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EFFECT OF PLANTING DATES AND DENSITIES OF MAIZE INTERCROPPED WITH GROUNDNUT ON GROWTH, YIELD AND YIELD COMPONENTS OF BOTH CROPS

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ABSTRACT

Two field trials were carried out at South Tahrir Research Station (Ali- Moubark). These trials were conducted in 2003 and 2004 to evaluate three planting dates of maize (the over story shade crop) intercropped with groundnut i.e, on 1st June, 10th June and 20th June, and four plant densities of maize intercropped with groundnut, i.e, maize was spaced at 50 and 100 cm apart leaving one or two plants/hill. Groundnut (the main crop) was grown on all rows. The data obtained indicate that ear length, ear diameter, number of rows/ear, number of kernels/row and the weight of 100grains increased with increasing maize spacing as well as with diminishing the number of plants remained per hill after thinning (to one plant/ hill). On other hand dense planting resulted in higher yield of maize whether by narrowing maize spacing or increasing the number of maize plants per hill after thinning. Yield and yield components of maize were significantly decreased by delaying planting date of maize up to the latest date. Yield /fed and yield components of groundnut were associated with maize density and distribution. The more the shade offered by maize the less the values of these traits were obtained. Highest values were obtained when maize was spaced at 100cm. and thinned to one plant/ hill. Increases in the values of yield and yield components of groundnut were associated with delaying the planting date of maize. Delaying the planting date of maize resulted in increases in the values of land equivalent ratio (LER) and the relative crowding coefficient. The treatment effect at any planting date of maize exerted very low competitive pressure when aggressivity was measured. With delaying seeding maize, competitive ratio (CR) diminished to the least. Spacing maize at 50cm. apart and leaving two plants / hill after thinning resulted in highest value of LER and relative crowding coefficient (RCC). Nor any maize density had any heavy competitive pressure on groundnut when aggressivity was measured.

Key words: Intercropping, Planting date, Densities of maize, Maize, Soybean

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INTRODUCTION

In the sandy soil of Egypt, where groundnut is considered the main summer crop, intercropping is popular now among the small holders in Egypt. Reason for this popularity is built in profit and resource maximization and efficient water utilization. However, to determine the processes which lead to the advantages and to maximize benefits, it is necessary to evaluate best intercropping pattern. Since groundnut is the main under story crop, prefereably, occupying the whole cultivated area, the geometrical distribution of maize (the shade crop) is expected to play an important role to maximize production and gross income of the intercrop per unit area of land. Studies on maize densities whether maize spacing or number of maize plants/ hill remained after thinning and date of maize planting seemed to be of prime importance. The effect of maize planting date grown solid or intercropped was studied by several investigators such as **Amer *et al* (1991) Khedr *et al* (1990) and Soliman *et al* (2004).** The effects of maize densities on growth, yield and yield component were also studied by several investigators. **Shams El-Din & El-Habbak (1996) and Zohry & Farghaly (2003).** They indicated that plant height, ear height and yield/ fed increased with narrowing distance between maize plants, whereas yield components values decreased.

The effect on maize intercropped with groundnut was also studied by several investigators. **Midmore *et al* (1988) and Ibrahim (2000)** indicated that for increasing geometric efficiency of the intercrop, degree of rectangularity of the over story crop should be increased **Misbuhulmunir *et al* (1989),** found that intercropping maize with groundnut reduced groundnut seed yield from 33 to 49% of sole crop yields. On other hand, **Abd-El-Motaleb and Yousef (1998),** reported that intercropping maize at 25% or 50% of its full pure stand density with groundnut increased number of pods/ plant, 100 seeds weight and pods yield/ fed of groundnut.

Hussein *et al* (2002) found that intercropping maize with legumes achieved yield advantage when measured whether by land equivalent ratio (LER) or by the relative crowding coefficient (RCC). Maize was always the dominant component while the under story legume crop was the dominated when aggressivity (A) was measured.

MATERIAL AND METHODS

Two field trials were carried out at South Tahrir Research Station (Ali Moubark), during 2003 and 2004 years. The aim of these trials were to study the effect of plant density and planting date of maize (the over story shade crop) with groundnut as the main crop in the intercrop on growth, yield and yield components of both crops.

The properties of the experimental soil are given in (Table 1).

These trials include;

I- Three planting dates of maize intercropped with groundnut as follows:

- **D1** 1st June (After 15 days from sowing groundnut)
- **D2** 10th June (After 25 days from sowing groundnut)
- **D3** 20th June (After 35 days from sowing groundnut)

Table 1. Chemical properties of the experimental soil at 0 -30cm depth

Properties	values
pH	7.83
EC (ds/m)	1.49
Exchangeable (cmol. Kg^{-1})	
Ca^{2+}	1.89
Mg^{2+}	6.26
Na^{+}	6.90
K^{+}	2.3
Anions (cmol. Kg^{-1})	
$Hc0^{3-}$	11.8
Cl^{-}	7.0
$S04^{2-}$	7.55
Mineral nutrients (mg. Kg^{-1})	
N	10
P	12
K	60

II- Four plant densities of maize intercropped with groundnut (Table 2) as follow

Groundnut (the main crop) was seeded at 10cm. apart on one side of the rows with a population of (140.000 plants/ fed). Whereas maize (the shade crop) was planted on the opposite side of the rows as follows:

- S1 at 50 cm. apart and thinned at two plants/ hill with a population of (28.000 plants / fed).
- S2 at 50 cm. apart and thinned at one plant/ hill with a population of (14.000 plants / fed).
- S3 at 100 cm. apart and thinned at two plants/ hill with a population of (14.000 plants / fed).
- S4 at 100 cm. apart and thinned at one plant/ hill with a population of (7.000 plants / fed).

