Effect of Sowing Dates, Plant Density of Sesame and Intercropping on Yield and Yield Components of Cotton and Sesame

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ABSTRACT

A field trial was conducted at Sakha Agricultural Research Station, Kafr El – Sheikh Governorate (31^0 07⁻ N Latitude and 30^0 57⁻ E longitude with an elevation of about 6 mean sea level MSL), Egypt, during the two growing seasons of 2017 and 2018 to study the effect of sowing dates, plant density, and intercropping on yield and some yield attributes of cotton and sesame. Cotton (*Gossypium barbadense L.*) and sesame (*Sesamum indicum*) were sole cropped and intercropped at three sowing dates (April 15 th (S_1), April 30 th (S_2) and May15th (S_3)) and two densities (33% (D_1) and 50% (D_2) of sole crop) with sesame. The experiment was laid out in randomized completely block design with split plot design with three replications. sowing date of sesame were randomized in main plots and plant density of sesame in subplots. The highest amount of applied water (AW) and water consumptive use (CU) were recorded under the first sowing date, while the highest productivity of irrigation water (PIW) and water productivity (WP) were recorded at the third sowing date and 33% density for sesame. Sowing dates had non-significant effect on all traits in cotton except seed yield /plant at the second season that was significant but seed yield /fed was significant of both two seasons, while, non-significant effect on all traits in sesame except seed yield /plant was significant at two seasons.

Plant densities were highly significant effect on all traits in cotton except plant height at two seasons. And boll weight at the first season, while, significant effect on all traits in sesame except no. of branches /plant that was in significant and seed yield /plant was significant at two seasons. The highest land equivalent ration (LER) were obtained 1.41, 1.40, respectively as mean of both two seasons. The highest mean net incomes were (30120 and 27688 L.E.) obtained from sowing date 3 (May15th) and density 1(33%) of sesame in the first and second seasons, respectively.

Key Words: Cotton; Sesame; Planting densities; Sowing date; water relations, Land Equivalent Ratio.

INTRODUCTION

Cotton (*Gossypium barbadense L.*) is the most important cash crop. In Egypt, more than one million rural families work in cotton production, over 850 thousand individuals participate in cotton manufacturing and trading and more than 1 million 250 persons serve indirectly in the cotton sector. The exports of cotton and textile products reached around US $2400 million, while exports of raw lint cotton reached around US $170 million in 2017/2018 due to the rise of world cotton prices. Egypt is considered one of the founders of the ICAC since 1939. Egypt seeks to face the challenges of cotton value chain and put intelligent and sustainable solutions for its cultivation, manufacturing and trading. Cotton productivity depends upon a large number of environmental factors such as crop and water management. An amount of irrigation water of cotton is ranged between 3400 and 4700 m^3/fed. To solve the problem of limitation of irrigation water resources a lot of ideas have been raised nowadays some of them were used in this present study such as cultivation on wide furrows (raised-beds technique) instead of cultivation on normal furrows (normal cultivation method) where raised-beds decreasing irrigation inlets, this technique tested on some field and vegetable crops and proved effective in increasing crop and water use efficiency, Raut et al., (2000) *and Anonymous (2006).*

Sesame (*Sesame indium*) is one of the major oil seed crops in the world and there are fifteen health and nutrition benefits of sesame seeds (*15 Health and Nutrition Benefits of Sesame Seeds (healthline.com*)). *Abou-Kerisha et al (2008)* showed that yields of all sesame varieties were decreased under condition of intercropping. Sesame Giza 32 variety surpassed the other varieties (Shandaweel 3 – and Toshka 1) in plant height, number of branches/plant, number of capsules/plant, seed yield/plant and seed yield/fed. the highest plant density (100%) recorded the highest sesame seed yield/fed. where the increase were 46.93 and 13.50 % in the first season, 2.46 and 8.71 % in the

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second season and 25.86 and 11.19 % in the combined data over the low and medium density treatments, respectively. *Abdel-Galil and Abdel-Ghany (2014)* indicated that the intercropping pattern 3 groundnut: 1 sesame recorded higher groundnut yield and its attributes than 2:2 pattern while the highest sesame yield and its attributes were obtained by 2:2 pattern.

Agricultural experts suggest that a way to improve productivity of cotton is intercropping system. For these reasons, Intercropping Cotton and sesame was done in Egypt as a conventional practice from years ago. Use of intercropping by smallholders is common in the rain fed areas all over the world (*Ofuso-Amin, 2007*). The advantages of intercropping over mono-cropping include soil conservation, lodging resistance, yield increment (*Banik et al, 2006*). When two crops are planted together, may occur intra and/or inter specific competition or facilitation between plants (*Zhang et al, 2003*). A number of indices such as Land Equivalent Ratio (LER), Relative Crowding Coefficient, Competitive Ratio, Actual Yield Loss and monetary advantages, have been proposed to describe competition and economic aspects of intercropping systems (*Ghosh, 2004; Yilmaz, 2007*) and *Shahid (1997)* reported a dominant effect of cotton having positive “A” value when grown in association with mung bean, mash bean and linseed. However, such indices have not been used for cotton and sesame to evaluate the competition among species in Egypt. Thus, the mains objectives of this current investigation were to investigate the effect of intercropping sesame (*Sesame indium*) and cotton (*Gossypium barbadense L.*) at different three sowing dates and two densities of sesame on growth, yield and its components of both plant species. Working on different intercropping patterns that could actually maximize resource efficiency would provide farmers opportunities for increasing the net incomes and maximum the use of their inputs.

