Arab Univ.
J. Agric. Sci.,
Ain Shams Univ.,
Cairo, 16(1), 71-83, 2008

EFFECT OF IRRIGATION INTERVALS AND INTERCROPPING PATTERNS ON YIELD AND ITS COMPONENTS OF SOYBEAN AND SUNFLOWER IN RECLAIMED LAND

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Nawar[1], F.R.R.

1- Crop Intensification Department, Field Crops Research Institute, Agric. Res. Center, Giza, Egypt

Keywords: Irrigation intervals, Intercropping, Soybean, Sunflower

ABSTRACT

Two field experiments were conducted at Nubaria Agric. Res. Station during 2003 and 2004 seasons. The objective of this investigation aimed to study the effect of irrigation intervals (irrigation every 14 and 28 days) and six intercropping patterns: (1) Pure stand of soybean (sown in hills 10 cm distance apart on each side of the ridge and thinned at two plants/hill). (2) Pure stand of sunflower (sown in hills 30 cm distance on side of the ridge and thinned at one plant/hill). (3) Soybean sown on one side of the ridge and sunflower sown on the other side of the ridge (100% soybean+100% sunflower). (4) Soybean sown in 2:2 rows with sunflower. (5) Soybean sown in 2:4 rows with sunflower. (6) Soybean sown in 4:2 rows with sunflower on yield and its components of both crops, as well as the competitive relationships. A split plot in complete randomize design with four replicates was used. The results indicated that Irrigation intervals had significant effects on soybean plant height, number of pods/plant, seed yield/fad. and seed oil percentage of soybean plants. Intercropping patterns had significant effects on all studied traits, except oil and protein content percentages in the two seasons. The highest seed yield/fad. was obtained by irrigation every 14 days and sowing soybean in pure stand. Pure stand gave higher seed yield of soybean than that of all intercropping patterns. Irrigation intervals had significant effects on sunflower plant height, number of leaves/plant, seed yield/plant and seed yield/fad. of sunflower plants in the two seasons. Also, intercropping patterns had significant effects on all studied traits in the two seasons. Pure stand of sunflower gave higher seed yield/fad. than all intercropping patterns. The highest seed yields of sunflower and soybean were obtained by irrigation every 14 days and pure stands in the two seasons. The results indicated that land equivalent ratios (LER) of soybean and sunflower values were more than one. Moreover, it could be concluded that soybean and sunflower sown at pure stands with irrigation every 14 days can be recommended for raising soybean and sunflower productivity as compared with all intercropping patterns under the condition of Nubaria region. Also, sunflower was always the dominant crop, whereas soybean was dominated.

INTRODUCTION

Intercropping is a cultivation practices to increase the productivity per unit area. Soybean and sunflower crops are commonly suggested as desirable intercrop species because of their different growth habits and sowing spacing which allow full utilization of the environment with minimum competition for light. **Garcia and Pinchinat (1976)** found that intercropped planting as (100% maize + 50% soybean and 100% soybean + 50% maize) did not reduce crop yield (maize and soybean yields), but planting as (100% soybean + 100% maize) recorded the highest maize and soybean yields. **Beets (1977)** reported that intercropping maize with soybean in different arrangements, i.e. 100% + 0%, 75% + 25%, 50% + 50%, 25% + 75% and 0% + 100% of maize : soybean reduced the grain and seed yields of both crops. **Moallem (1979)** noted that soybean yield was 0.58 t/ha when intercropped with maize. **Mohta and Rde (1980)** found that seed yield of soybean,