In addition to sole groundnut seeds of (Giza 5) were sown at a rate of 30kg/ fed on 15th May in the first and second seasons at 10 cm apart and sole Maize plants (Three – way hybrid 310) were planted on 15th May in first and second seasons at 30 cm apart. Drip irrigation system was used. Rowing was done 60cm apart.

Ordinary calcium superphosphate (15% P_2O_5) at the rate of 250kg/ fed was added with land preparation and prior to groundnut seeding. Nitrogen fertilizer (as ammonium sulphate 20.5%N) was applied at a rate of 100kg N/ fed in three equal doses. The first was after thinning groundnut, whereas the second was after one month from maize seeding and after one month later the third dose was applied. Potassium sulphate (48% k_20) was added at the rate of 100kg k_20/ fed in two equal doses with the first and second dose of N fertilizer. Other cultural practices were followed as recommended for both crops. Groundnut was harvested after 140 days from seeding, whereas, maize was harvested after 105 days from seeding in both seasons.

The experimental design was split plot with four replicates. Planting date of maize occupied the main plots, whereas density of maize occupied the sub plots. All treatments were assigned at random to their respective plots. The area of sub plot was 21.6m^2 (7.2 x 3).

Data recorded

At full growth and prior to harvest, samples of ten plants were taken from each sub plot and the following data were recorded on growth and yield components of both maize and groundnut crops.

Table 2. Plant populations of both groundnut and maize in different rectangularities of the intercropping system.

Treatment	Rectangularity		Population			
	Groundnut	Maize	Groundnut		Maize	
	cm	cm	$x10^3$ fa^{-1}	m^2	$x10^3$ fa^{-1}	m^2
Sole	060 X 10	0.60 X 30	140.000	33.00	23.000	5.40
Plant densities						
S1	060 X 10	060 X 50	140.000	33.00	28.000	6.60
S2	060 X 10	060 X 50	140.000	33.00	14.000	3.30
S3	060 X 10	060 X 100	140.000	33.00	14.000	3.30
S4	060 X 10	060 X 100	140.000	33.00	07.000	1.67

Maize data: plant height in cm, height of the topmost ear from the ground in cm (ear position), percentage of plants with double ears, ear length in cm, ear diameter in cm, number of rows/ ear, number of kernels/ row, weight of 100 kernels in g.

- Grain yield in "Ardab" per feddan was calculated on whole plot basis. one "Ardab" equals 140 kg of shelled grain adjusted to 15.5 % moisture content.

Groundnut data

Plant height (cm), number of branches/plant, number of pods/plant, pods weight/plant (g), 100- kernel weight (g). Yield/fed (ardab). was estimated on a whole –plot basis.

Competitive relationships

1- Land equivalent ratio (LER)

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

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

Where

Y_{aa} = Pure stand yield of species a.

Y_{bb} = Pure stand yield of species b.

Y_{ab} = Mixture yield of a (when combined with b).

Y_{ba} = Mixture yield of b (when combined with a).

2. Relative crowding coefficient (RCC)

This was proposed according to **Hall (1974)**. It assumes that mixture treatment forms a replacement series. Each series has its own coefficient (K) which gives a measure to indicate that series has produced more, less or equal yield to that expected. Relative crowding coefficient (RCC) was determined according to the following formula: for species (a) in a mixture with species (b).

$$Kab = \frac{Yab \times Zba}{(Yaa - Yab) \times Zab}$$

where

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

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

$$Kba = \frac{Yba \times Zab}{(Ybb - Yba) \times Zba}$$

If a species has a coefficient less than, equal to, or greater than 1, it means it has produced less yield, the same yield, or more yield than the "expected", respectively.

The component crop with the higher coefficient is the dominant one. To determine if there is a yield advantage of mixing, the product of the coefficient is formed by multiplying Kab x Kba.

If k > 1, there is a yield advantage, if K = 1 there is no difference and if K< 1 there is a yield disadvantage.

3- Aggressivity (A)

This parameter was proposed by **McGilichrist (1965).** It gives a simple measure of how much the relative yield increase in species (a) is greater than that of species (b). Aggressivity "A" is determined according to the following formula:

$$A_{ab} = \frac{\text{Mixture yield of a}}{\text{Expected yield of a}} - \frac{\text{Mixture yield of b}}{\text{Expected yield of b}}$$

$$A_{ab} = \frac{Yab}{Yaa \times Zab} - \frac{Yba}{Ybb \times Zba}$$

An Aggressivity value of zero indicates that the component species are equally competitive. For any other situation, both species will have the same numerical value but the sign of the dominant species will be positive and the dominated negative. The greater the numerical value the bigger the difference in competitive abilities and the bigger the difference between actual and "expected" yield.

4- Competition ratio (CR)

As proposed by **Willey and Rao (1980)** gives the exact degree of competition by indicating the times in which one crop is more competitive than the other. Competition ratio (CR) is calculated according to the following equation:

$$CR = \frac{LERa}{LERb} \times \frac{Zba}{Zab}$$

Where: LERa and LER_b represent relative yields of a and b intercrops, respectively. Since the CR values of the two crops will in fact be reciprocals of each other.