MATERIALS AND METHODS

A field investigation was conducted at Sakha Agricultural Research Station, Kafr El– Sheikh governorate (31^0 07¯ N Latitude and 30^0 57¯ E longitude with an elevation of about 6 meters above the sea level), Egypt, during the summer, season 2017and 2018 . The aim of this work was to study the effect of intercropping cotton with two densities of sesame (33% (D_1) and 50% (D_2) of sole crop) under three sowing dates in relation to yield and yield component of both crops. The cotton (the main crop) was grown on all ridges at (normal density). A split plot design with three replications was used. The main plots were occupied by three sesame sowing dates were (April 15 th (S_1), April 30 th (S_2) and May15th (S_3)) in the first and second seasons, respectively. and the sub plots were devoted to two sesame densities were 33%, 50% of solid crop .Cotton(c.v Giza 94) and sesame (c.v Shandaweel 3)were employed in this study seeds were received from Cotton Crop Research Inst., and oil Crops Research Dept., Field Crops Res. Inst., Agric. Res .Center. During 1st and 2nd seasons, cotton was sown on 31th march and 1st April, respectively. The area of each sub plot was 42 m^2 (6 MSL wide × 7 m. long), containing five broadcasts. Cotton seed rates was 30 kg seed/fed was grown on two sides of all ridges (100%) at 25 cm between hills (2 pl/hill), while sesame seed rate was 2 kg seed/fed. was grown on broadcast (50%) one alternative another broadcast, but (33%) one alternative another two broadcast at 20 cm. between hills (1 pl /hill) .Solid planting of cotton and sesame were sowing as recommended. Application of super phosphate fertilizer was added at a rate of 30 kg P_2O_5 fed^{-1} in the form of calcium super phosphate (15.5% P_2O_5) before sowing and during soil preparation. Nitrogen fertilizer was applied at a rate of 60 kg N fed^{-1} was applied in two equal doses (i.e. at the first and second irrigation). Potassium fertilizer was applied at a rate of 24 kg K fed^{-1} was applied with the first dose for nitrogen fertilizer. Irrigation was added nine times during each growing season. The experiment was established on a clayey and well-drained soil.

Monthly participation, relative humidity and air temperature data recorded near the experimental location are given in table (1).

Some physical and chemical characteristics of the studied site were shown in Tables (2 and 3), of particle size distribution, soil bulk density, soil field capacity and permanent wilting point were determined according to *(Klute, 1986)* in Table (2). The studied chemical characteristics, in Table (3): Soil reaction (pH) in 1:2.5 soil water suspension, Total soluble salts (Ec_e) and soluble cations and anions were determined in soil paste extract by the standard methods as described by *(Jackson, 1973).*

Data collection and calculations:

1-Applied water:

Applied water included an irrigation water plus rainfall. Irrigation water was controlled and measured by rectangular weir. Irrigation water discharge was determined according to ***Michael, (1978)*** as follows:

$$Q = 1.84\ LH^{1.5}$$

Where: Q = water discharge, m^3sec^{-1}, L = width of weir, cm and H = the head above weir crest, cm.

2-Water consumptive use:

To compute the actual consumed water of the growing plants. Soil moisture percentage was determined (on weight basis) before and after each irrigation as well as at harvesting. Water consumptive use by growing plants was calculated based on soil moisture depletion (SMD) according to *Hansen et al, (1979).*

$$CU = SMD = \sum \frac{\Theta 2 - \Theta 1}{100} * Db * D * 4200$$

Where: CU= Water consumptive use in the effective root zone (60cm), ϴ2= Gravimetric soil moisture percentage after irrigation, ϴ1= Gravimetric soil moisture percentage before irrigation, Db= soil bulk density (Mg m^{-3}) for depth, D= Soil layer depth (60 cm), and 4200 = feddan area in m^2.

3- Productivity of irrigation water (PIW):

The productivity of irrigation water (PIW) is generally denied as crop yield (kg) per cubic meter of applied water. It was calculated according to *Ali et al., (2007).*

$$PIW = \frac{Y}{AW}$$

Where: PIW = Productivity of irrigation water (kg m^{-3}), Y= Yield (kg) and AW = Applied water (m^3).

4- **Water productivity (WP):**

Water productivity (WP), is generally defined as crop yield (kgfed^{-1}.) per cubic metre of water consumption. It was calculated according to *Ali et al., (2007).*

$$WP = \frac{Y}{Cu}$$

Where: **WP**= Water productivity (kg m^{-3}), **Y**= Yield (kg) and **Cu** = Water consumptive use(m^3).