(Received December 12, 2007)
(Accepted January 28, 2008)

when intercropped, was less than that as a solid crop. The combined seed-grain yield of the two crops in the intercrop was more than the individual components. **Tetiokagho (1988)** found that soybean yield decreased with the increase of maize density. **Galal and Metwally (1982)** mentioned that intercropping corn and soybean reduced seed yield by 40% less than under monoculture. **Umrani *et al* (1987)** showed that intercropping sunflower and pigeonpea at 2:1 row ratio gave highest seed yield and land equivalent ratio. **Abdel-Gawad *et al* (1989a)** found that highest soybean seed yield/fad. was obtained by planting sunflower with soybean at 30 cm ridge width with 3:3 intercropping pattern. **Abdel-Gawad *et al* (1989b& c), Ujjinaiah *et al* (1990) and Dhingra *et al* (1991)** found that maize gave higher yield in intercrop. Average yield of maize over 4 years was highest (3.69 t/ha) when grown in alternate row with mungbean. **Pal *et al* (1991)** found that seed yields of sunflower and soybean were reduced by intercropping with grain sorghum. **Gode and Bobde (1993)** found that seed yield of soybean was 1.66 t/ha when grown alone and 0.35-0.58 t/ha when intercropped with sorghum. **Varughese and Iruthayaraj (1996)** showed that grain yield of maize was unaffected by cropping system, except in Kharif (monsoon) of 1989 when it was highest with intercropping at 2:2 row ratio. **Assey *et al* (1983)** found that increasing the cropped soybean density from 40 to 120 thousand plants/fad. did not reflect any significant difference respecting land equivalent ratio and aggressivity of maize and soybean. **Shafshak *et al* (1986)** found that land equivalent ratio (LER) increased with increasing plant density by intercropping sunflower with soybean. **Zamar and Giastiani (1997)** found that land equivalent ratio reached 1.09 and 1.11 in the 1st and 2nd years, respectively. **Nagavani *et al* (1997)** found that sunflower seed yield was highest (2329 kg/ha) from irrigation at 1.0 irrigation water : cumulative pan evaporation and application of 100 kg N. **Rajashekher and Reddy (1997)** showed that seed yield of sunflower was lowest with basin irrigation and highest with irrigation to broad beds and furrows. **Shahid Rafiq *et al* (1998)** found that seed yield, seed oil contents and values of yield components of sunflower were highest with 8 irrigations at 7 day intervals between 14 and 63 days after sowing. **Chavan *et al* (1998)** found that irrigation every 10 days to crop sown on 31 January produced the highest soybean seed yield of 2.17 t/ha. **Deolankar and Mogal (1998)** noticed that seed yield of soybean was highest with 37.5: 75 kg N : P_2O_5 (1.98 t/ha) and was similar with irrigation at cumulative pan evaporation (CPE) of 75 (1.84 t/ha) or 100 mm (1.74 t/ha) or at critical growth stages (1.75 t/ha) which was significantly higher than irrigation at CPE of 125 mm (1.6 t/ha). **Fernandes *et al* (1998)** found that the treatments with the greatest frequency of irrigation and a depletion of 45% of available water showed highest grain yield. The greatest water use by soybeans was in the treatments that presented the smallest interval between irrigations. **Wailis *et al* (1997)** found that deep tillage or the use of permanent beds did not affect soybean yield. Also, the combination of disc ploughing and furrow irrigation was successful. **Yadav and Kumar (1998)** noticed that intercropping mulberries with soybeans or *V. radiate* produced 40% higher overall yields and the best economic returns were obtained by growing crops in a 1:2 arrangement, i.e., 2 rows of mulberries between rows of soybeans or *V. radiate*.

Thus, this work was designated to study the effect of irrigation intervals and intercropping systems on yield and its attributes, seed oil and seed protein of soybean and sunflower seeds and the competitive relations of the two crops at the newly reclaimed land of Nubaria region.

MATERIALS AND METHODS

Two field experiments were carried out at Nubaria Agric. Res. Station during the two successive growing seasons of 2003 and 2004. The major objective of this study was to investigate the effect of two irrigation intervals and six planting patterns on yield and its components, seed oil content, seed protein content of soybean and sunflower plant and their competitive relations.

Each experiment included 12 treatments which were the combination between six planting patterns and two irrigation interval treatments.

A. The irrigation interval treatments were as follows:
   1. Irrigation every 14 days.
   2. Irrigation every 28 days.

B. The planting patterns were as follows:
   1. Soybean was sown on one side of the ridge in hills 10 cm apart and thinned at two plants/hill and sunflower was sown on the other side of the ridge (100% soybean + 100% sunflower).
   2. Soybean was sown at 2:2 rows ratio with sunflower.
   3. Soybean was sown at 2:4 rows ratio with sunflower.

