, in case of stem diameter wherein, differences did not reach the 5% level of significance in both seasons. The results also indicate the highest value of plant height (227.95 and 264.80cm.) and topmost ear height (107.21 and 117.43cm.) were observed when maize plant received heaviest dose of nitrogen fertilizer per feddan (120 Kg N/fed.) in (1:2) pattern, wherein maize was grown at the heaviest density (67% of it full stand), whereas, the lowest values of these traits were observed when maize plants received the lowest dose of nitrogen fertilizer (60 Kg N/fed.) as well as lowest maize density in (2:1) pattern wherein maize was grown at 33% of its full density.

In case of leaf area of topmost ear, the greatest leaf area of topmost ear (645.40 and 748.68 cm^2) was observed when maize was grown in (2:1) pattern having lowest density (33%) and the plants received 120 Kg N/fed. whereas minimum value was obtained when maize was grown in (1:2) pattern with highest maize density (67%) and the plants received 60 Kg N/fed. in both seasons.

It could be concluded that both main variables had its own effectiveness on growth traits which regulate the interaction effect, since no uniform trend over dominated the interaction.

d_3. Interaction effect between orientation of maize plants and nitrogen fertilizer levels (b × c):

Tasseling and silking were also statistically influenced by the interaction effect of both orientation the shade crop and nitrogen fertilizer level added to the maize plants (Table, 20). The results revealed the effectiveness of increasing nitrogen

Table (20): Interaction effect between orientation of maize plants and nitrogen fertilizer levels on some growth traits of maize in 2003 and 2004 seasons.

Treatments / Traits		No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)
		Tasseling	Silking				
Orient. of maize plants	N fert. levels (Kg/fed)	First season 2003					
35 cm (one plant/hill)	60	62.75 A	66.17 A	207.56 D	89.69 D	1.79 A	542.55 E
	90	61.25 C	64.50 C	223.00 B	101.64 B	1.91 A	583.70 C
	120	58.50 E	61.50 E	226.93 A	103.45 A	2.03 A	638.55 A
70 cm (two plants/hill)	60	62.25 B	65.42 B	204.98 E	87.70 E	1.75 A	510.10 F
	90	60.75 D	63.75 D	220.24 C	100.69 C	1.87 A	549.17 D
	120	58.00 F	60.75 F	224.07 B	101.17 BC	1.99 A	601.28 B
		Second season 2004					
35 cm (one plant/hill)	60	61.25 A	64.67 A	233.05 E	100.22 D	1.83 A	599.82 E
	90	59.75 B	63.00 C	249.73 B	115.68 A	1.96 A	651.03 C
	120	57.00 C	60.00 E	253.95 A	116.27 A	2.09 A	719.32 A
70 cm (two plants/hill)	60	60.75 A	63.92 B	227.50 F	98.93 E	1.77 A	581.53 F
	90	59.25 B	62.25 D	243.75 D	112.20 C	1.90 A	631.58 D
	120	56.50 C	59.25 F	247.88 C	114.75 B	2.02 A	698.30 B

fertilizer level as well as the orientation of the shade crop. It is evident that increasing nitrogen fertilizer level with each maize orientation has led to decrease number of days to 50% tasseling and silking in both seasons. On other hand, values of these traits when maize was orientated at 35cm. apart and one plant/hill was kept were in most cases higher than when maize was orientated at 70cm. apart with two plants/hill under same respective dose of nitrogen fertilizer.

The interaction results also revealed that the latest tasseling (62.75 and 61.25 day) and silking (66.17 and 64.67 day) were observed when maize was spaced at 35cm. apart with one plant/hill and received the lowest rate of nitrogen fertilizer (60 Kg N/fed.) whereas earliest tasseling (58.00 and 56.60 day) and silking (60.75 and 59.25 day) were observed when maize spaced at 70cm. apart with two plants/hill and received the highest rate of nitrogen fertilizer (120 Kg N/fed.). These observations were true in both seasons.

Plant height, topmost ear height and leaf area of topmost after 75 days from planting ear were influenced by interaction effect of both main variables in the same way as they behaved individually. Increases were observed in the values of these traits with increasing the nitrogen fertilizer level added to maize plant, but relatively higher when maize was grown at 35cm. apart with one plant/hill. From another angel of results highest values of plant height (226.93 and 253.95cm.), topmost ear height (103.45 and 116.27cm.) and leaf area of topmost ear (638.55 and 719.32cm^2) were observed when maize received the highest nitrogen fertilizer dose and maize was spaced at 35cm. apart with one plant/hill whereas minimum values were observed when maize was spaced at 70cm. with two plants/hill and received lowest dose of nitrogen fertilizer (60 Kg N/fed.).

The interaction effect on stem diameter was insignificant in both seasons.

It could be concluded that both increasing the level of nitrogen fertilizer and orientation the shade crop affects growth character of maize plants. Another interesting observation is the diminution of plant height (204.98 and 227.50cm.), topmost ear height (87.70 and 98.93cm) and leaf area of topmost ear (510.10 and 581.53cm^2) with widening maize spacing probably due to plant to plant competition when leaving two plants per hill in this system.

d_4. Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels (a × b × c):

The combined interaction effect of the three main variables (intercropping pattern, orientation of shade crop and nitrogen fertilizer levels) followed the general trends of the three main variables when behaved individually (Table, 21). The interaction effect followed the three conventional trends of the three main variables, i.e., there were increases in the values of plant height, topmost ear height, stem diameter and leaf area of topmost ear with increasing the nitrogen fertilizer level up to the heaviest (120 Kg N/fed.), decreases when maize was spaced at 70cm. with two plants/hill as compared with maize spaced at 35cm. leaving one plant/hill within the three intercropping

Table (21): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on some growth traits of maize in 2003 and 2004 seasons.

Treatments		Traits	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)
			Tasseling	Silking				
Inter. patterns	Orient. of maize plants	N fert. levels Kg/fed	First season 2003					
100% : 33% (2:1)	35 cm (one plant/hill)	60	62.50 AB	65.50 CD	205.30 JK	85.41 K	1.87 A	565.30 J
		90	61.00 EF	63.75 G	220.58 F-H	96.76 F	2.00 A	607.90 E
		120	58.25 GH	60.75 K	224.46 B-E	98.50 E	2.13 A	664.70 A
	70 cm (two plants/hill)	60	62.00 B-D	64.75 EF	202.78 K	83.52 L	1.83 A	531.70 N
		90	60.50 F	63.00 H	217.86 H	95.88 F	1.95 A	572.15 I
		120	57.75 H	60.00 L	221.45 E-G	96.32 F	2.08 A	626.10 C
100% : 50% (1:1)	35 cm (one plant/hill)	60	62.75 AB	66.00 BC	207.58 IJ	89.68 I	1.79 A	542.55 M
		90	61.25 D-F	64.50 F	223.00 C-G	101.66 D	1.91 A	583.70 G
		120	58.50 GH	61.50 J	226.93 A-B	103.45 C	2.03 A	638.55 B
	70 cm (two plants/hill)	60	62.25 A-C	65.25 DE	204.96 JK	87.69 J	1.75 A	510.10 Q
		90	60.75 EF	63.75 G	220.24 GH	100.69 D	1.87 A	549.15 L
		120	58.00 GH	60.75 K	224.07 B-F	101.17 D	1.99 A	601.30 F
100% : 67% (1:2)	35 cm (one plant/hill)	60	63.00 A	67.00 A	209.81 I	93.99 G	1.70 A	519.80 P
		90	61.50 C-E	65.25 DE	225.43 B-D	106.51 B	1.82 A	559.50 K
		120	58.75 G	62.25 I	229.41 A	108.40 A	1.94 A	612.40 D
	70 cm (two plants/hill)	60	62.50 AB	66.25 B	207.19 IJ	91.91 H	1.67 A	488.50 R
		90	61.00 EF	64.50 F	222.62 D-G	105.49 B	1.78 A	526.20 O
		120	58.25 GH	61.50 J	226.50 A-C	106.02 B	1.90 A	576.45 H

Table (21): Continued.

Treatments / Traits			No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)
			Tasseling	Silking				
Inter. patterns	Orient. of maize plants	N fert. levels Kg/fed	Second season 2004					
100% : 33% (2:1)	35 cm (one plant/hill)	60	61.00 AB	64.00 B-D	220.15 O	98.55 LM	1.91 A	634.90 J
		90	59.50 EF	62.25 FG	235.90 K	113.75 EF	2.05 A	688.35 E
		120	56.75 GH	59.25 JK	239.9 J	114.35 D-F	1.18 A	759.65 A
	70 cm (two plants/hill)	60	60.50 B-D	63.25 DE	214.90 P	97.30 M	1.85 A	615.80 L
		90	59.00 F	61.50 GH	230.25 M	110.30 H	1.99 A	668.05 G
		120	56.25 H	58.50 K	234.15 L	112.85 FG	2.12 A	737.70 B
100% : 50% (1:1)	35 cm (one plant/hill)	60	61.25 AB	64.50 BC	233.05 L	100.20 JK	1.83 A	599.80 N
		90	59.75 D-F	63.00 EF	249.75 F	115.70 CD	1.96 A	651.05 I
		120	57.00 GH	60.00 IJ	253.95 E	116.25 BC	2.09 A	719.30 C
	70 cm (two plants/hill)	60	60.75 A-C	63.75 C-E	227.50 N	98.95 KL	1.77 A	581.55 P
		90	59.25 EF	62.25 FG	243.75 I	112.20 G	1.90 A	631.60 K
		120	56.50 GH	59.25 JK	247.90 G	114.75 DE	2.02 A	698.30 D
100% : 67% (1:2)	35 cm (one plant/hill)	60	61.50 A	65.50 A	245.95 H	101.90 I	1.75 A	564.75 Q
		90	60.00 C-E	63.75 C-E	263.55 B	117.60 AB	1.87 A	613.70 M
		120	57.25 G	60.75 HI	268.00 A	118.20 A	1.99 A	679.00 F
	70 cm (two plants/hill)	60	61.00 AB	64.75 AB	240.10 J	100.55 IJ	1.69 A	547.25 R
		90	59.50 EF	63.00 EF	257.25 D	114.10 EF	1.81 A	595.10 O
		120	56.75 GH	60.00 IJ	261.60 C	116.65 BC	1.93 A	658.90 H

pattern and under same respective nitrogen fertilizer dose. Consistent and gradient increases in the values of plant height and topmost ear height with increasing maize density in the intercrop up to the heaviest, i.e., (2:1) < (1:1) < (1:2). On the other hand in case of leaf area of topmost ear decreases were evident with increasing maize density in the intercrop. i.e., (1:2) < (1:1) < (2:1). The statistical analysis revealed significant differences among the treatment imposed, except, in case of stem diameter in both seasons.