5- Growth parameters

At harvesting, ten plants were randomly chosen to determine the plant averages of

a) Cotton were:

1-Plant height, cm.

2- No. of days to first flower appearance,

3-Boll weight (g), 4-Seed cotton yield /plant (g),
5- Seed yield /fed (kantar), 6-Lint cotton yield /plant,
7-Fiber length (mm), 8-Fiber Strength (g/tex),
9- Fiber Fineness (micromaire value),
10-Number of fruiting branches. 11- Lint %.

b) Sesame were:

1-Plant height (cm) 2- number of branches /plant

3- Number of capsules/plant 4-seed index (g)

5- Seed yield /plant (g), 6- seed yield /fed.

Table 1. Climatological data of Sakha region during the two seasons of study 2017 and 2018.

Month	T (C^0)			RH (%)			W_s m sec^{-1}	Pan Evap. mm.	Rain, Mm
	Max	Min	Mean	Max	Min	Mean			
2017									
Mar.	22.5	18.0	20.2	84.9	60.3	72.6	0.97	2.97	0.00
April.	26.5	21.6	24.1	79.4	50.8	65.1	1.03	4.54	0.00
May	30.6	25.8	28.2	77.7	45.6	61.7	1.23	6.59	0.00
June	32.5	28.1	30.3	80.1	51.4	65.8	1.19	7.10	0.00
July	32.2	29.0	30.6	84.4	57.6	71.0	0.94	6.44	0.00
August	33.9	28.3	31.1	85.9	55.3	70.6	0.81	6.04	0.00
Sep.	32.5	25.9	29.2	86.3	50.3	68.3	0.99	5.37	0.00
Oct.	28.7	24.0	26.4	81.1	54.7	67.9	0.85	3.26	10.6
2018									
Mar.	25.5	16.6	21.1	89.3	48.4	68.8	0.54	4.24	0.00
April	27.2	19.9	23.6	80.9	43.9	62.4	0.85	5.78	0.00
May	31.2	23.9	27.6	75.6	43.3	59.4	1.10	6.34	0.00
June	32.6	25.3	29.00	75.5	48.2	61.9	1.14	7.72	0.00
July	34.2	25.4	29.8	82.5	51.0	66.8	1.03	7.90	0.00
August	33.9	25.3	29.6	79.5	51.9	65.7	0.87	6.42	0.00
Sep.	32.8	23.5	28.2	28.2	48.3	65.7	0.79	4.99	0.00
Oct.	29.5	20.6	25.1	25.1	49.6	66.1	0.66	3.24	10.5

Source: Sakha Meteorological Station.

Table 2. The mean values of some physical characteristics of the studied site before cultivation through the two growing seasons 2017/18.

Soil Depth, cm.	Particle Size Distribution			Texture classes	Soil moisture constants on weight basses			Bulk density (Mg/m³)
	Sand%	Silt %	Clay %		F.C %	P.W.P %	AW %	
0 – 20	15.2	29.4	55.4	Clayey	43.7	23.8	19.9	1.14
20 – 40	21.9	30.8	47.3	Clayey	39.8	21.6	18.2	1.19
40– 60	24.2	32.3	43.5	Clayey	38.3	20.8	17.5	1.21
Mean	20.4	30.8	48.7	Clayey	40.6	22.1	18.5	1.18

Where:- F.C % = Field capacity, P.W.P % = Permanent wilting point and AW % = Available water

Table 3. The mean values of some chemical characteristics of the studied site before cultivation through the two growing season 2017/18.

Soil Depth, cm	Ec, dS/m	PH	Soluble ions meq/l							
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{--}	Cl^{-}	SO_4^{--}
0-20	2.37	8.44	7.11	3.89	12.55	0.26	0.00	4.55	10.50	8.76
20-40	2.76	8.40	8.72	5.60	13.20	0.28	0.00	4.45	11.10	12.25
40-60	3.59	8.37	11.05	7.89	16.80	0.29	0.00	4.40	11.50	20.13
Mean	2.91	….	8.96	5.79	14.18	0.28	0.00	4.47	11.03	13.71

PH was measured in 1:2.5 soil water suspension and SO_4 – calculated by the difference by soluble cations and anions.

6- Land Equivalent Ratio (LER):

The ratio of area needed under sole cropping to that of intercropping at the same management level to produce an equivalent yield was calculated according to Mead and Willey (1980) as follows:

$LER = (Y_{ab}/Y_{aa}) + (Y_{ba}/Y_{bb})$

Where, (Y_{aa}) and (Y_{bb}) are the sole crop yields of crops (a) and (b), respectively; while (Y_{ab}) is the intercrop yield of crop a, and (Y_{ba}) is the intercrop yield of crop b.