The statistical analysis was applied according to **Snedecor and Cochran (1982).** LSD at 0.05 level was used to compare between treatments.

RESULTS AND DISCUSSION

A. Effect on maize (the shade crop)

1-Effect of maize densities

Data in Table (3). indicate that there were gradual increases in maize plant heights with increasing maize density in the intercrop. Narrowing spacing between hills from 100cm. between plants to 50cm

Table 3. Effect of maize densities on yield and yield components of maize intercropped with groundnut in 2003 and 2004 seasons

Treatments	Plant height (cm)	Ear height (cm)	Plants with two ears %	Ear length (cm)	Ear diameter (cm)	No of rows/ ear	No of kernels/ row	100 kernels wt. (g)	Grain yield (ardab /fed)
Plant densities					2003				
S1 (28000 plants/ fed)	243.56	127.22	15.20	18.26	3.90	12.92	35.90	32.29	13.01
S2 (14000 plants/ fed)	241.33	125.33	16.00	19.23	4.21	13.43	38.13	33.57	8.54
S3 (14000 plants/ fed)	238.89	122.89	16.88	19.87	4.39	13.38	41.11	34.98	8.62
S4 (7000 plants/ fed)	233.67	121.11	17.66	20.96	4.89	13.57	43.16	36.72	4.87
L. S. D 0.05	6.11	NS	0.56	1.31	0.13	NS	2.16	1.98	2.11
					2004				
S1 (28000 plants/ fed)	245.67	129.11	15.57	18.08	3.87	12.36	35.33	32.52	12.52
S2 (14000 plants/ fed)	240.56	127.22	16.33	18.76	4.16	12.50	37.53	33.57	7.84
S3 (14000 plants/ fed)	237.00	125.00	17.12	19.49	4.41	13.54	39.68	34.60	8.14
S4 (7000 plants/ fed)	234.22	122.22	17.81	20.37	4.84	13.20	42.23	35.72	4.67
L. S. D 0.05	NS	NS	0.53	0.61	0.74	NS	1.78	1.98	2.55

resulted in increases in maize plant height. Furthermore, growing two plants per hill whether at 50 or 100cm apart, resulted in more increases in maize plant height. These results were valid in first season but does not reach significant level in the 2nd season. Many investigators supported these results such **Shams El-Din & El-Habbak (1996) and Zohry & Farghaly (2003).** Interpretation for this observation is feasible. Plant to plant competition for light which in turn resulted in taller internodes might owe much to the increase in maize plant height with narrowing distance between maize plants and plant density per unit area of land. **Ibrahim (2000)** came to similar conclusion. The effect on ear height was not significant in both seasons. The trend was also regular. Ear height increased with the increases in maize density whether by narrowing plant spacing or increasing number of plants/ hill. These results are also in agreement with those obtained by **Ibrahim (2000) and Zohry & Farghaly (2003).** It seemed that this trait was tenaciously correlated genetically rather than environmentally. Number of plants with two ears was significantly affected by maize spacing. However, the trend was reversed to the previous two traits. Increasing maize spacing or diminishing the number of plants / hill had a favourable effect on the number of plants with two ears. These results were valid in both seasons. These results were also concordant with those obtained by **Ibrahim (2000) and Hussein *et al* (2002).**

Yields per feddan of maize the shade crop as well as yield components were significantly affected by plant spacing and plant density. Ear length, ear diameter, number of kernels/row, and the weight of 100 grains increased consistently and regularly with increasing maize spacing as well as with diminishing the number of maize plants per hill. While the highest values of these traits with maize spaced at 100cm. apart and thinned to one plant/ hill, the lowes values of these traits were obtained when maize (the shade crop) was spaced at 50cm. apart and 2 plants/ hill. These results hold fairly true in both seasons. Several investigators supported these results such **Shams El-Din & El-Habbak (1996); El-Douby *et al* (2001) and Hussein *et al* (2002).** It seems that maize geometry per unit area could play an important role in optimizing the favourable conditions predisposed by the arrangement. The values of these traits increased with increasing rectangularity orientation with increasing maize spacing to the maximal which rather fierce interplant competition for growth resources especially intercepted irradiance. Similar conclusion has been previously reported by **Midmore *et al* (1988).** They added that superiority of maize yield components when the crop was grown in thin planting over those grown in dense planting might be due to less competition between plants for light intercepted by foliage as well as for mineral and water absorbed by the root system.

Grain yield of maize/ fed inversely behaved. The data revealed that dense planting resulted in higher yield of maize by narrowing maize spacing and/ or increasing the number of maize plants per hill. These results hold true in both seasons. These results also are in agreement with those obtained by **El-Douby *et al* (2001) and Ibrahim (2000).** The data indicate that maize plants grown at 50cm. apart and thinned at two plants/ hill

outyielded those grown at 100cm. and thinned to one plant per hill by 167% in 2003 season and by 168% in 2004 season. Explicit interpretation for this trend might fell heavily upon the increase of maize stand at harvest in dense planting as compared with thin planting of the shade crop, i.e, to a reduction in population rather than to a fierce interplant competition for growth resources. Moreover, grain yield of maize was influenced by neither geometry of maize plants in the associations nor rectangularity but tenaciously bounded with maize population density.

2- Effect of planting dates

Maize plant height (the overstory component in the intercrop) was significantly influenced by date of planting. The data in Table (4) indicate that there was consistent and gradual decrease in plant height with delaying time of planting maize till 20th June.