The interaction effect of the three main variables on the number of days to 50% tasseling and silking also was governed by the combined effect of the main variable; increasing nitrogen fertilizer decreased number of days to 50% tasseling and silking. Orientating maize plants at 70cm. apart with two plants/hill decreased the average number of days to 50% tasseling and silking under any intercropping pattern. From another angel of results latest tasseling and silking were observed when maize was spaced at 35cm. apart and leaving one plant/hill in (1:2) pattern with heaviest density of maize and when plants received lowest dose of nitrogen fertilizer indicating that the maize density and maize orientation played reversed role other than the dose of nitrogen fertilizer. Maximum values of plant height (229.41 and 268cm.) and topmost ear height (108.40 and 118.20cm.) were also observed when maize was spaced at 35cm. with one plant/hill in (1:2) pattern where maize was at its highest density and maize received 120 Kg N/fed. These results hold true in both seasons and were coincided with the degree of shading offered by maize plants.

On the other hand maximum values of leaf area of topmost ear (664.70 and 759.65cm^2) was observed when maize plants received heaviest dose of nitrogen fertilizer (120 Kg N/fed.), spaced at 35cm. with one plant/hill in (2:1) pattern which had least maize plant density (33%) in the first and second season, indicating the importance of maize density and orientation in as well as nitrogen fertilizer level to increase leaf area of topmost ear.

Several investigators evidenced the importance of both maize density and orientation in intercropping pattern on leaf area of maize such as **Ibrahim, Sahar (1996** and **2000)** and **Shams (2002)**.

2. Yield and yield component traits:

a. Effect of intercropping patterns:

Maize yield components; ear length, ear diameter, ear weight, shelling percentage, kernels weight/ear and 100-kernel weight were significantly affected by the intercropping pattern. Results in Table (22) 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, whereas, the minimum values were obtained in (1:2) pattern with 67% maize density. Concerning ear length its highest values were 17.74 and 18.48cm. where they were 3.85 and 3.90cm. for ear diameter and 219.99 and 251.53gm. for ear weight on both seasons, respectively under 33%. maize in (2:1) pattern. The minimum values for these traits were, 15.58 and 15.78cm. , 3.31 and

Table (22): Effect of intercropping patterns on yield and yield component traits of maize in 2003 and 2004 seasons.

Treatments / Traits	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
Inter. patterns Peanut : Maize	First season 2003										
100% : 33% (2:1)	17.74 A	3.85 A	219.99 A	81.40 A	179.23 A	32.18 A	1170 C	870 C	2040 C	5.80 A	10.10 A
100% : 50% (1:1)	16.66 B	3.67 A	197.05 B	79.98 B	157.67 B	31.43 B	1540 B	1150 B	2690 B	5.78 AB	10.08 B
100% : 67% (1:2)	15.58 C	3.31 B	178.84 C	79.72 B	142.59 C	30.28 C	1860 A	1360 A	3220 A	5.76 B	10.03 C
	Second season 2004										
100% : 33% (2:1)	18.48 A	3.90 A	251.53 A	80.13 A	201.86 A	34.80 A	1330 C	980 C	2310 C	5.90 A	10.54 A
100% : 50% (1:1)	17.13 B	3.75 A	224.24 B	78.76 B	176.68 B	33.98 B	1750 B	1310 B	3060 B	5.88 B	10.50 AB
100% : 67% (1:2)	15.78 C	3.42 B	197.96 C	78.50 B	155.46 C	32.88 C	2050 A	1540 A	3590 A	5.86 C	10.46 B

3.42cm., 11.75 and 12.25 row, 178.84 and 197.96gm., respectively in both season when 67% of maize plants were intercropped in (1:2) pattern. 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. However different responses were obtained by several investigators. While **Koraiem *et al* (1980), Salem *et al* (1983), El-Hosary and Salwau (1989), El-Bana and Gomaa (2000), Ibrahim and Abd El-Maksoud (2001) and El-Wakil (2002)** have demonstrated that maize yield components, increased with decreasing maize density in the intercrop, **Mohamed (1986)** revealed that ear diameter, shelling percentage, 100-grain weight were not significantly affected by increasing plant density from 20000 to 30000 plans/fed. which indicated higher maize densities than in the intercrop patterns in this study. Increases in the values of these traits in (2:1) pattern over both (1:1) and (1:2) pattern could be explained according to light theory's been repeated throughout the study.

Results on grain, straw and the biological 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) whereas 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. The increases of grain, straw and biological yields of maize in (1:2) pattern over (1:1) pattern were amounted to 20.78, 18.26 and

19.70% in 2003 season and 17.14, 17.56 and 17.32% in 2004 season. The increases in these yields in (1:2) pattern over (2:1) pattern were also amounted to 58.97, 56.32 and 57.84% in first season and 54.14, 57.14 and 55.41% in second season. These results are in agreement with those obtained by several investigators such as **Mahmoud *et al* (1980), Lucas (1986)** and **El-Bana and Gomaa (2000)**. Their results and conclusion supported the interpretation that the yields of maize in the intercrop were governed by maize density in the association **Ibrahim, Sahar (1996 and 2000)**. Further, **Eliseu and freire (1992)** reported that when peanut was intercropped with maize in different patterns maize:peanut row ratios (1:1), (1:2), (1:3) or a zigzag pattern, they found that yield of maize was greater from a zigzag pattern. **Mandimba *et al* (1993)** also revealed that when maize was intercropped with peanut in 1:4, 1:8 or 1:12 maize peanuts intercrops the maize yield increased to maximum in 1:4 pattern indicating maize yield advantage with increasing maize ratio in the pattern. **Abd El-Motaleb and Yousef (1998)** supported these results, they also found that grain yield of maize significantly increased by increasing maize population combined with peanut in three cropping pattern where 100% peanut was intercropped with 25, 50 and 75% maize. **Metwally *et al* (2005)** also came to similar conclusion.

Oil and crude protein percentages were significantly influenced by the intercropping pattern and the trend was similar to the general trend of the intercropping on yield components of maize. Concentrations of both traits decreased with increasing maize ratio in the intercropping patterns. These observation hold true in both seasons.

b. Effect of orientation of maize plants:

Results in Table (23) indicate that maize yields and yield components were significantly influenced by maize orientation in the intercrop in both seasons, except, in case of ear diameter, differences failed to reach the 5% level in both seasons. The results indicate that values of all yield component 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. 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 70cm. spacing.

The yield of grain/fed., straw yield/fed. and the biological yield/fed. followed the same trend and could be explained with the same interpretation of the maize yield components. Furthermore, **Ibrahim, Sahar (1996)** had demonstrated that the yield of maize when maize plants were orientated in squaricity was higher than when orientated in rectangular pattern. Several investigators were in agreement with these results. and conclusion. In addition the transfer of nitrogen from legume and the consequent improvement of N and Fe nutrition in the associated cereal in low-fertility situations are therefore expected

Table (23): 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)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
	First season 2003										
Orient. of maize plants											
35 cm (one plant/hill)	17.12 A	3.65 A	204.74 A	80.98 A	166.12 A	30.79 B	1580 A	1180 A	2760 A	5.80 A	10.04 B
70 cm (two plants/hill)	16.21 B	3.57 A	192.51 B	79.75 B	153.55 B	31.80 A	1470 B	1070 B	2540 B	5.76 B	10.10 A
	Second season 2004										
35 cm (one plant/hill)	17.40 A	3.72 A	235.88 A	79.76 A	188.49 A	33.01 B	1800 A	1340 A	3140 A	5.94 A	10.38 B
70 cm (two plants/hill)	16.86 B	3.66 A	213.28 B	78.50 B	167.51 B	34.76 A	1630 B	1210 B	2840 B	5.82 B	10.62 A

to be high when maize plants were in proximate to the legume. Thence it is expected that the beneficial effect of nitrogen and iron nutrition by legume to maize plants spaced at 35cm. was much more evident than when maize was spaced at 70cm. apart. **Zuo *et al* (2000)** came to the similar interpretation. Moreover, the increases in maize yield arranged in squarcity (70 × 70) rather than rectangularity may fell heavily upon more incident irradiance on the individual plants in the squarcity rather than double plants/hill in rectangular configuration.

The excesses of yields of grain, straw and biological yield when maize spaced at 35cm. apart leaving one plant/hill over those spaced at 70cm. and leaving two plants/hill were estimated to 7.48; 10.28 and 8.66% and 10.43; 10.74 and 10.56% in both successive years of experimentation, respectively.

The results also indicate that while oil percent in the grain was significantly influenced by maize orientation as the yields were influenced crude protein trend behaved the reverse. Crude protein percent significantly increased with widening maize distances between plants to 70cm. apart.

c. Effect of nitrogen fertilizer levels:

The effect of nitrogen fertilizer on yield and yield components of maize in the intercrop is presented in Table (24). The results obtained evidenced that there were increases in all yield components, namely, ear length and diameter, ear weight, shelling percentage, kernels weight/ear and 100-kernel weight and yield of maize with increasing nitrogen fertilizer dose up to 120 Kg N/fed. Increases were significant among the treatment

Table (24): Effect of nitrogen fertilizer levels on yield and yield component traits of maize in 2003 and 2004 seasons.