7- Economic evaluation:

It was calculated for each treatment in Egyptian pounds (L.E.) using the average market prices for both seasons. The average market prices were 2150 L.E. kentar^{-1} for cotton, and 2500 L.E. ardb^{-1} for sesame yield.

8- Statistical analysis:

Data was statically analyzed according to Gomez and Gomez (1984). The experimental design was a split plot design with three replications.

RESULTS AND DISCUSSIONS

1-Amount of seasonal applied water (AW) and consumptive use (CU):

Results presented in Tables (4&5) showed that, the overall mean values of AW and CU for cotton and sesame together were affected by sowing date and plant density treatments. These crops consider summer field crops. Seasonal amount of applied water for sesame was slightly affected by sowing date treatments. The highest seasonal values for IW were recorded under sowing date S_1 (first sowing date) where the over mean value is 3637.42 m^3 fed^{-1} (86.61 cm) in the mean two seasons, respectively. Meanwhile, the lowest seasonal values were recorded under S_3 and the values are 3540.3 m^3 fed^{-1} (84.29 cm) in the two growing seasons, respectively. Generally, the seasonal values for Wa can be descended in this order $S_1 > S_2 > S_3$.

Concerning, water consumptive use CU presented data in Table (5) indicated that the highest overall mean value for CU were recorded under S_1 (first sowing date) and the values is 2495.04 m^3 fed^{-1} (59.41 cm). Meanwhile, the lowest overall mean values were recorded under S_3 treatment and the value is 2325.87 m^3 fed^{-1} (55.38 cm). Generally, the overall mean values of water consumptive use can be descended in order $S_1 > S_2 > S_3$ and under plant density treatments $D_2 > D_1$, respectively. Decreasing the values of Cu under S_3 in comparison with S_1 and S_2 might be attributed to decreasing the amount of applied water and hence, forming weak plants with low vegetative cover. Therefore, decreasing amount of transpiration from plant surface. These results are in agreement with those reported by *Chimanshette and Dhoble (1992), Meleha (2000), Raut et al. (2000) and Kassab, M. M. (2003).*

Table 4. Effect of sowing date and Plant Density on seasonal applied water (AW) for sesame intercropped on cotton in the two growing seasons.

Sowing date	Plant Density	AW					
		1st growing season		2nd growing season		Mean	
		m^3fed^{-1}	Cm	m^3fed^{-1}	Cm	m^3fed^{-1}	Cm
	D_1	3647.50	86.85	3905.82	93.00	3776.66	89.92
S_1	D_2	3647.50	86.85	3905.82	93.00	3776.66	89.92
Mean		3647.50	86.85	3905.82	93.00	3776.66	89.92
	D_1	3501.24	83.36	3773.60	89.85	3637.42	86.61
S_2	D_2	3501.24	83.36	3773.60	89.85	3637.42	86.61
Mean		3501.24	83.36	3773.60	89.85	3637.42	86.61
	D_1	3449.27	82.18	3631.33	86.46	3540.30	84.29
S_3	D_2	3449.27	82.18	3631.33	86.46	3540.30	84.29
Mean		3449.27	82.18	3631.33	86.46	3540.30	84.29
Cotton sole		3588.21	85.43	3872.07	92.19	3709.18	88.31
Sesame sole		2219.6	52.8	2374.5	56.54	2297.05	54.69

Wa= water applied, S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, and D_2 =50% density

Table 5. Effect of sowing date and Plant Density on seasonal consumptive use (Cu) for sesame intercropped on cotton in the two growing seasons.

Sowing date	Plant Density	CU					
		1st growing season		2nd growing season		Mean	
		m^3fed^{-1}	Cm	m^3fed^{-1}	cm	m^3fed^{-1}	Cm
	D_1	2342.11	55.76	2402.59	57.20	2372.35	56.48
S_1	D_2	2586.95	61.59	2648.50	63.06	2617.73	62.33
Mean		2464.53	58.68	2525.55	60.32	2495.04	59.41
	D_1	2255.88	53.71	2314.31	55.10	2285.10	54.41
S_2	D_2	2400.72	57.16	2437.62	58.03	2419.17	57.60
Mean		2378.3	56.63	2375.97	56.57	2377.14	56.60
	D_1	2180.0	51.90	2236.62	53.25	2208.31	52.58
S_3	D_2	2414.90	57.49	2471.93	58.86	2443.40	58.18
Mean		2297.45	54.70	2354.28	56.05	2325.87	55.38
Cotton sole		2254.15	53.67	2380.67	56.68	2317.41	55.18
Sesame sole		1553.75	36.99	1665.27	39.65	1609.51	38.32

CU= consumptive use, S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, and D_2 =50% density

2- Some irrigation efficiencies:

Presented data in Table (6) indicated that the values of productivity of irrigation water (PIW) and water productivity (WP) were affected by both the two studied treatments (sowing date and plant density). Concerning, the effect of sowing dates treatments on PIW and WP, the highest mean values were recorded under S_3 in the first and second growing seasons and the values are 0.56 kg m^{-3} for PIW and 0.86 kg m^{-3} for WP in the two growing seasons, respectively. Meanwhile, the lowest mean values were recorded under S_1 and the values are 0.53 kg m^{-3} for PIW and 0.80 kg m^{-3} for WP in the two growing seasons, respectively. Generally, the mean values for PIW and WP can be descended in order D_2 >