These results were fairly true in both seasons and were in agreement with those obtained by **Amer *et al* (1991) and Soliman *et al* (2004).** Long duration of maize growth associated with early date of seeding might owe much to the increases in maize plant heights when the crop was seeded early. The effect of planting date on ear height followed the same trend, although, differences were not significant.

The parallel behaviour of both traits support the view that ear height was governed genetically more than influenced by the environment.

Table 4. Effect of maize planting dates on yield and yield components of maize intercropped with groundnut in 2003 and 2004 seasons.

Treatments	Plant height (cm)	Ear height (cm)	Plants with two ear %	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels/ row	100 kernels wt. (g)	Grain yield (ardab /fed)
Planting Dates					2003				
D1 (1st June)	252.08	131.33	17.59	21.28	4.78	14.30	42.23	35.66	10.26
D2 (10th June)	240.92	123.83	16.58	19.28	4.42	13.98	39.94	34.29	8.68
D3 (20th June)	225.08	117.25	18.13	18.17	3.84	13.19	36.55	33.22	7.34
L. S. D 0.05	5.92	NS	0.55	1.31	0.16	NS	1.61	NS	1.55
					2004				
D1 (1st June)	252.92	132.83	17.83	20.34	4.93	13.69	42.34	35.42	9.90
D2 (10th June)	240.83	126.58	16.98	19.12	4.28	13.19	37.87	34.13	8.26
D3 (20th June)	224.33	118.25	15.32	18.06	3.75	12.57	35.88	32.77	6.71
L. S. D 0.05	15.22	NS	0.34	1.21	0.11	NS	1.31	NS	1.42

However these results are in accordance with those obtained by **Khedr *et al* (1990).** In the second season delaying time of planting had a detrimental effect on the average number of plants with two ears. Earliest date (first of June) had the highest percent of plants with two ears and the percent decreased with delaying time of planting. It seemes that the rate of various vital processes were optimum when maize was planted at the earliest date and resulted in more metabolites synthesized by the plant which intern improved ear set. Whereas, on the first season the trend was not regular.Yield and yield components of maize were significantly affected by date of planting, further, all studied traits (ear length, ear diameter, number of kernels/row, 100-grain weight and grain yield/ fed.) followed the same general tendency. There were ever decreases in the values of these traits with delaying date of planting. However, these results may be due to the favourable environmental conditions which had led to increase vegetative growth of maize plants. Similar results were obtained by **Soliman *et al* (2004).** The data also evidenced that the yield of maize/fed grown as late as 20th June decreased by 28.4 and 32.2% in 2003 and 2004 seasons, respectively as compared with maize planted on first of June (earliest date) and by 15.4 and 18.7% as compared with maize planted on 10th June in 2003 and 2004 seasons, respectively.

B- Effect on groundnut (the main crop)

1- Effect of maize densities on groundnut

The effect of maize densities on plant heights of groundnut was evident (Table 5), although groundnut was spaced as recommended, i.e, 10cm. apart on all ridges. The data revealed that plant heights were tenaciously associated with shade offered by the shade crop. Heights of groundnut plants were positively correlated with maize shade and reached maximal when maize was planted at 50cm. apart and two plants per hill. Whereas when groundnut plants were shaded by one maize plants/ hill grown at 100cm. apart values reached minimal. Height of groundnut plants shaded by one maize plant/ hill and grown at 50cm. apart ranked the second, whereas those shaded by two maize plants/ hill at 100cm. apart ranked the third. These results were true in both seasons. The effect of the shade crop on stem elongation of the understory crop has been previously demonstrated by **Ibrahim (2000).** A regular trend could be detected for the average number of branches/ plant as influenced by densities of the shade crop. The effect was also governed by the magnitude of shading. The average number of branches/ plant significantly increased to maximum when shaded by maize grown as an overstory crop at 100cm. apart and thinned at one plant/ hill (least density of the shade crop), whereas minimum groundnut branching was obtained when the shade crop was orientated at 50cm. apart and thinned at two plants/ hill. Groundnut plants under two maize plants/ hill spaced at 100cm. ranked the second, and those orientated at 50cm. apart and thinned at one maize plant/ hill ranked the third. These results were true in both season. Yield and yield components were also significantly affected by the geometric distribution of the shade crop. The data indicate that all these traits followed similar trends. The

Table 5. Effect of maize densities on yield and yield components of groundnut intercropped with maize in 2003 and 2004 seasons

Treatments	Plant height (cm)	No. of branches /plant	No. of pods/ plant	Wt. of Pods / plant (g)	Wt. of 100 seeds (g)	Yield (Ardab/ fed)
Plant densities						
				2003		
S1 (28000 plants/fed)	52.56	6.34	33.78	37.62	55.24	6.18
S2 (14000 plants/fed)	47.61	7.07	37.67	41.77	65.47	6.94
S3 (14000 plants/fed)	45.10	7.90	41.56	46.78	66.77	7.41
S4 (7000 plants/fed)	41.56	8.48	48.56	50.06	70.08	8.18
LSD 0.05	1.86	0.34	3.74	2.56	0.99	0.39
				2004		
S1 (28000 plants/fed)	51.77	5.98	31.56	35.92	56.73	5.64
S2 (14000 plants/fed)	47.29	6.64	35.33	39.00	62.49	6.58
S3 (14000 plants/fed)	44.27	7.53	38.67	43.50	64.31	6.90
S4 (7000 plants/fed)	40.40	8.04	45.67	45.43	66.46	7.57
LSD 0.05	1.52	0.48	3.26	4.15	1.98	0.32