Treatments \ Traits	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
	First season 2003										
N fert. levels (Kg/fed)											
60	15.84 C	3.56 A	179.11 C	80.04 B	143.51 C	30.03 C	1370 C	1030 B	2400 C	5.81 A	10.05 C
90	16.71 B	3.58 A	199.29 B	80.37 AB	160.31 B	31.63 B	1530 B	1130 A	2660 B	5.78 B	10.07 B
120	17.43 A	3.70 A	217.47 A	80.69 A	175.68 A	32.23 A	1670 A	1210 A	2880 A	5.75 C	10.10 A
	Second season 2004										
60	16.29 C	3.63 A	211.00 C	78.83 B	166.59 C	32.85 C	1600 C	1190 C	2790 C	5.90 A	10.46 B
90	17.17 B	3.65 A	226.19 B	79.15 AB	179.30 B	34.08 B	1720 B	1280 B	3000 B	5.88 AB	10.50 AB
120	17.93 A	3.79 A	236.55 A	79.41 A	188.10 A	34.73 A	1810 A	1360 A	3170 A	5.87 B	10.54 A

imposed in both seasons, except, in case of ear diameter where differences failed to reach 5% level of significance.

It seemed that ear diameter was governed by genetic factors rather than the environmental ones. It could be concluded that increasing nitrogen fertilizer levels from 60 to 120 Kg N/fed. caused considerable increase in the yield components and yield of maize. These results were in agreement with several investigators such **Younis *et al* (1995), El-Gizawy (2000), El-Douby *et al* (2001) and Hussein, Samira (2005).**

The increase in nitrogen application from 60 up to 90 and 120 Kg N/fed. significantly increased grain, straw and biological yields in both seasons. However the increases in grain, straw and biological yields with increasing nitrogen fertilizer dose to 90 Kg N/fed. were 11.68, 9.71 and 10.83% in 2003 and were 7.50, 7.56 and 7.53% in 2004 season and to 120 Kg N/fed. were 21.90, 17.48 and 20.00% in 2003 and were 13.13, 14.29 and 13.62% in 2004 season.

The results also revealed a contradictory trend between oil percent and the crude protein percent of the grain in both seasons. While oil percent decreased gradually with increasing nitrogen fertilizer level, crude protein behaved the reverse. It seemed that the plants were devoted to protein metabolite activities rather than fatty acid metabolites with increasing nitrogen fertilizer level. The results also evidenced that differences were statistically significant in both seasons.

It could be concluded that the increases in yield components, grain yield, straw yield and biological yield of maize as well as protein percent due to increasing nitrogen application are mainly attributed to the important role of nitrogen in stimulating metabolite activity which contribute to the increase in the metabolites amounts most of which is used in building yield and yield components.

d. Effect of interactions:

d_1. Interaction effect between intercropping patterns and orientation of maize plants (a × b):

Results presented in Table (25) indicate that the interaction effects of intercropping patterns and orientation of maize plant on yield and yield components of maize in the intercrop were significant, except, in case of ear diameter within both seasons, among most the interacted treatments. However, the statistical analysis revealed significant differences between (1:2) pattern at any maize arrangement in the intercrop and other interaction treatments.

The interaction effect revealed that within each intercrop pattern, values of ear length, ear weight, shelling percent and kernels weight/ear decreased when maize spacing was increased from 35cm. to 70cm. apart in both seasons.

On other hand, the trend was reversed in case of 100-kernel weight in both seasons. From another angle, values decreased gradually with increasing maize density in the intercrop up to the heaviest (67% of full maize density).

In case of grain, straw and biological yields, although the values of these traits diminished within widening maize spacing in all the intercropping patterns, yet, there were gradual increases

Table (25): Interaction effect between intercropping patterns and orientation of maize plants on yield and yield component traits of maize in 2003 and 2004 seasons.

Inter. patterns Peanut : Maize	Orient. of maize plants	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
First season 2003												
100% : 33% (2:1)	35 cm (one plant/hill)	18.23 A	3.89 A	231.75 A	82.59 A	191.51 A	31.71 B	1250 D	950 D	2200 D	5.82 A	10.06 C
	70 cm (two plants/hill)	17.25 B	3.81 A	208.22 B	80.20 BC	166.96 B	32.65 A	1090 E	780 E	1870 E	5.78 BC	10.14 A
100% : 50% (1:1)	35 cm (one plant/hill)	17.10 B	3.71 A	203.13 B	80.49 B	163.56 B	30.97 C	1610 B	1210 B	2820 B	5.80 AB	10.05 C
	70 cm (two plants/hill)	16.22 C	3.63 A	190.97 C	79.48 D	151.78 C	31.88 B	1480 C	1090 C	2570 C	5.76 CD	10.11 B
100% : 67% (1:2)	35 cm (one plant/hill)	16.02 C	3.34 B	179.35 D	79.87 B-D	143.28 CD	29.67 D	1870 A	1390 A	3260 A	5.78 BC	10.01 D
	70 cm (two plants/hill)	15.15D	3.28 B	178.34 D	79.56 CD	141.90 D	30.88 C	1850 A	1330 A	3180 A	5.74 D	10.05 C
Second season 2004												
100% : 33% (2:1)	35 cm (one plant/hill)	18.77 A	3.93 A	271.81 A	81.31 A	221.03 A	34.00 C	1460 D	1080 D	2540 D	5.95 A	10.42 C
	70 cm (two plants/hill)	18.20 A	3.87 A	231.26 B	78.95 BC	182.68 B	35.60 A	1210 E	890 E	2100 E	5.85 B	10.66 A
100% : 50% (1:1)	35 cm (one plant/hill)	17.40 B	3.78 A	235.96 B	79.33 B	187.19 B	33.16 D	1850 B	1390 B	3240 B	5.94 A	10.38 CD
	70 cm (two plants/hill)	16.87 B	3.72 A	212.53 C	78.20 D	166.18 C	34.80 B	1650 C	1230 C	2880 C	5.82 C	10.62 AB
100% : 67% (1:2)	35 cm (one plant/hill)	16.03 C	3.45 B	199.87 CD	78.65 CD	157.25 CD	31.87 E	2080 A	1570 A	3650 A	5.93 A	10.34 D
	70 cm (two plants/hill)	15.52 C	3.39 B	196.06 D	78.35 CD	153.67 D	33.90 C	2030 A	1510 A	3540 A	5.79 D	10.58 B

in these values with increasing maize density in the intercrop in contradiction with the interaction effect on most yield components of maize. These results could be easily interpreted as consequences to increases in maize density up to the heaviest.

Results of the interaction effect on yields of maize also indicate that the highest grain yield of maize (1870 and 2080 Kg) per feddan was obtained when maize was orientated in squaricity (35×60cm.) leaving one plant/hill and maize plants were at 67% of its full density, whereas, minimum yields (1090 and 1210 Kg) were obtained when maize was orientated in rectangular (70×60cm.) with least maize density in the intercrop (33%) in both seasons, respectively.

Ibrahim, Sahar (2000) came to similar result and conclusion. The results were true in both seasons. Further the excesses were estimated to 71.56 and 71.90% in 2003 and 2004 seasons, respectively. Superiority of 35cm. maize spacing in 67% maize density in the intercrop (1:2) could be due to (a): the excess in the incident sun radiation on maize arranged in squarcity (b): less plant to plant competition when maize was grown in single plant pattern (c): minimum shading effect.

Oil percent in maize grain trend was contradictory to the crude protein percent trend. While oil percent decreased with widening distances between maize plants in all the intercropping patterns the reverse was true in crude protein percents. Nevertheless, both traits decreased consistently with increasing maize density in the intercrop up to the highest (1:2).

d_2. Interaction effect between intercropping patterns and nitrogen fertilizer levels (a × c):

Results presented in Table (26) indicated that the trends of the interacted main variables; intercropping pattern and nitrogen fertilizer level were similar as they behaved alone. There were increases in all yield components with increasing the nitrogen fertilizer level up to 120 Kg N/fed. within intercropping pattern. On the other hand, values of these traits significantly decreased with increasing maize ratio in the intercropping pattern. These results were fairly true in both seasons. The statistical analysis although revealed insignificant differences in case of ear diameter in most cases under any fertilizer level.

Grain, straw and biological yields per feddan were influenced by same interaction effect on yield components of maize. Differences were also significant in both seasons.

The highest grain yield (2020 and 2180 kg/fed.) was associated with maize plants received the highest level of nitrogen fertilizer (120 Kg N/fed.) in (1:2) pattern with highest maize ratio (67%), whereas, minimum yield of maize grains (1040 and 1260 Kg/fed.) was obtained when maize ratio was minimized in the intercrop pattern (2:1) with 33% maize density and received lowest dose of nitrogen fertilizer (60 Kg N/fed.). Differences between maximum and minimum yield of grain were estimated to 94.23 and 73.02% in the first and second season, respectively.

However, these results indicate that while the intercrop pattern had a profound effect on yield components of maize, since, the ratio of maize density had similar trend to that of the

Table (26): Interaction effect between intercropping patterns and nitrogen fertilizer levels on yield and yield component traits of maize in 2003 and 2004 seasons.