D_1 in the first and second growing seasons under sowing dates treatments. Increasing the mean values of PIW and WP under treatment S_3 in comparison with other irrigation treatments S_1 and S_2 in the two growing seasons may be attributed to decreasing yield and increasing the amount of applied water and consumptive use under the conditions of irrigation treatment S_1 comparing with irrigation treatment S_3 which recorded the highest value for applied water and recorded the highest value for water consumptive use. Consequently, under these conditions the lowest mean values for PIW and WP were recorded. These findings are in the same line with those reported by *Raut et al., (2000), Kassab, M. M. (2003) and Anonymous (*2006*).*

Effect of sowing date and plant density treatments on Cotton

Presented data in Table (7) illustrated that the effect of sowing date and plant density on Plant height, no. of days to first flower appearance, boll weight of cotton in the two growing seasons. All traits were not significantly affected by sowing date and plant density in the two seasons while no. of days to first flower appearance was significant in two seasons but boll weight was significant in the second season. The tallest plants and the first flower appearance were found at the first sowing date and the second density of sesame in the two growing seasons. *The results obtained are in conformity with the findings of Raghuwanshi et al., (1994), Ghosh (2004), Yilmaz(2007) and Dhima et al.(2007)*

Presented data in Table (9) showed that the effect of sowing date on seed cotton yield /plant was not significantly and significant at the two seasons respectively .While, the effect of density was significant at two seasons. The effect of sowing date and density on seed yield /fed was significant, highly significant respectively at two seasons. Lint cotton yield /plant and fiber length (mm), the effect of sowing date for them were non-significant. But the effect of density for lint cotton yield /plant, fiber length (mm) were significant and highly significant respectively at two seasons. The highest values in all traits at Table (9) were found at the third sowing date (S_3), first density (D_1) (33%) at the two growing seasons. The obtained results were harmony with those reported by *Shahid (1997), Mohammad et al., (2001), Banik et al (2006), Dhima et al., (2007) and Iqbal et al .,(2007).*

Table (9) showed that the effect of sowing date on fiber strength (g/tex), fiber fineness (micromaire value), number of fruiting branches and lint were not significant in all pervious traits at two seasons. While the effect of density were significant in all traits except the first season of fiber strength and two seasons of lint %.The highest values in all traits at table (10) were found at the third sowing date(S_3) ,first density (D_1) (33%) at the two growing seasons. *There results agreed with those reported by Iqbal et al., (2007), Ofuso-Amin (2007) and yilmaz (2007).*

Table 6. Effect of sowing date and Plant Density on productivity of irrigation water (PIW) and water productivity (WP) for sesame intercropped on cotton in the two growing seasons.

Sowing date	Plant Density	PIW (kg m^{-3})			WP (kg m^{-3})		
		1st growing season	2nd growing season	Mean	1st growing season	2nd growing season	Mean
	D_1	0.56	0.52	0.54	0.87	0.85	0.86
S_1	D_2	0.52	0.49	0.51	0.74	0.73	0.74
Mean		0.54	0.51	0.53	0.81	0.79	0.80
	D_1	0.58	0.54	0.56	0.90	0.89	0.90
S_2	D_2	0.54	0.51	0.53	0.79	0.78	0.79
Mean		0.56	0.53	0.55	0.85	0.84	0.85
	D_1	0.59	0.57	0.58	0.94	0.92	0.93
S_3	D_2	0.55	0.53	0.54	0.79	0.78	0.79
Mean		0.57	0.55	0.56	0.87	0.85	0.86
Cotton sole		0.50	0.47	0.49	0.80	0.76	0.78
Sesame sole		0.27	0.27	0.27	0.39	0.39	0.39

PWa= productivity of irrigation water, WP= water productivity, S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, and D_2 =50% density

Table 7. Effect of sowing date and plant density for sesame with cotton on plant height cm, no. of days to first flower appearance, boll weight(g) of cotton in the two growing seasons.