values of yield component traits, i.e, the average number of pods/plant, pods weight/ plant, 100 seeds weight and the yield of seeds/ (ardab) /fed when maize plants was grown at 100cm. apart exceeded those when maize plants were orientated at 50cm. apart. Further within both groups, when maize was thinned at one plant/ hill exceeded those thinned at two maize plants/ hill. Based on the results obtained, it seems that yield and yield components of groundnut were associated with maize density and distribution. The more the shade offered by the overstory crop the less the values of these traits were obtained. Differences among the treatments imposed were also statistically significant. Several investigators reached the conclusion that modification of the shade crop population and geometry did influence the spatial variability of solar irradiance intercepted by groundnut foliage **Liu and Midmore 1990).** Furthermore, they found that the square planting over the understory crop had the highest maize population and resulted in substantially reduced yield and yield components of intercropped crop due to the low amount of light intercepted. On other hand, rectangularity increased with widening distances between maize plants (the shade crop) which in turn increased

exponentially the light transmitted by maize canopy to the interplanted groundnut (edge).

The yield of groundnut when shaded with least maize density (S_4) exceeded that with most dense maize population (S_1) by 32.3 and 34.2% in 2003 and 2004 seasons, respectively. It could be concluded that maize grown as the shade crop in groundnut fields to increase, the utilization rate of sandy soil (in particular) and conserve water budget should be at 100cm. apart and thinned at one plant/ hill to avoid the deleterious effect of shading on the main crop.

2- Effect of planting dates of maize on groundnut

Data presented in (Table 6) indicate that the planting dates of the shade crop had significant effects on growth, yield and yield components of groundnut (the main crop). The result hold true in both seasons. Furthermore, the trends as influenced by the treatment imposed were similar in both seasons. Data indicate that plant heights of groundnut decreased gradually and consistently with delaying planting date of maize. The long life cycles of both components in the intercrop they live together stimulated groundnut stems internodes to elongate as a result of more shading seemed to be cogent and feasible associated with early date of maize planting. The increases might be due to lower shading on the understory crop with delaying maize planting Yield/fed and yield components, i.e, average number of pods/ plant, pods weight/ plant, and 100 seeds weight followed the same trend. Increases in the values of these traits were associated with delaying the date of maize planting. Diminution the light intercepted by groundnut canopy was associated with early maize planting might be the cause of the favorable effect. It could be concluded that delaying

Table 6. Effect of maize planting dates on yield and yield components of groundnut intercropped with maize in 2003 and 2004 seasons.

Treatments	Plant height (cm)	No. of branches /plant	No. of pods/ plant	wt. of pods / plant (g)	wt. of 100 seeds (g)	Yield (Ardab/ fed)
Dates of planting						
			2003			
D1 (1st June)	51.14	5.82	33.92	35.98	55.08	5.53
D2 (10th June)	45.85	7.51	38.25	43.27	64.13	7.19
D3 (20th June)	34.13	9.02	49.00	52.93	76.97	8.81
LSD 0.05	2.82	1.23	4.69	3.77	0.74	0.35
			2004			
D1 (1st June)	50.43	5.43	31.17	33.43	52.41	4.98
D2 (10th June)	45.23	7.15	35.42	40.35	61.46	6.74
D3 (20th June)	42.55	8.57	46.83	49.18	73.63	8.29
LSD 0.05	2.26	0.83	3.78	5.38	1.65	0.38

planting date of the overstory crop to 20th of June is advisable, since yield of groundnut increased by 59 and 66% in 2003 and 2004 seasons, respectively.

C- Interaction effect of planting dates and densities of the shade crop on maize

Data of the interaction effects of planting dates and plant densities of maize on growth, yield components and yield/ fed were insignificant in most traits except in case of ear diameter in 2003 and 2004 seasons. However, the course of change for all traits followed the general tendency of the main treatment effect as a whole. Data on the interaction effect of these traits were governed by the trend predominated the two main variables, i.e, maize densities and date of maize planting as they behaved individually. Growth traits, plant height, and ear height reached maximum values when maize was spaced at 50cm and thinned at two plants/ hill and maize was planted on the earliest date, whereas, these traits reached minimal values when maize spaced at 100cm and one maize plant per hill and maize planting delayed to 20th of June. Percent of plants with two ears, ear length, ear diameter, number of rows/ear, number of kernels/row, and 100-grain weight behaved different. Highest values of yield/ fed were associated with maize grown at 50cm. apart and thinned to two plants/ hill, and maize was planted at the earliest date whereas the lowest was associated with maize spaced at 100cm. and thinned to one plant/ hill when maize planting delayed to 20th of June. These results hold true in both seasons (Table 7).