Treatments: Inter. patterns Peanut : Maize	N fert. levels (Kg/fed)	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
First season 2003												
100% : 33% (2:1)	60	16.88 C	3.79 A	196.76 C	81.07 A	159.64 C	30.81 EF	1040 G	790 F	1830 H	5.83 A	10.08 BC
	90	17.78 B	3.81 A	220.17 B	81.38 A	179.24 B	32.52 B	1170 F	890 F	2060 G	5.80 A-C	10.10 AB
	120	18.58 A	3.95 A	243.02 A	81.75 A	198.82 A	33.22 A	1290 E	920 EF	2210 F	5.77 B-D	10.13 A
100% : 50% (1:1)	60	15.83 EF	3.62 A-C	177.79 D	79.70 BC	141.72 D	30.17 F	1380 E	1050 DE	243 E	5.81 AB	10.06 CD
	90	16.73 CD	3.64 A-C	197.82 C	80.02 BC	158.32 C	31.78 CD	1550 D	1150 CD	2700 D	5.78 BC	10.08 BC
	120	17.43 B	3.77 AB	215.55 B	80.23 B	172.97 B	32.33 BC	1700 C	1240 BC	2940 C	5.75 CD	10.11 AB
100% : 67% (1:2)	60	14.83 G	3.26 C	162.78 E	79.36 C	129.16 E	29.10 G	1690 C	1260 BC	2950 C	5.79 A-C	10.01 E
	90	15.63 F	3.28 C	179.89 D	79.70 BC	143.37 D	30.59 EF	1870 B	1350 AB	3220 B	5.76 B-D	10.03 DE
	120	16.30 DE	3.39 BC	193.85 C	80.09BC	155.25 C	31.14 DE	2020 A	1460 A	3480 A	5.73 D	10.06 CD
Second season 2004												
100% : 33% (2:1)	60	17.58 C	3.84 AB	238.52 BC	79.81 A	190.65 BC	33.64 DE	1260 F	910 G	2170 G	5.92 A	10.50 BC
	90	18.53 AB	3.86 A	252.72 AB	80.11 A	202.77 AB	35.03 AB	1340 EF	990 FG	2330 FG	5.90 AB	10.54 AB
	120	19.35 A	4.00 A	263.36 A	80.47 A	212.14 A	35.73 A	1400 E	1040 F	2440 F	5.89 A-C	10.58 A
100% : 50% (1:1)	60	16.30 DE	3.69 A-C	209.04 D	78.55 B	164.21 DE	32.96 E	1630 D	1230 E	2860 E	5.90 A-C	10.46 BC
	90	17.18 CD	3.71 A-C	226.32 C	78.87 B	178.52 CD	34.17 CD	1770 C	1300 DE	3070 D	5.88 A-D	10.50 BC
	120	17.93 BC	3.85 A	237.37 BC	78.88 B	187.32 C	34.80 BC	1860 BC	1390 CD	3250 C	5.87 B-D	10.54 AB
100% : 67% (1:2)	60	15.00 F	3.37 C	185.45 E	78.15 B	144.92 F	31.95 F	1910 B	1430 BC	3340 C	5.88 B-D	10.42 C
	90	15.80 EF	3.39 C	199.52 DE	78.49 B	156.62 EF	33.04 E	2070 A	1540 AB	3610 B	5.86 CD	10.46 BC
	120	16.53 DE	3.51 BC	208.92 D	78.87 B	164.83 DE	33.66 DE	2180 A	1640 A	3820 A	5.85 D	10.50 BC

level of nitrogen fertilizer, i.e., both trends of intercropping patterns and the level of nitrogen fertilizer had the same effect on grain yield of maize.

Oil percents decreased with increasing nitrogen fertilizer level within each intercrop pattern as well as with decreasing maize ratio in the intercrop. Differences were significant in the first season. In the second season although differences were in most cases insignificant the trend was the same as in first season.

In case of crude protein, the trend was reversed. Within each intercrop pattern, crude protein percents increased with increasing nitrogen fertilizer level up to 120 Kg N/fed. and decreased with increasing maize ratio in the intercrop.

d_3. Interaction effect between orientation of maize plants and nitrogen fertilizer levels (b × c):

The interaction effect between orientation of maize plants and nitrogen fertilizer level followed also the general tendency of both main variables when behaved alone (Table, 27). There were ever significant increases with increasing nitrogen fertilizer level in most yield component traits except in case of ear diameter in both seasons, where differences failed to reach the 5% level of significance. On other hand, generally values of these traits when maize was spaced at 35cm. apart leaving one plant/hill were higher than those spaced at 70cm. leaving two plants/hill indicating that squarish orientation of the shade crop had more favorable effect rather than rectangular orientation of maize. These results were in agreement with those obtained by **Ibrahim, Sahar (2000).**

Table (27): Interaction effect between orientation of maize plants and nitrogen fertilizer levels on yield and yield component traits of maize in 2003 and 2004 seasons.

Orient. of maize plants	N levels (Kg/fed)	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
First season 2003												
35 cm (one plant/hill)	60	16.28 C	3.59 A	184.67 C	80.65 BC	149.20 C	29.58 E	1420 C	1090 BC	2510 C	5.83 A	10.02 E
	90	17.15 B	3.61 A	205.26 B	80.97 AB	166.40 B	31.13 C	1590 B	1190 AB	2780 B	5.80 AB	10.04 DE
	120	17.92 A	3.74 A	224.29 A	81.33 A	182.75 A	31.64 BC	1730 A	1270 A	3000 A	5.77 BC	10.06 CD
70 cm (two plants/hill)	60	15.40 D	3.52 A	173.55 D	79.43 D	137.81 D	30.47 D	1320 D	980 C	2300 D	5.79 BC	10.07 C
	90	16.27 C	3.54 A	193.32 C	79.76 D	154.22 C	32.13 B	1480 C	1080 BC	2560 C	5.76 CD	10.10 B
	120	16.95 B	3.66 A	210.66 B	80.05 CD	168.61 B	32.82 A	1610 B	1150 B	2760 B	5.73 D	10.13 A
Second season 2004												
35 cm (one plant/hill)	60	16.55 DE	3.66 A	221.92 C	79.44 B	176.60 B	32.06 D	1680 C	1260 BC	2940 CD	5.95 A	10.34 D
	90	17.43 BC	3.68 A	238.18 AB	79.75 AB	190.26 A	33.19 C	1810 AB	1350 AB	3160 B	5.94 A	10.38 CD
	120	18.22 A	3.82 A	247.54 A	80.10 A	198.61 A	33.77 C	1890 A	1430 A	3320 A	5.93 A	10.42 C
70 cm (two plants/hill)	60	16.03 E	3.60 A	200.09 D	78.23 C	156.59 C	33.64 C	1520 D	1130 D	2650 E	5.84 B	10.58 B
	90	16.90 CD	3.62 A	214.20 C	78.56 C	168.35 B	34.96 B	1640 C	1210 CD	2850 D	5.82 BC	10.62 AB
	120	17.65 AB	3.75 A	225.55 BC	78.71 C	177.59 B	35.68 A	1730 BC	1290 BC	3020 BC	5.80 C	10.66 A

The interaction results also revealed that maximum values of ear length, ear diameter, ear weight, shelling percent and kernel weight/ear when maize was spaced at 35cm. leaving one plant/hill but the reverse was true when maize was spaced at 70cm. in case of 100-kernel weight. These results were in agreement with those obtained by **Ibrahim, Sahar (2000).**

Grain, straw and the biological yields were statistically influenced by the interaction effect in resemblance to the effect on maize yield components, i.e., the two dimensionally effects of main variables were also apparent. However, the results also indicate that highest grain (1730 and 1890 Kg), straw (1270 and 1430 Kg) and biological yields/fed. (3000 and 3320 Kg) were evident when maize plants were orientated in squarish (maize was spaced at 35cm. leaving one plant/hill) and received 120 Kg N/fed. of nitrogen per feddan, whereas least values of grain yield (1320 and 1520 Kg), straw yield (980 and 1130 Kg) and biological yield (2300 and 2650 Kg) were obtained when maize was orientated in rectangular system (maize was spaced at 70cm. leaving two plants/hill and received 60 Kg N/fed.) and the excesses in grain, straw and biological yields were estimated to 31.06, 29.59 and 30.44% and 24.34, 26.55 and 25.28% in 2003 and 2004 seasons, respectively.

It could be concluded that both systems took benefit from the nitrogen fertilizer level up to 120 Kg N/fed. The more benefit occurred when maize plants were spaced at 35cm. leaving one plant/hill could be due from one hand to loss competition for N nutrient rather than spacing at 70cm. leaving two plants/hill. From other hand, the narrow spaced system was associated with less competition for light rather than the wide spaced but with two plants/hill which had higher plant to plant competition for light which in turn had indirect diminishing effect of the N supply provided by the understory legume, (since the shade had a detrimental effect on nitrogen fixation by the bacterial nodules). Many investigators are in agreement with these results and interpretation. **Patra and Poi (1998)** reported that intercropping caused the number of nitrogen fixing nodules on the legume crops to decrease due to shading. When legumes were intercropped with cereals, legume nodulation became poor and less nitrogen fixation took place. Some of nitrogen fixed may act as a fertilizer for cereal crop, increasing the shading and further reducing legume nodulation and N fixation.

The interaction effect had two contradictory trends on oil and crude protein percents in maize grain. The results revealed that while there were increases in crude protein percent with increasing nitrogen fertilizer level up to 120 Kg N/fed. in both systems in both seasons, there were decreases in oil percent with increasing the nitrogen fertilizer level in both systems in both seasons. From another angle of results, values of the crude protein percents when maize was spaced at 70cm. with two plants/hill were higher than when maize was spaced at 35cm. with one plant/hill. The trend was reversed in case of oil percent.

d_4. Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels (a × b × c):

The combined interaction effect of the three main variables (Table, 28 and Fig., 2) had significant effects on all yield component traits although, ear diameter and shelling percent in the first year and ear diameter in the second year were insignificant with most treatments. The interaction results also revealed that the general trend was governed by the three main variables (intercropping pattern, orientation of maize plants and nitrogen fertilizer levels).

Increases in values of yield component traits namely, ear length and diameter, ear weight, shelling percentage, kernels weight/ear and 100-kernel weight with increasing nitrogen fertilizer level, increasing maize ratio in the intercrop and decreasing maize spacing in the orientation system were observed. These observation hold true in both seasons.

Grain, straw and biological yields revealed increases in the values of these traits with increasing nitrogen fertilizer level up to 120 Kg N/fed. in all the intercrop patterns. Spacing maize at 35cm. with one plant/hill was superior to maize oriented at 70cm. leaving two plants/hill. The yields of maize increased with increasing maize ratio in the intercrop, i.e., (2:1) < (1:1) < (1:2). Differences among the treatment imposed were significant in both seasons.