Sowing date	Plant Density	Plant height, cm		No. of days to first flower appearance		Boll weight (g)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
S_1	D_1	179.7	180.2	71.2	71.4	2.48	2.50
	D2	180.0	180.8	72.7	72.2	2.36	2.39
Mean S_1		179.9	180.5	72.0	71.8	2.42	2.45
	D_1	178.0	178.7	71.9	72.0	2.53	2.56
S_2	D_2	180.5	180.5	71.1	71.2	2.46	2.48
Mean S_2		179	179.6	71.5	71.6	2.50	2.52
S_3	D_1	177.3	177.9	71.8	71. 9	2.58	2.60
	D_2	179.7	179.8	71.4	71.6	2.37	2.39
Mean S_3		178.5	178.8	71.6	71.8	2.51	2.51
Mean S		179.13	179.37	71.7	71.7	2.5	2.5
L.S.D. 5% at S		1.435	1.724	0.232	0.846	0.009	0.177
F. Test		Ns	Ns	Ns	Ns	Ns	Ns
L.S.D. 5% at D		2.390	2.320	0.841	0.634	0.180	0.120
F. Test		Ns	Ns	*	*	Ns	*
S * D		Ns	Ns	Ns	Ns	Ns	Ns
Cotton sole		186.54	188.22	73.31	75.11	2.95	3.02

S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, D_2 =50% density * and ** represent significant differences between means at 0.05 and 0.01 level of probability, respectively; NS, non – significant. Each value is mean ±S.D.

Table 8. Effect of sowing date and density for sesame with cotton on seed cotton yield /plant(g), seed yield /fed (kantar), lint cotton yield /plant, fiber length (mm)of cotton in the two growing seasons.

Sowing date	Plant Density	Seed yield /plant (g)		Seed yield /fed (kantar)		Lint yield /plant		Fiber length (mm)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
	D_1	194.1	194.2	11.17	11.24	79.2	79.3	32.1	32.12
S_1	D2	192.0	193.0	10.48	10.53	79.0	79.1	31.2	31.3
Mean S_1		193.5	193.6	10.82	10.89	79.1	79.2	31.65	31.71
	D_1	195.0	195.2	11.18	11.28	79.2	79.3	32.1	32.1
S_2	D_2	193.4	193.5	10.42	10.48	78.6	78.9	30.6	30.7
Mean S_2		194.2	194.35	10.80	10.88	78.9	79.1	31.4	31.4
	D_1	196.1	196.3	11.36	11.47	79.4	79.4	32.3	32.2
S_3	D_2	194.0	194.2	10.48	10.56	79.1	79.1	31.2	31.3
Mean S_3		195.05	195.3	10.92	11.02	79.3	79.3	31.8	31.8
Mean S		194.3	194.4	10.85	10.93	79.1	79.1	31.6	31.6
L.S.D. 5% at S		1.290	1.098	0.428	0.415	0.684	0.534	1.070	0.608
F. Test		Ns	*	*	*	Ns	Ns	Ns	Ns
L.S.D. 5% at D		1.199	1.228	0.0102	0.129	0.311	0.291	0.601	0.380
F. Test		*	*	**	**	*	*	**	**
S * D		Ns	Ns	**	**	Ns	Ns	Ns	Ns
Cotton sole		193.2	193.4	11.51	11.53	79.2	79.4	34.36	34.48

S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, D_2 =50% density
* and ** represent significant differences between means at 0.05 and 0.01 level of probability, respectively; NS, non–significant. Each value is mean ±S.D.

Table 9. Effect of sowing date and density for sesame with cotton on fiber strength(g/tex), fiber fineness (micromaire value). no. of fruiting branches and lint% of cotton in the two growing seasons.

Sowing date	Plant Density	Fiber Strength (g/tex)		Fiber Fineness (micromaire value)		No. of fruiting branches.		Lint %	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
	D_1	39.32	39.36	3.98	4.10	7.87	8.03	40.75	40.79
S_1	D2	39.19	39.20	3.93	4.01	7.53	7.70	40.43	40.50
Mean S_1		39.3	39.3	3.96	4.06	7.7	7.9	40.6	40.7
	D_1	39.33	39.37	4.01	4.12	7.43	7.73	40.75	40.78
S_2	D_2	39.22	39.25	3.95	3.98	7.50	7.67	40.70	40.71
Mean S_2		39.28	39.32	4.01	4.07	7.5	7.74	40.73	40.7
	D_1	39.34	39.38	4.06	4.15	7.97	8.23	41.02	40.90
S_3	D_2	39.27	39.30	3.95	3.98	7.57	7.73	40.86	40.95
Mean S_3		39.3	39.34	3.98	4.05	7.77	7.98	40.94	40.9
Mean S		39.3	39.4	3.98	4.06	7.7	7.87	40.7	41.3
L.S.D. 5% at S		0.174	0.097	0.114	0.104	0.336	0.343	0.349	0.063
F. Test		Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
L.S.D. 5% at D		0.163	0.112	0.063	0.112	0.203	0.256	0.099	0.338
F. Test		Ns	*	*	*	*	*	Ns	Ns
S * D		Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
Cotton sole		39.34	39.37	4.22	4.35	7.92	8.11	40.51	40.63

S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D1= 33%, D2 =50% density
* and ** represent significant differences between means at 0.05 and 0.01 level of probability, respectively; NS, non–significant.
Each value is mean ±S.D.