D- Interaction effect of planting dates and spacing of the shade crop on groundnut

Resemblance to the interaction effects of both main variables on maize traits, were the interaction effects on groundnut traits, i.e, growth, yield components and yield/ fed were governed by both main variable effects when they behaved individually. Plant height reached maximum value when maize was grown at 50cm. apart and was thinned at two plants/ hill and maize was grown at the earliest date. Nevertheless, the interaction effects on all traits were insignificant except in case of the average number of branches /plant and 100-seeds weight in 2003 season although, regular trends could be detected. Whereas the value of plant height minimized to the lowest when maize was grown at 100cm. apart and thinned to one plant/ hill at the latest planting date (20th of June). The average number of branches and all other traits of yield components and yield/ fed, behaved different trend. Maximum values of these traits were obtained when maize was grown at 100cm. apart and thinned to one plant/ hill and maize was seeded at the latest date (20th of June) whereas minimum values were obtained when maize was grown at 50cm. apart with two plants/ hill and maize was seeded at the earliest date. It could be concluded that thin planting of the shade crop is recommended rather than dense planting to avoid any detrimental effects on the main crop (Table 8).

Table 7. Interaction effect of planting dates and maize densities on yield and yield components of maize intercropped with groundnut in 2003 and 2004 seasons

Treatments		Plant height (cm)	Ear height (cm)	Plants with two ears %	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/ row	Wt. of 100-grains (g)	Grain yield (ardab/fed)
Date of planting	Plant densities					2003				
D1 (1st June)	S1 (28000 plants/fed)	254.00	134.0	16.10	19.60	4.27	12.73	37.53	33.27	15.35
	S2 (14000 plants/fed)	253.70	133.67	17.10	21.20	4.60	13.67	41.80	34.50	10.33
	S3 (14000 plants/fed)	252.00	129.70	18.17	21.67	4.77	14.70	43.73	36.77	9.90
	S4 (7000 plants/fed)	248.67	128.0	19.00	22.67	5.50	16.13	45.87	38.10	5.27
D2 (10th June)	S1 (28000 plants/fed)	244.33	126.33	15.13	18.27	4.13	12.30	36.40	32.27	12.60
	S2 (14000 plants/fed)	241.30	123.33	16.03	18.70	4.37	13.33	37.47	33.17	8.53
	S3 (14000 plants/fed)	240.70	123.0	17.07	19.23	4.50	14.53	41.93	34.60	8.60
	S4 (7000 plants/fed)	237.33	122.67	18.07	20.93	4.67	15.77	43.97	37.13	5.00
D3 (20th June)	S1 (28000 plants/fed)	232.33	121.33	14.37	16.90	3.30	10.73	33.77	31.33	10.90
	S2 (14000 plants/fed)	229.00	119.0	14.87	17.80	3.67	13.30	35.13	33.03	6.77
	S3 (14000 plants/fed)	224.00	116.0	15.40	18.70	3.90	13.93	37.67	33.57	7.37
	S4 (7000 plants/fed)	215.00	112.67	15.90	19.27	4.50	14.80	39.63	34.93	4.33
	L.S.D. 0.05	NS	NS	NS	NS	0.22	NS	NS	NS	NS

Table 7. Cont.

Treatments		Plant height (cm)	Ear height (cm)	Plants with two ears %	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/ row	Wt. of 100-grains (g)	Grain yield (ardab/fed)
Date of planting	Plant densities					2004				
D1 (1st June)	S1 (28000 plants/fed)	257.33	135.67	16.33	19.50	4.37	12.00	38.17	33.80	14.50
	S2 (14000 plants/fed)	253.30	134.33	17.30	19.87	4.60	12.67	42.27	34.23	9.77
	S3 (14000 plants/fed)	251.33	131.33	18.40	20.50	5.13	14.10	43.60	36.43	8.77
	S4 (7000 plants/fed)	249.67	130.00	19.27	21.50	5.63	16.00	45.33	37.20	5.30
D2 (10th June)	S1 (28000 plants/fed)	245.0	129.00	15.73	17.80	3.93	11.67	35.03	33.27	12.40
	S2 (14000 plants/fed)	243.0	127.67	16.70	18.80	4.23	12.57	36.07	33.73	10.03
	S3 (14000 plants/fed)	238.67	126.67	17.30	19.60	4.37	13.33	38.57	34.23	9.77
	S4 (7000 plants/fed)	236.67	123.0	18.20	20.27	4.57	15.20	41.80	35.27	4.90
D3 (20th June)	S1 (28000 plants/fed)	234.67	122.67	14.63	16.93	3.30	10.40	32.80	30.50	10.67
	S2 (14000 plants/fed)	225.33	119.67	15.00	17.60	3.63	12.27	34.27	32.73	6.00
	S3 (14000 plants/fed)	221.0	117.0	15.67	18.37	3.73	13.20	36.87	33.13	6.37
	S4 (7000 plants/fed)	216.33	113.67	15.97	19.33	4.33	14.40	39.57	34.70	3.80
L.S.D. 0.05		NS	NS	NS	NS	1.27	NS	NS	NS	NS

Table 8. Interaction effect of plant densities and planting dates of maize on yield and yield components of groundnut intercropped with maize in 2003 and 2004 seasons

	Treatments	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Pods wt. plant (g)	100 seeds wt. (g)	Yield Ardab/ fed)
Date of planting	Plant densities			2003			
D1 (1st June)	S1 (28000 plants/fed)	54.93	4.30	30.33	29.47	50.77	4.33
	S2 (14000 plants/fed)	51.40	5.37	31.67	33.63	54.63	5.25
	S3 (14000 plants/fed)	50.00	6.37	35.67	40.40	55.97	5.83
	S4 (7000 plants/fed)	47.33	7.23	38.00	40.40	58.93	6.69
D2 (10th June)	S1 (28000 plants/fed)	51.47	6.40	30.67	39.80	58.57	6.56
	S2 (14000 plants/fed)	47.47	7.10	34.67	40.23	63.57	7.11
	S3 (14000 plants/fed)	44.23	7.93	41.00	44.70	65.03	7.42
	S4 (7000 plants/fed)	40.22	8.60	46.67	48.07	69.33	7.67
D3-(20th June)	S1 (28000 plants/fed)	51.27	8.33	40.33	43.60	68.40	7.64
	S2 (14000 plants/fed)	43.97	8.73	46.67	51.43	78.20	8.47
	S3 (14000 plants/fed)	40.17	9.40	48.00	59.97	79.30	8.97
	S4 (7000 plants/fed)	37.13	9.60	61.00	61.70	81.97	10.17
	L.S.D. 0.05	NS	0.60	NS	NS	1.72	NS

Table 8. Cont.