4. Soybean was sown at 4:2 rows ratio with sunflower.
5. Soybean in solid stand was sown in hills 10 cm apart and thinned at two plants/hill as the monoculture checks.
6. Sunflower in solid stand was sown in hills 30 cm apart on one side of the ridge.

Soil samples were collected from the experimental site for mechanical and chemical analysis. Results of the analysis are presented in **Table (1)**.

A split plot in complete randomized block design with four replications was used. The two irrigation interval treatments occupied the main plots. The six planting patterns were arranged randomly in the sub-plots. The plot area was 19.2 m^2 and included eight ridges 60 cm apart each 4 m lenth. Majac sunflower variety and Crawford as early soybean cultivar from IV Group was used. Soybean was sown on May 25th in the first season and on May 30th in the second season. Whereas, sunflower was sown in June 16th in the first season and on June 22nd in the second season. Soybean seeds were mixed at sowing with the recommended soybean inoculation. Plants were thinned to two plants/hill. Also, sunflower was thinned to one plant/hill after 18 days from sowing. Other cultural practices were carried out as recommended.

Table 1. Mechanical and chemical analyses of the soil at the experimental site

Soil properties	Seasons	
	2003	2004
Soil particles (%)		
Sand	52.9	53.3
Silt	21.8	20.8
Clay	25.3	25.9
Soil texture	Sand clay loam	Sand clay loam
Chemical analysis		
Total N (%)	0.046	0.051
Available N (ppm)	26.30	26.60
Available P (ppm)	9.68	8.40
Available K (ppm)	425.0	403.0
pH	8.2	8.1
E.C. (mmhos/cm)	2.21	1.95
O.M. (%)	0.16	0.18
$CaCO_3$ (%)	22.9	22.5

At harvest, 10 plants were randomly selected from the middle ridges of each plot of soybean plants to measure plant height (cm), number of pods/plant, 100-seed weight (g) and seed yield/plant (g). Seed yield per faddan was estimated from the whole plot. Also, at harvest, 10 plants were randomly taken from the middle ridges of each plot of sunflower plants to measure plant height (cm), number of leaves/plant, stem diameter (cm), head diameter (cm), 100-seed weight (g) and seed yield/plant (g). Seed yield per faddan was estimated from the whole plot. Oil content of soybean and sunflower seeds was determined by Soxhlet apparatus on dry weight basis as described by **Sorenson (1947)**. Protein content was determined as total nitrogen by micro-Kjeldahl method according to **A.O.A.C. (1970)**, then ultiplied by 6.28 **(Tripathi *et al* 1971)** to obtain protein content in soybean seads.

The following competitive relations were estimated

1. Land equivalent ratio (LER): It was determined according to **De Wit and Den Bergh (1965)** equation as follows:

$$L\ Soybean = \frac{ycs}{ycc} \qquad L\ Sunflower = \frac{ysc}{yss}$$

LER = L Soybean + L Sunflower

2. Relative crowding coefficient (RCC): It was determined according to **De Wit and Hall (1974)** equation as follows:

$$Kab\ soybean = \frac{ycs \times Zba}{(ycc - ycs)\ Zab}$$

$$Kba\ sunflower = \frac{ysc \times Zba}{(yss - ysc)\ Zab}$$

RCC = Kab x Kba

3. Aggressivity (A): It was determined according to McGilchrist (1965) formula as follows:

$$ACS = \frac{ycs}{ycc \times Zab} - \frac{ysc}{yss \times Zba}$$

$$ASC = \frac{ysc}{yss \times Zba} - \frac{ycs}{ycc \times Zab}$$

where

ycs = intercrop yield of soybean in combination with sunflower
ycc = pure stand yield of soybean
ysc = intercrop yield of sunflower in combination with soybean

yss = pure stand yield of sunflower
Zba = sown proportion of species b (in combination with a)
Zab = sown proportion of species a (in combination with b)
ACS = aggressivity of soybean
ASC = aggressivity of sunflower

The collected data were statistically analyzed according to **Snedecor and Cochran (1967)**.