Sesame

Data in Table (10) showed that the effect of sowing date on plant height, number of branches /plant and number of capsules/ plant of sesame were not significant in all traits in the two growing seasons. While, the effect of density were highly significant in plant height and number of capsules/ plant. But not significant in number of branches /plant in the two growing seasons. *These results are in accordance with those obtained by Toaima et al (2004), Bhatti et al.,(2006), Rahnama and Bakhshandel (2006) and Iqbal et al,.(2007).*

Table (11) presented that the effect of sowing date on seed index (g), seed yield /plant (g) and seed yield /fed were non-significant except seed yield /plant was significant. While the effect of density were highly significant in seed index and seed yield /plant except seed yield / fed. The highest values in all traits at table (12) were found at the first sowing date (S_1) ,first density (D_1) (33%) except plant height was found at the first sowing date(S_1) and second density (D_2) (50%) at the two growing seasons. These results are in a great harmony with those reported by *Badran (2002), Bhatti et al., (2006), El-Sawy et al (2006), Rahnama and Bakhshandel (2006).*

Land Equivalent Ratio (LER) and Gross Return (L.E., fed^{-1})

The land equivalent ratio is a method used to calculate the effectiveness of intercropping systems. It is the most widely used index for measuring the advantages of intercropping systems on the combined yield of both crops. It is defined as the relative land area under sole crops required producing yields achieved in intercropping. Data in Table (13) recorded that, the land equivalent ratio values were affected by the sowing date and density for sesame in the two growing seasons. Concerning the effect of sowing date on land equivalent ratio, the highest values in the two growing seasons were shown under the third sowing date treatment (S_3) under the first density (D_1). Whereas, the lowest values were recorded under the second sowing date treatment (S_2), under the second sesame density (D_2) (50%). These results are in harmony with those obtained by *AbouKhadra et al. (2013), Toaima et al (2004) and El-Sawy et al (2006*) they concluded that LER values were high at any intercropping systems.

Sowing date and density for sesame affected gross return, for sowing date the highest values were recorded under sowing date treatment (S_3) and the values are 31240 and 28712 (L.E. fed^{-1}) at the same time, the lowest values were showed under sowing date treatment $S_2$and density D_2 the values are 29078 and 26732 the first and second growing seasons, respectively. On the other hand, density showed an effect on gross return under the overall sowing date for sesame in the two growing seasons. These results were in line with were reported by *Mahdy and El-Said.(2015)*.

Table 10. Effect of sowing date and density for sesame with cotton on plant height, no. of branches /plant and no. of capsules/ plant of sesame in the two growing seasons.

Sowing date	Plant Density	Plant height, cm		No. of branches / plant		No. of capsules / plant	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
	D_1	96.6	99.01	2.29	2.35	108.53	108.65
S_1	D2	114.1	114.53	1.97	2.04	105.87	106.15
Mean S_1		105.85	106.77	2.115	2.195	107.2	107.4
	D_1	97.6	99.01	2.26	2.33	108.13	108.35
S_2	D_2	113.5	114.34	1.90	1.90	106.48	106.67
Mean S_2		105.85	106.77	2.095	2.115	107.31	107.51
	D_1	97.7	97.75	2.25	2.31	108.01	108.07
S_3	D_2	112.4	113.39	1.85	1.91	105.32	105.54
Mean S_3		104.55	105.57	2.05	2.11	106.76	106.86
Mean S		105.42	106.37	2.087	2.14	107.06	107.26
L.S.D. 5% at S		3.108	3.401	0.150	0.093	1.662	1.830
F. Test		Ns	Ns	Ns	Ns	Ns	Ns
L.S.D. 5% at D		1.675	1.520	0.409	0.412	0.909	0.857
F. Test		**	**	Ns	Ns	**	**
S * D		Ns	Ns	Ns	Ns	Ns	Ns
Sesame sole		116.21	116.36	2.32	2.44	109.48	109.56

S1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, D_2 =50% density
* and ** represent significant differences between means at 0.05 and 0.01 level of probability, respectively; NS, non–significant.
Each value is mean ±S.D.

Table 11. Effect of sowing date and plant density for sesame with cotton on seed index (g) , seed yield /plant (g) and seed yield /fed of sesame in the two growing seasons.

Sowing date	Plant Density	Seed index (g)		Seed yield / plant (g)		Seed yield / fed (ardab)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
	D_1	4.45	4.55	13.90	14.12	2.28	2.34
S_1	D2	4.18	4.21	12.81	12.94	2.19	2.25
Mean S_1		4.31	4.38	13.56	13.69	2.24	2.30
	D_1	4.45	4.54	13.72	13.83	2.26	2.33
S_2	D_2	3.93	4.01	12.56	12.67	2.13	2.22
Mean S_2		4.19	4.28	13.36	13.53	2.20	2.28
	D_1	4.42	4.51	13.09	13.23	2.14	2.23
S_3	D_2	3.92	3.97	13.02	13.15	2.11	2.19
Mean S_3		4.17	4.24	13.14	13.26	2.21	2.21
Mean S		4.22	4.30	13.35	13.49	2.19	2.26
L.S.D. 5% at S		0.312	0.254	0.227	0.258	0242	0.250
F. Test		Ns	Ns	*	*	Ns	Ns
L.S.D. 5% at D		0.298	0.452	0.620	0.659	0.090	0.077
F. Test		**	**	**	**	Ns	Ns
S * D		Ns	Ns	Ns	Ns	Ns	Ns
Sesame sole		4.63	4.75	15.22	16.34	5.00	5.40

S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, D_2 =50% density
* and ** represent significant differences between means at 0.05 and 0.01 level of probability, respectively; NS, non–significant.
Each value is mean ±S.D.