Treatments		Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Pods wt. plant (g)	100 seeds wt. (g)	Yield Ardab/ fed)
Date of planting	Plant densities	2004					
D1 (1st June)	S1 (28000 plants/fed)	53.93	4.03	28.33	27.43	47.93	3.83
	S2 (14000 plants/fed)	50.93	5.00	29.00	31.07	51.87	4.73
	S3 (14000 plants/fed)	50.00	6.07	32.00	37.73	54.50	5.37
	S4 (7000 plants/fed)	46.83	6.06	35.33	37.50	55.33	6.00
D2 (10th June)	S1 (28000 plants/fed)	50.93	5.97	27.67	39.03	56.77	5.92
	S2 (14000 plants/fed)	47.00	6.72	32.67	38.43	61.33	6.83
	S3 (14000 plants/fed)	43.13	7.67	38.00	41.20	61.67	6.92
	S4 (7000 plants/fed)	39.83	8.27	43.33	43.03	66.07	7.28
D3 (20th June)	S1 (28000 plants/fed)	50.43	7.93	38.67	41.30	65.50	7.17
	S2 (14000 plants/fed)	43.93	8.20	44.33	48.07	74.27	8.17
	S3 (14000 plants/fed)	39.67	8.87	46.00	51.57	76.77	8.42
	S4 (7000 plants/fed)	36.17	9.27	58.33	55.77	77.97	9.42
	L.S.D. 0.05	NS	NS	NS	NS	NS	NS

E- Effect on competitive relationships

1- Effect of planting date of maize

The effect of planting dates of maize on the relative yield of both components in the intercrop had distinctive patterns. With delaying time of seeding maize (the shade crop) there were gradual decreases in the values of the relative yield of maize, but on other hand there were gradual increases in the values of relative yield of groundnut. The results were true in both seasons. These results also indicate that all land equivalent rate values obtained as influenced by time of seeding maize achieved yield advantage. The excesses as compared with solid planting averaged 36% and 26% in 2003 and 2004 seasons, respectively. LER values increased with delaying the planting date of maize. The excess with delaying to 20th June (the latest date) over maize grown at the earliest date (1st June) was estimated to 9.2 and 6.5% in both successive seasons, respectively. The relative crowding coefficient data (which considered the ratio of each compound in the intercrop) followed the same trend as land equivalent rate data in both seasons. **Hussein *et al* (2002)** demonstrated yield advantage when maize was intercropped with groundnut. Data on aggressivity revealed that the treatment effect at any date of maize planting exerted low competitive pressure between both components in the intercrop in both seasons. Moreover maize was the dominant component, whereas groundnut was the dominated when maize was seeded at the earliest date, on other hand, reversal trend was observed when maize was seeded at the second and the latest date (20th June).

Data on the competitive ratio to estimate the exact degree of competition, indicate that maize was more competitive than groundnut at the earliest date (1st June) whereas, groundnut was more competitive in the second and latest dates. These results indicate that with delaying seeding maize, competitiveness degree diminished to the least and became in favour growth and yield potential of groundnut in both seasons (Table 9).

2- Effect of plant density of maize

The effect of maize density on the relative yields of both components in the intercrop showed two opposing trends. Data indicate that the relative yield of maize decreased with increasing maize spacing and with diminishing the number of maize plants/ hill to one plant. On the other hand groundnut relative yield followed a reversed trend. Data on total LER indicated yield advantage under any of the treatment imposed. These results also hold fairly true in both seasons. Spacing maize (the shade crop) at 50cm. apart and leaving two plants/ hill after thinning resulted in highest value of Land equivalent rate, with 100cm spacing leaving two plants/ hill after thinning 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 maize density on (RCC) values followed the general tendency of the treatment effect on (LER) values. The results hold true in both seasons. Several investigators supported these results such as **Hussein *et al* (2002) and Ibrahim (2000).** Data on aggressivity indicate that nor any of maize density treatments had any heavy competitive pressure between

Table 9. Effect of plant spacing and planting dates of maize on competitive relationships and yield advantages of groundnut intercropped with maize in 2003 and 2004 seasons