RESULTS AND DISCUSSION

A. Soybean

1. Effect of irrigation intervals

The results presented in **Tables (2 and 3)** indicated that irrigation intervals had significant effects on plant height, number of pods/plant, seed yield/fad. and seed oil percentage in the two seasons, whereas, the effect on 100 seeds weight, seed yield/plant and seed protein percentage was not significant. These results revealed that irrigation every 14 days gave higher values for all studied traits.

Higher values for plant height, number of pods/plant, seed yield/fad. and seed oil content were obtained from irrigation every 14 days compared to irrigation every 28 days in both seasons. Soybean yields of the 14 days irrigation interval were 11.7 and 20% higher than those of the 28 days interval for the 1st and 2nd growing seasons, respectively. The significant yield reduction could be due to water stress during the long interval between irrigations. Similar results were reported by **Chavan *et al* (1998), Deolankar and Mogal (1998), Fernandes *et al* (1998) and Willis *et al* (1998)**.

2. Effect of intercropping patterns

The results presented in **Tables (2 and 3)** indicated that intercropping patterns had significant effects on plant height, number of pods/plant, 100-seed weight, seed yield/plant and seed yield/fad. in the two seasons. The pure stand gave the highest values for all studied traits as compared to the intercropping patterns, except in cases of oil and protein percentages in the two growing season. The obtained results could be due to higher competition between soybean and sunflower for light, water and nutrition elements.

The results presented in **Table (2)** indicated that significant differences were found for plant height and seed yield/fad. when soybean was sown on one side of the ridge and sunflower on the other side (100% soybean + 100% sunflower) and 2:4 rows of soybean and sunflower, respectively. Also, significant differences were found when soybean was sown on one side of the ridge and sunflower on the other side (100% soybean + 100% sunflower) and 2:2 rows (soybean : sunflower) for plant height in the two seasons. Similar results were also reported by **Assey *et al* (1983), Abdel-Gawad *et al* (1989b) and Dhingra *et al* (1991)**.

The data also showed significant differences between pure stand and all intercropping patterns for number of pods/plant, 100-seed weight and seed yield/plant. Whereas, no significant effect was observed among all intercropping patterns on seed oil and seed protein percentages.

The results presented in **Table (3)** showed that intercropping patterns had significant effect on seed yield/fad. and insignificant effect on oil and protein content in the two seasons. The pure stand gave higher yield than that of intercropping patterns in the two seasons. It was clear that sowing 4 rows soybean : 2 rows sunflower gave the highest yield compared to other intercropping patterns. The obtained results could be due to higher competition between soybean and sunflower for light, water and nutrition elements. The obtained yields were higher 97.7, 35.9 and 16.2% in the first season and 98.0, 37.5 and 20.4% in the second season than average seed yield/fad. of the 2:4, 2:2 and 100%+100% intercropping patterns, respectively. Similar results were also reported by **Zamar and Giambastiani (1997), Assey *et al* (1983), Umrani *et al* (1987) and Abdel-Gawad *et al* (1989b)**.

3. Interaction effects

The results presented in **Tables (4 and 5)** revealed that the interaction between irrigation intervals and intercropping patterns had significant effects on plant height, number of pods/plant, seed yield/plant and seed yield/fad. in the two seasons.

The highest seed yield/fad. was obtained by irrigated soybean pure stand every 14 or 28 days in the two seasons. The highest values of plant height, number of pods/plant, seed yield/plant and seed yield/fad. were obtained by soybean pure stand with irrigation every 14 days in both seasons. The obtained results may be due to higher competition between soybean and sunflower for

Table 2. Mean values of plant height, number of pods/plant, 100-seed weight and seed yield/plant of soybean plants as affected by irrigation intervals and intercropping patterns in 2003 and 2004 seasons