Highest grain yield (2040 and 2190 Kg/fed.) was obtained when maize ratio reached the maximum in the intercrop pattern (1:2) and maize was orientated at 35cm. apart with one plant/hill

Table (28): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on yield and yield component traits of maize in 2003 and 2004 seasons.

Inter. Patterns	Orient. of maize plants	N fert. levels Kg/fed	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
			First season 2003										
100% : 33% (2:1)	35 cm (one plant/hill)	60	17.35 C-E	3.83 A-D	207.60 CD	82.29 A	170.90 C-	30.45 EF	1120 IJ	870 FG	1990 J	5.85 A	10.04 D-G
		90	18.25 B	3.85 A-C	231.47 B	82.58 A	191.14 B	32.10 B-D	1250 HI	970 EF	2220 HI	5.82 A-C	10.06 C-F
		120	19.10 A	3.99 A	256.17 A	82.92 A	212.48 A	32.59 BC	1390 FG	1020 D-F	2410 GH	5.79 A-E	10.08 CD
	70 cm (two plants/hill)	60	16.40 F-I	3.75 A-E	185.92 E-	79.85 B-D	148.39 G-I	31.18 DE	970 K	720 G	1690 K	5.81 A-D	10.11 BC
		90	17.30 C-E	3.77 A-E	208.88 CD	80.18 B-D	167.34 D-F	32.93 AB	1090 JK	810 FG	1900 JK	5.78 A-F	10.14 AB
		120	18.05 BC	3.91 AB	229.87 B	80.58 BC	185.15 BC	33.84 A	1200 H-J	820 FG	2020 IJ	5.75 C-F	10.17 A
100% : 50% (1:1)	35 cm (one plant/hill)	60	16.25 G-I	3.65 A-E	183.62 E-	80.15 B-D	147.26 G-I	29.77 F	1440 FG	1120 C-E	2560 G	5.83 AB	10.03 D-G
		90	17.15 D-F	3.67 A-E	203.64 C-	80.47 B-D	163.82 D-	31.33 DE	1620 E	1210 B-D	2830 EF	5.80 A-E	10.05 D-F
		120	17.90 B-D	3.81 A-E	222.13 BC	80.83 B	179.60 B-	31.81 CD	1770 CD	1290 A-C	3060 C-E	5.77 B-F	10.07 C-E
	70 cm (two plants/hill)	60	15.40 JK	3.58 A-E	171.95 GH	79.24 D	136.18 IJ	30.57 EF	1320 GH	980 EF	2300 H	5.79 A-E	10.08 CD
		90	16.30 G-I	3.60 A-E	191.99 D-	79.57 B-D	152.83 F-I	32.23 B-D	1490 F	1100 C-E	2590 G	5.76 B-F	10.11 BC
		120	16.95 E-G	3.72 A-E	208.97 CD	79.63 B-D	166.33 D-F	32.84 B	1630 E	1190 B-E	2820 F	5.73 E-F	10.14 AB
100% : 67% (1:2)	35 cm (one plant/hill)	60	15.25 K	3.29 C-E	162.79 H	79.51 CD	129.46 J	28.53 G	1690 DE	1280 A-C	2970 D-F	5.81 A-D	9.99 G
		90	16.05 H-J	3.31 C-E	180.68 F-	79.86 B-D	144.23 H-J	29.97 F	1890 BC	1380 AB	3270 BC	5.78 A-F	10.01 FG
		120	16.75 E-H	3.42 A-E	194.57 D-F	80.24 B-D	156.17 E-	30.52 EF	2040 A	1500 A	3540 A	5.75 C-F	10.03 D-G
	70 cm (two plants/hill)	60	14.40 L	3.23 E	162.78 H	79.21 D	128.86 J	29.67 F	1680 DE	1240 B-D	2920 EF	5.77 B-F	10.02 E-G
		90	15.20 K	3.25 DE	179.10 F-	79.55 CD	142.50 H-J	31.22 DE	1850 C	1330 A-C	3180 CD	5.74 D-F	10.05 D-F
		120	15.85 I-K	3.36 B-E	193.13 D-F	79.94 B-D	154.33 E-	31.76 CD	2010 AB	1420 AB	3430 AB	5.71 F	10.08 CD

Table (28): Continued.

Inter. Patterns	Orient. of maize plants	N fert. levels Kg/fed	Ear length (cm)	Ear diameter (cm)	Ear weight (g)	Shelling (%)	Weight of kernels/ear (g)	100-kernel weight (g)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Oil (%)	Crude protein (%)
			Second season 2004										
100% : 33% (2:1)	35 cm (one plant/hill)	60	17.85 B-E	3.87 A-D	257.23 BC	81.01 A	208.35 BC	32.88 F-I	1380 GH	1000 H-J	2380 JK	5.96 A	10.38 F-G
		90	18.80 A-C	3.89 A-C	275.08 AB	81.29 A	223.63 AB	34.25 C-E	1480 G	1090 G-I	2570 IJ	5.95 A	10.42 EF
		120	19.65 A	4.03 A	283.12 A	81.62 A	231.11 A	34.86 B-D	1530 FG	1140 F-H	2670 I	5.94 A	10.46 DE
	70 cm (two plants/hill)	60	17.30 D-G	3.81 A-E	219.81 E-I	78.61 B-D	172.95 E-	34.40 C-E	1140 I	830 J	1970 M	5.87 B	10.62 A-C
		90	18.25 B-D	3.83A-E	230.36 D-	78.93 B-D	181.91 D-	35.80 AB	1200 I	890 J	2090 LM	5.85 BC	10.66 AB
		120	19.05 AB	3.97 AB	243.60 C-	79.32 BC	193.18 C-	36.59 A	1280 HI	940 IJ	2220 KL	5.83 B-D	10.70 A
100% : 50% (1:1)	35 cm (one plant/hill)	60	16.55 E-I	3.72 A-E	220.65 E-I	79.00 B-D	174.29 E-	32.25 HI	1730 DE	1300 D-F	3030 FG	5.95 A	10.34 FG
		90	17.45 C-F	3.74 A-E	237.88 C-F	79.31 BC	188.65 C-F	33.34 E-H	1870 CD	1390 C-E	3260 D-F	5.94 A	10.38 E-G
		120	18.20 B-D	3.88 A-D	249.35 CD	79.67 B	198.63 CD	33.88 C-F	1970 BC	1480 B-D	3450 CD	5.93 A	10.42 EF
	70 cm (two plants/hill)	60	16.05 G-J	3.66 A-E	197.44 I-K	78.09 CD	154.13 H-J	33.67 D-G	1530 FG	1160 F-H	2690 HI	5.84 B-D	10.58 BC
		90	16.90 D-H	3.68 A-E	214.76 F-J	78.42 CD	168.39 F-I	35.00 BC	1670 EF	1220 E-G	2890 GH	5.82 CD	10.62 A-C
		120	17.65 C-E	3.82 A-E	225.39 D-	78.09 CD	176.02 E-	35.72 AB	1760 DE	1310 D-F	3070 E-G	5.80 C-E	10.66 AB
100% : 67% (1:2)	35 cm (one plant/hill)	60	15.25 IJ	3.40 C-E	187.86 JK	78.30 CD	147.15 IJ	31.04 J	1940 BC	1480 B-D	3420 CD	5.94 A	10.30 G
		90	16.05 G-J	3.41 C-E	201.57 H-	78.64 B-D	158.50 H-J	31.99 IJ	2090 AB	1560 A-C	3650 A-C	5.93 A	10.34 FG
		120	16.80 E-H	3.54 A-E	210.16 G-	79.02 B-D	166.10 G-I	32.58 G-I	2190 A	1670 A	3860 A	5.92 A	10.38 E-G
	70 cm (two plants/hill)	60	14.75 J	3.34 E	183.03 K	77.99 D	142.70 J	32.86 F-I	1880 CD	1390 C-E	3270 DE	5.81 C-E	10.54 CD
		90	15.55H-J	3.36 DE	197.48 I-K	78.33 CD	154.74 H-J	34.09 C-E	2040 A-C	1530 A-C	3570 BC	5.79 DE	10.58 BC
		120	16.25 F-I	3.47 B-E	207.67 G-	78.72 B-D	163.56 G-J	34.74 B-D	2160 A	1610 AB	3770 AB	5.77 E	10.62 A-C