Traits	Land Equivalent Ratio (LER)			Relative Crowding Coefficient (RCC)			Aggressivity "A"		Competition Ratio (CR)	
Treatment	Groun-dnut LG	Maize L_m	Total LER	Groun-dnut KG	Maize Km	K	Groundnut AG	Maize Am	Groun-dnut	Maize
Date of planting									2003	
D1(1st June)	0.55	0.75	1.30	1.24	3.07	3.81	-0.20	+0.20	1.36	0.73
D2(10th June)	0.72	0.64	1.36	2.56	1.76	4.51	+0.08	-0.08	0.89	1.13
D3(20th June)	0.88	0.54	1.42	7.40	1.18	8.73	+0.34	-0.34	0.61	1.63
Plant densities										
S1(28000 plants/fed)	0.62	0.96	1.58	1.62	2.05	35.72	-0.67	+0.67	1.55	0.65
S2(14000 plants/fed)	0.69	0.62	1.31	1.12	3.43	3.84	-0.86	+0.86	1.83	0.54
S3(14000 plants/fed)	0.74	0.63	1.37	1.41	3.52	4.96	-0.81	+0.81	1.73	0.56
S4(7000 plants/fed)	0.82	0.36	1.18	1.12	2.23	2.50	-0.77	+0.77	1.76	0.57
Date of planting						2004				
D1(1st June)	0.47	0.75	1.22	0.90	3.00	2.70	-0.28	+0.28	1.60	0.63
D2(10th June)	0.64	0.63	1.27	1.79	1.67	2.99	+0.01	-0.01	0.98	1.02
D3(20th June)	0.79	0.51	1.30	3.75	1.03	3.86	+0.28	-0.28	0.65	1.55
Plant densities										
S1(28000 plants/fed)	0.54	0.95	1.49	1.16	18.41	21.36	-0.83	+0.83	1.76	0.57
S2(14000 plants/fed)	0.63	0.59	1.22	0.83	2.97	2.47	-0.87	+0.87	1.91	0.52
S3(14000 plants/fed)	0.66	0.62	1.28	0.95	3.26	3.10	-0.89	+0.89	1.91	0.52
S4(7000 plants/fed)	0.73	0.37	1.10	0.65	2.19	1.42	-0.87	+0.87	2.04	0.49

both components in the intercrop. However, maize was always the dominant component crop (in favour the shade crop) and groundnut was always the dominated. in both seasons.

The exact degree of competition as measured by competitive ratio (CR) indicate that maize was more competitive than groundnut with diminishing maize density to the least (i. e, up to spacing at 100cm and leaving one plant/ hill) these observations were true in both seasons, and in harmony with those obtained by **Ibrahim (2000).**

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مجلة اتحاد الجامعات العربية للدراسات والبحوث الزراعية، جامعة عين شمس، القاهرة ، ١٣(٣)، ٧٧١-٧٩١، ٢٠٠٥

تأثير ميعاد الزراعة والكثافة النباتية للذرة الشامية المحمل مع الفول السوداني على النمو والمحصول ومكوناته لكلا المحصولين

[٥١]

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أجريت تجربتان حقليتان بمحطة بحوث جنوب التحرير (على مبارك) خلال عامي ٢٠٠٣، ٢٠٠٤ وذلك لدراسة تأثير اربعة معدلات من الكثافة النباتية للذرة الشامية وهي زراعة الذرة على مسافات ٥٠سم مع ترك نبات واحد أو نباتين في الجورة والزراعة على مسافات ١٠٠سم مع ترك نبات واحد أو نباتين في الجورة، كذلك دراسة تأثير ميعاد زراعة الذرة الشامية (أول يونيه ،١٠ يونيه ،٢٠ يونيه) المحمل مع الفول السوداني والمنزرع على جميع الخطوط على النمو وكمية الحاصل ومكونات الحاصل لكلا المكونين (الذرة الشامية والفول السوداني).

وقد أشارت البيانات المتحصل عليها أن طول الكوز وقطر الكوز وعدد الصفوف/كوز وعدد الحبوب/صف قد زدات بزيادة المسافة بين النباتات وتقليل عدد النباتات بالجورة (نبات واحد). كما زاد حاصل الذرة بتضييق المسافة بين النباتات وبزيادة عدد النباتات بالجورة. ونقصت قيم حاصل الذرة الشامية ومكوناته بتأخير ميعاد الزراعة حتى آخر ميعاد (٢٠ يونيه).

كما أوضحت البيانات إرتباط حاصل الفول السوداني ومكوناته بكثافة نباتات الذرة (المسافة بين النباتات وعدد النباتات بالجورة) كلما ازداد الظل الناتج من زيادة كثافة نباتات الذرة تأثرت قيم المحصول و حاصل الفول السوداني سلبا. حيث أوضحت البيانات أن أفضل قيم تم التحصل عليها جاءت عندما زرعت الذرة على مسافات ١٠٠سم مع ترك نبات واحد بالجورة. ومن

ناحية أخرى فان تأخير ميعاد زراعة الـذرة إلى الميعاد الثالث قد أدى إلى زيادة حاصل الفول السوداني ومكوناتة.

أوضحت البيانات أيضا أن تأخير ميعاد زراعة الذرة الشامية قد أدى إلى زيادات في قيم معدل كفاءة استخدام الأرض وكذا معامل الحشد النسبي. ولم تؤدى هذه المعاملات إلى ضغوط تنافسية محسوسة وذلك عند قياس قيم العدوانية.

كما نقصت النسبة التنافسيةلأقصى مدى بتأخير ميعاد الزراعة. ادت زراعة الـذرة على مسافات ٥٠سم وترك نباتين بـالجورة إلى زيادة معدل كفـاءة اسـتخدام الأرض وأيضـا قيمـة معامـل الحشـد النسـبى. وأوضحت البيانات أيضا أن جميع معاملات الكثافات النباتية لم تؤدى الـى أى ضـغط تنافسى مـؤثر وذلـك عنـد قيـاس قـيم العدوانيـة.

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