Treatments	Plant height (cm)		Number of pods /plant		100-seed weight (g)		Seed yield /plant (g)	
	2003	2004	2003	2004	2003	2004	2003	2004
I_{14}	77.25	78.01	35.53	37.28	17.45	17.90	7.75	7.62
I_{28}	72.16	71.00	30.52	30.52	17.25	16.89	6.98	7.13
L.S.D$_{0.05}$	4.11	4.94	3.11	4.32	N.S	N.S	N.S	N.S
Intercropping patterns								
100% + 100%	59.65	62.75	28.46	28.34	16.44	16.76	6.42	6.23
2 : 2	75.20	75.47	27.65	28.66	17.27	17.43	6.56	6.29
2 : 4	69.62	72.75	27.70	27.63	17.18	17.30	6.36	6.18
4 : 2	67.60	67.55	28.39	29.45	17.08	17.16	6.18	6.98
Pure stand	96.43	94.00	52.93	55.22	17.99	18.32	11.31	11.20
L.S.D$_{0.05}$	7.78	9.32	6.03	8.39	0.95	1.03	2.93	2.76

I_{14} = irrigation every 14 days.
I_{28} = irrigation every 28 days.

Table 3. Mean values of seed yield/faddan, seed oil percentage and seed protein percentage of soybean plants as affected by irrigation intervals and intercropping patterns in 2003 and 2004 seasons

Treatments	Seed yield /faddan (kg)		Seed oil (%)		Seed protein (%)	
	2003	2004	2003	2004	2003	2004
I_{14}	783.52	735.76	19.30	19.18	39.86	40.02
I_{28}	701.50	623.60	18.07	18.07	38.97	39.38
L.S.D$_{0.05}$	46.34	66.73	0.56	0.66	NS	NS
Intercropping systems						
100% + 100%	710.75	636.00	18.32	18.44	39.05	39.89
2 : 2	607.75	556.95	19.26	18.51	39.58	39.22
2 : 4	417.85	386.85	18.96	18.74	39.06	39.19
4 : 2	825.90	765.90	18.01	18.38	39.99	39.94
Pure stand	1150.30	1052.70	18.78	19.04	39.39	40.25
L.S.D$_{0.05}$	83.68	91.39	NS	NS	NS	NS

I_{14} = irrigation every 14 days.
I_{28} = irrigation every 28 days.

Table 4. Average plant height, number of pods/plant and seed yield/plant of soybean plants as affected by the interaction between irrigation intervals and intercropping patterns in 2003 and 2004 seasons

Irrigation interval	Intercropping systems	Plant height (cm)		Number of pods/plant		Seed yield /plant (g)	
		2003	2004	2003	2004	2003	2004
I_{14}	100%+100%	60.14	63.28	30.59	31.75	6.83	6.32
	2 : 2	77.13	80.17	32.17	30.19	6.82	6.41
	2 : 4	70.12	75.66	30.01	29.80	6.51	6.35
	4 : 2	66.73	70.19	28.17	30.73	6.17	6.99
	Pure stand	102.13	100.77	56.73	63.91	12.45	12.05
I_{28}	100%+100%	59.17	62.23	26.33	25.33	6.01	6.14
	2 : 2	73.28	70.78	23.14	27.13	6.31	6.18
	2 : 4	69.13	69.85	25.39	25.46	6.21	6.01
	4 : 2	68.47	64.91	28.62	28.17	6.20	6.98
	Pure stand	90.74	87.23	49.13	46.53	10.17	10.35
$L.S.D_{0.05}$		11.94	13.85	9.50	11.29	3.45	3.68

Table 5. Average seed yield/faddan of soybean plants as affected by interaction between irrigation intervals and intercropping patterns in 2003 and 2004 seasons