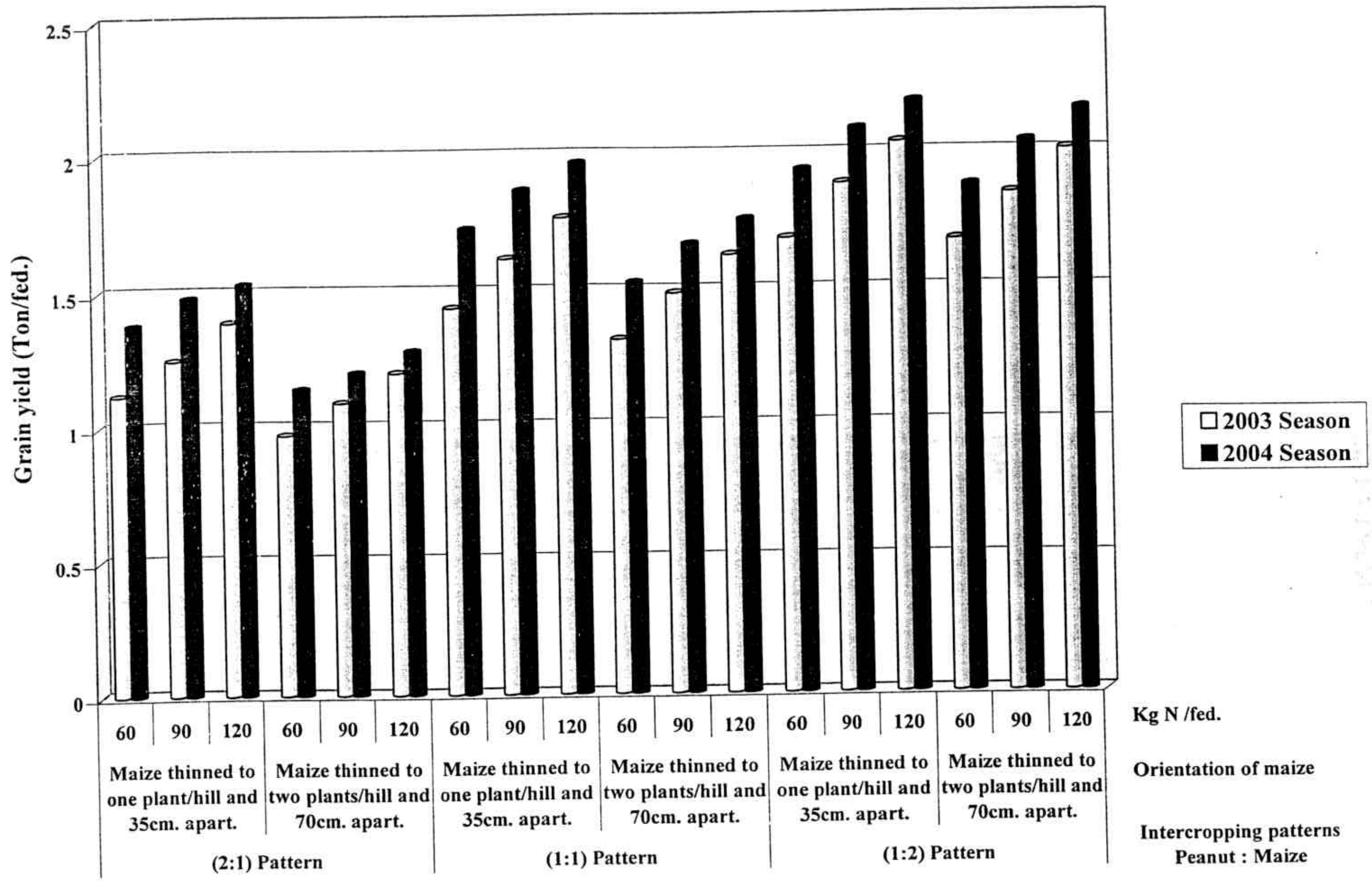

Fig. (2): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on yield of maize in 2003 and 2004 seasons.

and received 120 Kg N/fed. whereas, lowest grain yield (970 and 1140 Kg/fed.) was obtained when maize was spaced at 70cm. with two plants/hill and received 60 Kg N/fed. in (2:1) pattern in the first and second seasons, respectively. Differences were estimated to 110.31 and 92.11% in 2003 and 2004 season, respectively. It seemed that squarcity, increasing nitrogen fertilizer level and maize ratio in the intercrop (1:2) maximized grain yield/fed. These results coincided with those explained by **Mandimba *et al* (1993)**. **Senaratne and Ratnasinghe (1993)** also reported that the transfer of N from legume and the consequent improvement of N nutrition in the associated cereal in low-fertility situations are therefore expected to be high when the growth of legume is intermediate and does not suppress the growth of cereal. **Zuo *et al* (2000)** further added that the beneficial effect of peanut on maize extended to the third row in the alternative systems of intercropping.

The combined interaction also evidenced the contradictory result of both the crude protein percent and the oil percent in maize grain. There were parallel increases in crude protein with increasing the level of nitrogen fertilizer up to 120 Kg N/fed. within each maize orientation system and within every intercropping pattern.

C. Competitive relationships.

Results presented in Table (29) and Fig. (3) indicate that the values of LER of peanut or maize in the intercrop treatments were less than the unit indicating yield losses as influenced by the treatment imposed. These results were true in both seasons

Table (29): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on Competitive relationships in 2003 and 2004 seasons.

Treatments: Inter. patterns	Orient. of maize plants	N levels Kg/fed	Land Equivalent Ratio (L. E. R.)			Relative Crowding Coefficient (R. C. C.)			Aggressivity (A)		Competitive Ratio (C. R.)		Area Time Equivalent Ratio (A. T. E. R.)
			LER_p	LER_m	LER	K_p	K_m	K	A_p	A_m	CR_p	CR_m	
First season 2003													
100% : 33% (2:1)	35 cm (one plant/hill)	60	0.61	0.38	0.99	0.31	3.03	0.95	-0.02	0.02	0.32	3.09	0.84
		90	0.68	0.42	1.10	0.43	3.63	1.57	-0.02	0.02	0.33	3.08	0.94
		120	0.70	0.47	1.17	0.46	4.40	2.04	-0.02	0.02	0.30	3.35	0.99
	70 cm (two plants/hill)	60	0.83	0.33	1.16	0.98	2.42	2.38	-0.01	0.01	0.51	1.96	0.99
		90	0.91	0.37	1.28	2.07	2.90	5.99	-0.01	0.01	0.50	2.01	1.09
		120	0.93	0.40	1.34	2.82	3.39	9.57	-0.01	0.01	0.46	2.16	1.14
100% : 50% (1:1)	35 cm (one plant/hill)	60	0.59	0.48	1.07	0.48	2.82	1.34	-0.01	0.01	0.40	2.47	0.91
		90	0.65	0.55	1.19	0.61	3.60	2.20	-0.01	0.01	0.40	2.53	1.01
		120	0.66	0.60	1.26	0.65	4.42	2.89	-0.02	0.02	0.37	2.70	1.07
	70 cm (two plants/hill)	60	0.79	0.44	1.23	1.23	2.40	2.95	-0.01	0.01	0.59	1.69	1.05
		90	0.87	0.50	1.37	2.19	3.02	6.60	-0.01	0.01	0.58	1.73	1.17
		120	0.89	0.55	1.44	2.69	3.65	9.81	-0.01	0.01	0.54	1.85	1.22
100% : 67% (1:2)	35 cm (one plant/hill)	60	0.49	0.57	1.06	0.49	2.64	1.28	-0.01	0.01	0.43	2.31	0.90
		90	0.55	0.64	1.19	0.61	3.50	2.15	-0.01	0.01	0.43	2.31	1.01
		120	0.56	0.69	1.25	0.63	4.39	2.78	-0.01	0.01	0.41	2.46	1.06
	70 cm (two plants/hill)	60	0.67	0.57	1.24	1.01	2.61	2.63	-0.01	0.01	0.59	1.69	1.05
		90	0.74	0.62	1.37	1.44	3.30	4.77	-0.01	0.01	0.60	1.68	1.16
		120	0.76	0.68	1.43	1.56	4.19	6.54	-0.01	0.01	0.56	1.79	1.22

Table (29): Continued.

Inter. patterns	Orient. of maize plants	N levels Kg/fed	Land Equivalent Ratio (L. E. R.)			Relative Crowding Coefficient (R. C. C.)			Aggressivity (A)		Competitive Ratio (C. R.)		Area Time Equivalent Ratio (A. T. E. R.)
			LER_p	LER_m	LER	K_p	K_m	K	A_p	A_m	CR_p	CR_m	
			Second season 2004										
100% : 33% (2:1)	35 cm (one plant/hill)	60	0.61	0.42	1.03	0.31	3.61	1.12	-0.02	0.02	0.29	3.46	0.87
		90	0.68	0.45	1.13	0.42	4.09	1.70	-0.02	0.02	0.30	3.33	0.96
		120	0.69	0.47	1.16	0.45	4.35	1.96	-0.02	0.02	0.30	3.36	0.98
	70 cm (two plants/hill)	60	0.83	0.35	1.18	0.97	2.65	2.57	-0.01	0.01	0.48	2.09	1.00
		90	0.91	0.36	1.27	1.93	2.87	5.53	-0.01	0.01	0.50	2.01	1.08
		120	0.91	0.39	1.30	1.93	3.18	6.14	-0.01	0.01	0.47	2.15	1.10
100% : 50% (1:1)	35 cm (one plant/hill)	60	0.58	0.53	1.11	0.46	3.33	1.54	-0.01	0.01	0.37	2.71	0.94
		90	0.64	0.57	1.21	0.60	3.95	2.35	-0.01	0.01	0.38	2.66	1.03
		120	0.66	0.60	1.26	0.64	4.48	2.87	-0.02	0.02	0.37	2.73	1.07
	70 cm (two plants/hill)	60	0.78	0.47	1.25	1.17	2.61	3.04	-0.01	0.01	0.56	1.79	1.06
		90	0.85	0.51	1.36	1.83	3.09	5.67	-0.01	0.01	0.56	1.80	1.15
		120	0.87	0.54	1.41	2.27	3.45	7.82	-0.01	0.01	0.54	1.84	1.20
100% : 67% (1:2)	35 cm (one plant/hill)	60	0.49	0.59	1.08	0.47	2.87	1.37	-0.01	0.01	0.41	2.42	0.91
		90	0.55	0.64	1.19	0.60	3.48	2.10	-0.01	0.01	0.43	2.32	1.01
		120	0.55	0.67	1.22	0.60	3.98	2.40	-0.01	0.01	0.41	2.43	1.03
	70 cm (two plants/hill)	60	0.66	0.57	1.23	0.96	2.67	2.57	-0.01	0.01	0.58	1.74	1.05
		90	0.73	0.62	1.35	1.33	3.26	4.34	-0.01	0.01	0.59	1.71	1.15
		120	0.74	0.66	1.40	1.45	3.82	5.54	-0.01	0.01	0.57	1.77	1.19