Table 12. Effect of sowing date and Plant Density on total yield (kg fed^{-1}) of cotton and sesame in the two growing seasons.

Sowing date	Plant Density	1st growing season			2nd growing season		
		Cotton	Sesame	Total	Cotton	Sesame	Total
	D_1	1753.7	273.6	2027.3	1764.7	280.8	2045.5
S_1	D_2	1645.4	262.8	1908.2	1653.2	270.0	1923.2
Mean		1699.6	268.2	1967.8	1709.0	275.4	1984.4
	D_1	1755.3	271.2	2026.5	1771.0	279.6	2050.6
S_2	D_2	1635.9	255.6	1891.5	1645.4	266.4	1911.8
Mean		1695.6	263.4	1959.0	1708.2	273.0	1981.2
	D_1	1783.5	256.8	2040.3	1800.8	267.6	2068.4
S_3	D_2	1645.4	253.2	1898.6	1657.9	265.2	1923.7
Mean		1714.5	255.0	1969.5	1729.4	266.4	1994.0
Cotton sole		1807.1	-----	1807.1	1810.2	-----	1810.2
Sesame sole		------	600	600	-----	648	648

S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, and D_2 =50% density.

Table 13. Effect of sowing date and density for sesame with cotton on the land equivalent ratio (LER) and gross return (L.E., fed.$^{-1}$) in the two growing seasons

Sowing date	Plant Density	Land equivalent ratio		Gross return (L.E. fed^{-1})	
		1st season	2nd season	1st season	2nd season
	D_1	1.45	1.39	31163	28564
S_1	D2	1.33	1.31	29360	26910
Mean S_1		1.39	1.35	30262	27760
	D_1	1.41	1.39	31138	28618
S_2	D_2	1.36	1.30	29078	26732
Mean S_2		1.39	1.35	30120	27688
	D_1	1.44	1.38	31240	28712
S_3	D_2	1.32	1.30	29168	26814
Mean S_3		1.38	1.34	30420	27786

S_1= first sowing date for sesame, S_2 = second sowing date, S_3= third sowing date D_1= 33%, D_2 =50% density sesame sole=12000,14140(LE) cotton sole =23.690, 20900(LE).

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الملخص العربي

تأثير مواعيد الزراعة والكثافة النباتيه للسمسم ونظام التحميل على المحصول ومكوناتة فى القطن والسمسم

مشيرة أحمد ابراهيم الشامى، منى عبدالحليم المنصورى ومها عبد الله البيلى

اقيمت تجربة حقليه بمحطة البحوث الزراعية بسخا– محافظة كفر الشيخ خلال موسمى ٢٠١٧، ٢٠١٨ م لدراسة تأثير ثلاثة مواعيد لزراعة السمسم وهى (١٥ /٤، ٣٠ /٤، ١٥/٥) وكثافتين زراعة للسمسم وهى (٣٣ %، ٥٠ %) وكان التصميم الاحصائئ المستخدم هو القطع المنشقة مرة واحده فى ثلاثة مكرارات حيث يتم توزيع مواعيد زراعة السمسم فى القطع الرئيسيه وتوزيع كثافات السمسم فى القطع الشقيه.

اوضحت النتائج ما يلى:–

*كانت أعلى قيمه للماء المضاف والمستهلك عند الميعاد الاول والكثافه ٥٠٪ بينما كانت أعلى انتاجيه للماء المضاف كانت عند الميعاد الثالث والكثافه ٣٣٪.

*تأثير مواعيد الزراعه كان غير معنوى على كل الصفات فى القطن ماعدا محصول البذور /نبات فى الموسم التانى كان معنوى فى حين كان محصول البذور /فدان معنوى فى كلا الموسمين. بينما تأثيره كان غير معنوى فى كل الصفات فى السمسم ماعدا محصول البذور /نبات كان معنوى فى كلا الموسمين.

*تأثير الكثافة النباتيه كان معنوى وعالى المعنويه على كل الصفات فى القطن ماعدا ارتفاع النبات فى كلا الموسمين ووزن اللوزة فى الموسم الاول. بينما التاثير كان معنوى فى كل صفات السمسم ماعدا عدد الفروع /نبات ومحصول البذور /فدان كان غير معنوى فى كلا الموسمين.

أعلى قيمه للمكافئ الارضى كانت (١.٤٠،١.٤١) وأعلى قيمة للعائد النقدى كانت(٣٠.١٢٠،٢٧.٦٨٨)ج عند الميعاد الثالث والكثافة ٣٣٪.