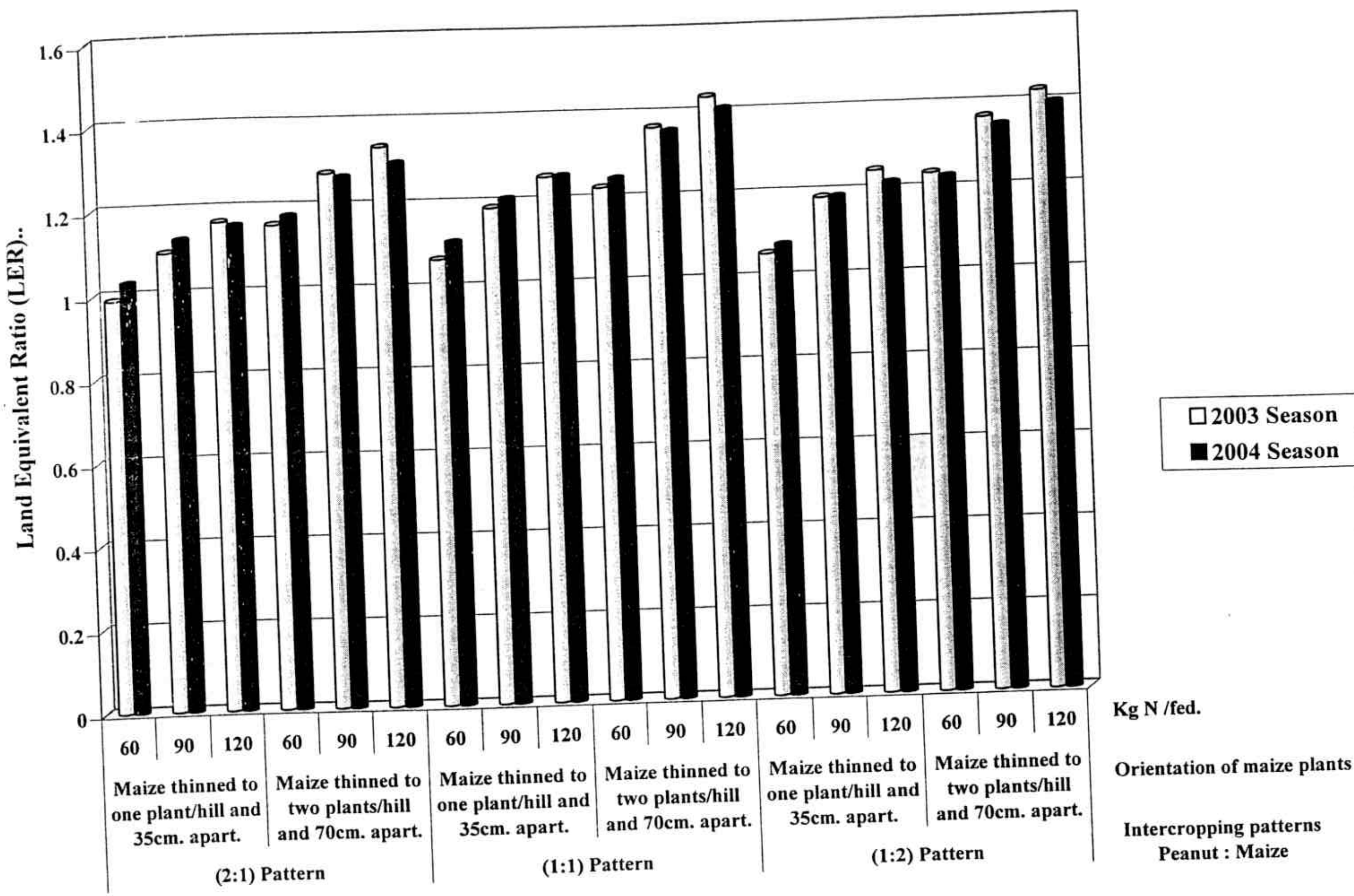

Fig. (3): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on Land Equivalent Ratio in 2003 and 2004 seasons.

and were supported by several investigators such as **Kamel *et al* (1990), Ibrahim, Sahar (2000), Shams (2002) and Sherif, Sahar *et al* (2005)**. Inter-specific competition between both components in the intercrop for light, mineral and water are the main causes and effects.

Values of LER_p were governed by the treatment imposed. There were relative increases within each orientation of the shade crop under any intercrop pattern with increasing nitrogen fertilizer level. Values of LER_p when peanut plants were grown under maize spaced at 70cm. with two plants/hill were relatively higher than those grown under maize plants spaced at 35cm. leaving one plant/hill under same respective dose of nitrogen fertilizer. From a third point LER_p were relatively higher with the intercrop pattern (2:1) than (1:1) and those of (1:1) were relatively higher than (1:2).

These results could be explained as to the combined effects of nitrogen fertilizer, orientation of the shade crop in the intercrop treatments and plant density in the intercrop patterns.

Values of LER_m when maize spaced at 35cm. with one plant/hill were relatively higher than those spaced at 70cm. leaving two plants/hill under same respective dose of nitrogen fertilizer. From a third point LER_m were relatively higher with the intercrop pattern (1:2) than (1:1) and those of (1:1) were relatively higher than (2:1).

These results could be explained as to the combined effects of nitrogen fertilizer, orientation of the shade crop in the intercrop treatments and plant density in the intercrop patterns. However it is evident that all LER_p were relatively higher than those of maize, except in case of the intercrop treatments where the shade crop was orientated at 35cm. apart with one plant/hill under different levels of nitrogen fertilizer in (1:2) pattern. This observation seemed true in both seasons. Interpretation for these reversed trends might be due to more maize density in the intercrop as well as to more shading when maize plants were at 35cm. apart.

It could be concluded that the trends of the treatments effect on LER_p and LER_m were contradicted.

Land Equivalent Ratio values indicate 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. Total LERs. were also governed by the treatment imposed, consequently, the gradual effects with increasing the nitrogen fertilizer were observed within each orientation of maize crop and within each intercropping pattern as well the effects of maize orientation within each pattern were also observed. Thence, the treatment imposed on LER values can be categorized according to nitrogen fertilizer, maize density and orientation in the intercrop as they interacted with each other in distinctive pattern of change. 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.

It could be noticed that to obtain 89 and 87% of peanut yield in addition to 55 and 54% of maize yield with LER of 1.44 and 1.41 in first and second season, respectively, maize was grown with a density of 50% at distance of 70cm. with two plants/hill and giving 120 Kg N/fed.

From the biological point of view, it is also evident that although, the total LER of (1:1) were slightly higher than those of (1:2) pattern indicating that there is no need to increase the shade crop over 50% of its full stand (2.4 plants/m^2) as compared with (1:2) where maize density is 67% of its full stand (3.2 plants/m^2). In this respect, it seemed that the unit price of each component in the intercrop will lead to the correct choice of each component percent in the intercrop. Maximum total 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 70cm. apart and two plants/hill were left in (1:1) pattern.

Peanut received same dose of nitrogen fertilizer and grown under same orientation of the shade crop but with more plant density (67%) i.e., 3.2 plants/m^2 resulted in second rank of total LER.

In conclusion, in plots received 120 Kg N/fed. and peanut plants were shaded with maize plants at densities of 2.4 and 3.2 plants/m^2 have approximately same land equivalent ratios but at 1.6 plants/m^2 have an apparent lower land equivalent ratio. Yield advantage in the intercrop as compared with sole cropping were also supported by **Calavan and Weil (1988)** who found that peanut-maize intercrop resulted in land equivalent rate ranging from 1.28 to 1.49, **Eliseu and Freire (1992)** who also found that peanut-maize intercrop gave yield advantage estimated to 1.20-1.99, particularly in peanut-maize (3:1), and **Mandimba *et al* (1993)** who found that land equivalent ratio of peanut-maize ranged between 1.53-1.61.

Tofinga and Tukunga (1995) explained yield advantage when both peanut and maize were combined in the intercrop as due to significant interaction of both shoot and root systems of both components (LER=1.8).

In Egypt **Abd El-Motaleb and Yousef (1998)** also supported these results. They found that maximum LER was obtained when peanut Giza 5 was combined with maize at 75% of its pure stand. They also revealed that intercropping maize at 75% of its pure stand with the erect peanut variety Giza 5 under the high level of nitrogen fertilizer (80 Kg N/fed.) produced the maximum land equivalent ratio. **Metwally *et al* (2005)** also indicated that intercropping maize and peanut in mixed pattern using high population from the two crops and distributing maize in wide distance between hills gave the highest value of LER

(1.8). This advantage of LER was due to higher densities of intercropped maize and peanut, as well as suitable distribution of the intercropped area. The results of **Sherif, Sahar *et al* (2005)** indicated yield advantage under any intercrop treatments. They found that spacing maize at 50cm. apart and leaving two plants/hill after thinning resulted in highest value of LER, with 100cm. spacing leaving two plants/hill ranked the second, whereas spacing at 50cm. apart and leaving one plant/hill ranked the third, but 100cm. spacing leaving one plant/hill had the least value.

The effect of the treatment imposed on the relative crowding coefficient (RCC) followed the same trends of land equivalent ratios in concern the effect of orientation and nitrogen fertilizer treatments. These results were observed in both seasons. However, values of K_p were ever lower than those of K_m in both seasons, whatever maize density in the intercropping pattern. Although K_p values were in parallel with the RCC values, yet, K_m values of maize followed a distinctive pattern of change. There were increases in the K_m values with increasing nitrogen fertilizer but the values when peanut plants were grown under maize spaced at 35cm. and one plant/hill were relatively higher than K_m values spaced at 70cm. and leaving two plants/hill under same respective nitrogen fertilizer levels. However, RCC values as influenced by the intercropping treatments followed that of land equivalent ratios. All intercropping treatments achieved yield advantage in both seasons. Maximum values were obtained when peanut-maize intercrop received the highest dose of nitrogen fertilizer (120 Kg

N/fed.) and peanut plants were grown under maize plants spaced at 70cm. apart with two plants/hill in (1:1) pattern where maize density was 50% of its full stand (2.4 plants/m^2).

It is also evident the slow down of RCC values when maize density in the intercrop increased to 67% in (1:2) pattern with heaviest dose of nitrogen fertilizer and two plants were left per hill. (3.2 plants/m^2). This abruptly decrease might be associated with the inclusion of component percent in the formula of the relative crowding coefficient. **Sherif, Sahar** ***et al*** **(2005)** supported these results. They concluded that the effect of maize density in the intercrop on RCC values followed the general tendency of the treatment effect on LER values.

The interaction effect of intercropping patterns, orientation of maize plants and the nitrogen fertilizer levels on agressivity values were not pronounced. It seemed that none of the treatment imposed had heavy competitive pressure. Agressivity values of maize did not exceed the fraction of 0.01, except in case of pattern (2:1) under any nitrogen fertilizer dose and maize orientation or in (1:1) pattern under the heaviest dose of nitrogen fertilizer and maize was spaced at 35cm. apart with one plant/hill. These results were true in both seasons.

The results also revealed that within all the treatment imposed maize was the dominant component whereas peanut was the dominated. The results were in agreement with those obtained by **Krishna and Raikhelkar (1997)** who indicated that the agressivity values showed that maize was vigorous in growth habit compared with peanut in the intercrops **Liphadzi** ***et al*** **(1997)** emphasized the positive values of aggressivities and indicated that maize was the stronger competitor when grown with peanut. **Sherif, Sahar *et al* (2005)** also indicated that no any of maize density treatments had any heavy competitive pressure between both components in the intercrop. Maize was always the dominant component crop.

The exact degree of competition as measured by the competitive ratio (CR) indicate that maize was more competitive than peanut under all the treatment imposed in both seasons. The results also revealed that orientation of the shade crop had an apparent effect on the values of CR_m. The narrow spaced (35cm.) maize and one plant/hill had relatively higher values of CR_m under any nitrogen fertilizer dose as compared with maize spaced at 70cm. apart with two plants/hill within any intercropping pattern. The results seemed valid in both seasons. On other hand, CR_p values followed a reversed trend. It seemed that the narrow spaced at 35cm. increased competition rather than the wide space treatment. These results coincided with those obtained by **Ibrahim, Sahar (2000) and Sherif, Sahar *et al* (2005)**.

The results on area time equivalent ratio (ATER) indicated lower values than those recorded on LERs as time which the crops remained on land as compared with crops grown in pure stand. Nevertheless, the results indicated that most values obtained in both seasons evidenced slight yield advantage. Further more, when maize plants (the shade crop) were narrow spaced at 35cm. and one plant/hill was left under all nitrogen fertilizer doses in (2:1) pattern and under lowest dose in (1:1) and (1:2) pattern, ATER values were beyond the unit and gave slight yield losses. These results were evident in both seasons. Maximum values of ATER were obtained when the intercrop plot received the highest dose of nitrogen fertilizer and maize plants were orientated at 70cm. apart with two plants/hill whether in (1:1) or in (1:2) pattern with lesser percents than those of LER by 18.03, 17.21 and 17.50, 17.65% in the first and second seasons, respectively and indicating biologically that there is no need to increase maize density more than 10000 plants per feddan (2.4 plants/m^2). These results were true in both seasons and results were in agreement with those obtained by **Ibrahim, Sahar (2000)**.

D. Net return.

Results on total revenue presented in Table (30) and Fig. (4) indicate that the treatment effect had apparent impose on the total revenue with increases in nitrogen fertilizer dose up to the highest, i.e., 120 Kg N/fed. under all the intercrop patterns. The results also evidenced that within any intercrop, total revenue as well as 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 total revenue and net return were 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 70cm. 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 70cm. apart with two plants/hill had the second total revenue and net return

Table (30): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on net return in 2003 and 2004 seasons.

Treatments: Inter. patterns	Orient. of maize plants	N levels Kg/fed	Total revenue (L.E.)	Costs of production (L.E.)	Net return (L.E.)	Total revenue (L.E.)	Costs of production (L.E.)	Net return (L.E.)
			First season 2003			Second season 2004		
100% : 33% (2:1)	35 cm (one plant/hill)	60	2642.19	1733.20	908.99	3120.12	1747.30	1372.82
		90	2956.59	1814.70	1141.89	3428.58	1840.05	1588.53
		120	3100.11	1896.20	1203.91	3523.17	1932.80	1590.37
	70 cm (two plants/hill)	60	3177.68	1733.20	1444.48	3477.59	1747.30	1730.29
		90	3507.46	1814.70	1692.76	3744.81	1840.05	1904.76
		120	3650.41	1896.20	1754.21	3888.06	1932.80	1955.26
100% : 50% (1:1)	35 cm (one plant/hill)	60	2820.36	1829.50	990.86	3444.44	1852.00	1592.44
		90	3123.29	1911.00	1212.29	3756.67	1944.75	1811.92
		120	3276.64	1992.50	1284.14	3906.02	2037.50	1868.52
	70 cm (two plants/hill)	60	3311.30	1829.50	1481.80	3764.24	1852.00	1912.24
		90	3675.14	1911.00	1764.14	4094.44	1944.75	2149.69
		120	3844.21	1992.50	1851.71	4252.45	2037.50	2214.95
100% : 67% (1:2)	35 cm (one plant/hill)	60	2724.38	1925.50	798.88	3418.51	1956.40	1462.11
		90	3041.20	2007.00	1034.20	3739.50	2049.15	1690.35
		120	3175.98	2088.50	1087.48	3871.73	2141.90	1729.83
	70 cm (two plants/hill)	60	3234.66	1925.50	1309.16	3805.89	1956.40	1849.49
		90	3575.55	2007.00	1568.55	4181.08	2049.15	2131.93
		120	3736.71	2088.50	1648.21	4353.09	2141.90	2211.19
Pure stand of peanut			2952.13	1550.00	1402.13	2680.40	1477.00	1203.40
Pure stand of maize			2240.19	1709.00	531.19	3601.29	1846.00	1755.29

- 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.).

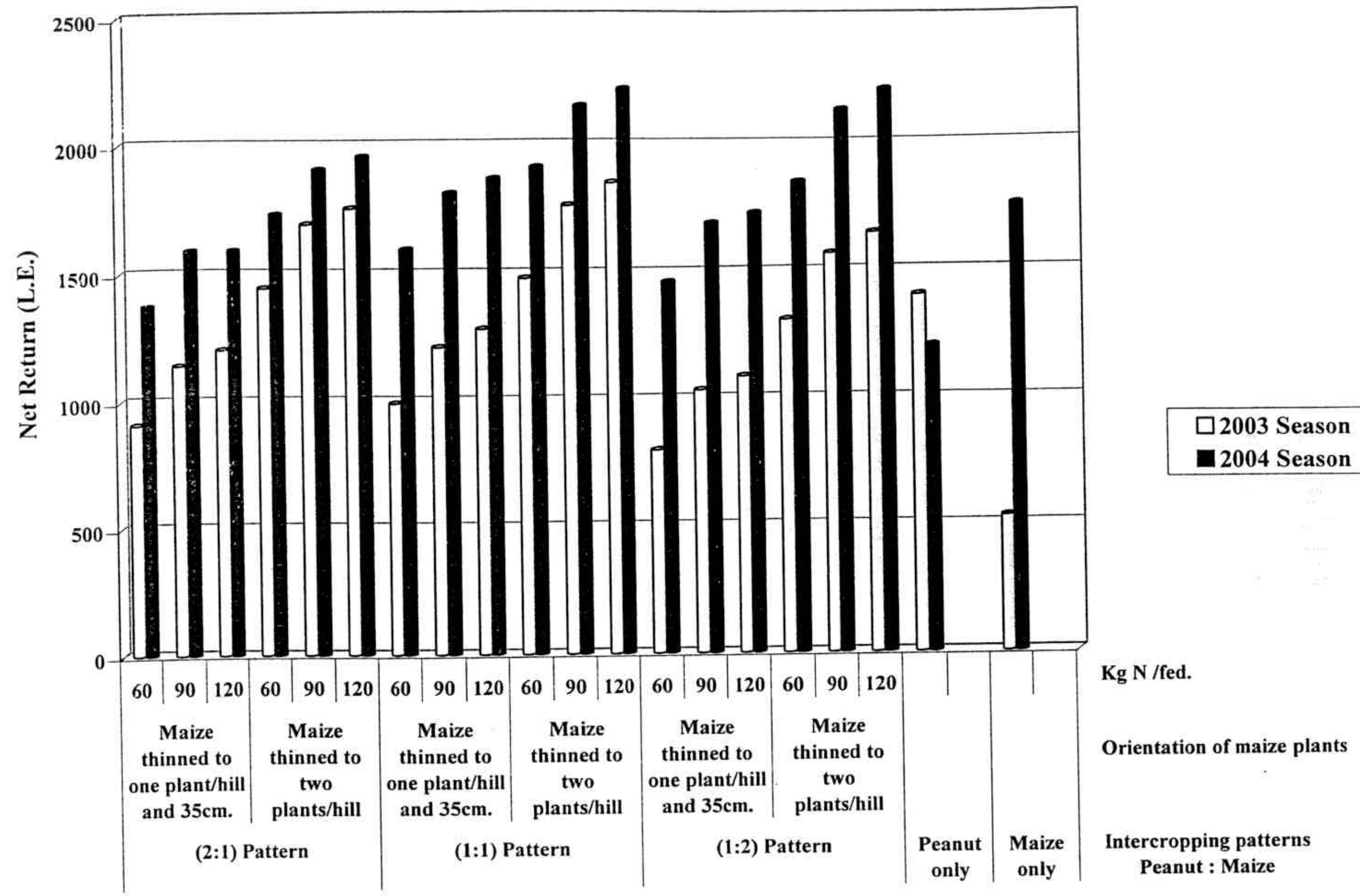

Fig. (4): Interaction effect among intercropping patterns, orientation of maize plants and nitrogen fertilizer levels on net return in 2003 and 2004 seasons.

indicating that increasing the shade crop density to maximum, 67% (3.2 plants/m^2) had no any beneficial effect whether on production per unit of land (measured in LER) or any more economical values (measured in total revenue and net return). The excesses in net return of (1:1) pattern over (1:2) and (2:1) were estimated to 12.35 and 5.56% in first season and 0.17 and 13.28% in the second season.

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.