Irrigation interval	Intercropping systems	Seed yield/faddan (kg)	
		2003	2004
I_{14}	100%+100%	751.10	681.70
	2 : 2	614.70	613.00
	2 : 4	430.60	423.60
	4 : 2	870.90	839.90
	Pure stand	1250.30	1120.60
I_{28}	100%+100%	750.40	590.30
	2 : 2	600.80	500.90
	2 : 4	405.10	350.10
	4 : 2	780.90	691.90
	Pure stand	1050.30	984.80
$L.S.D_{0.05}$		114.95	123.39

light, water and nutritive elements in both seasons. It is clear from **Tables (4 and 5)** data that differences between the intercropping patterns (100% soybean : 100% sunflower), (2:2), (2:4) and (4:2) on number of pods/plant, 100 seeds weight and seed yield/plant were not significant in both seasons under the two irrigation intervals. The obtained results may be due to higher competition between soybean and sunflower for light, water and nutritive elements in both seasons. Similar results were reported by **Chavan *et al* (1998), Deolankar and Mogal (1998) and Shahid Rafiq *et al* (1998).**

In respect to the significant effect of this interaction on seed yield/fad., results showed no significant differences among the following two intercropping patterns 100% soybean : 100% sunflower and the 4:2 under the 28 days irrigation interval but this was not the case with the 14 days irrigation interval.

B. Sunflower

1. Effect of irrigation intervals

The results presented in **Tables (6 and 7)** indicated that irrigation intervals had significant effects on plant height, number of leaves/plant, seed yield/plant and seed yield/fad. in the two seasons. Results revealed that irrigation every 14 days gave higher values of plant height, number of leaves/plant, seed yield/plant and seed yield/fad. in the two seasons. Whereas, no significant effect was found in cases of stem diameter, head diameter, 100-seed weight and seed oil percentage in the two seasons. The resulted seed yields/fad. from irrigation every 14 days interval were 26.7 and 19.2% higher than seed yield/fad. of the 28 days interval in the first and second seasons, respectively. Similar results were reported by **Nagavani *et al* (1997), Rajashekher and Reddy (1997) and Shahid Rafiq *et al* (1998).**

2. Effect of intercropping patterns

The results presented in **Tables (6 and 7)** showed that all studied traits were significantly affected by the intercropping patterns in the two seasons. The pure stand gave the highest values for all studied traits compared to the intercropping patterns in the two seasons.

The results showed no significant effects among almost intercropping patterns on plant height, number of leaves/plant, stem diameter, head diameter, 100-seed weight and seed yield/plant in the two seasons. The pure stand gave the highest value of plant height, number of leaves/plant, stem and head diameters, 100-seed weight, seed yield/plant and seed yield/fad. as compared to the intercropping patterns in both seasons. These increases could be due to the competition between soybean and sunflower plants on light, water and nutritive elements.

It was clear from **Table (7)** that seed yield/fad. of pure stand recorded the highest values and there were significant differences between pure stand and all intercropping patterns in the two seasons. Also, there were significant differences among all intercropping patterns in the two seasons. Moreover, significant effect of intercropping patterns on oil percentage was found in the two growing season.

Similar results were reported by **Garcia and Pinchinat (1976), Assey *et al* (1983), Umrani *et al* (1987), Abdel-Gawad *et al* (1989a) and Varughese and Iruthayaraj (1996).**

3. Interaction effect

Results in **Tables (8 and 9)** revealed that the interaction between irrigation intervals and intercropping patterns had significant effects on all studied traits, except the stem and head diameters and oil seed percentages in the two seasons. The highest seed yield/fad. was obtained by sowing sunflower in pure stand and irrigated every 14 days. Results showed that the seed yield/fad. of the two intercropping patterns, i.e., 100% soybean + 100% sunflower and the 2:2 were not the same under the two irrigation intervals. The highest values of plant height, number of leaves/plant, 100-seed weight and seed yield/plant were obtained by sowing sunflower in pure stand and irrigated every 14 days in both seasons. The obtained results may be due to higher competition between soybean and sunflower for light, water and nutritive elements in both seasons. Similar results were reported by **Abdel-Gawad *et al* (1989b) and Dhingra *et al* (1991).**

C. Competitive relations

1. Land equivalent ratio (LER)

Results presented in **Table (10)** show the effect of intercropping soybean with sunflower on land equivalent ratio (LER). Land equivalent ratio (LER) values were greater than one by intercropping soybean with sunflower in the two seasons.

Table 6. Average plant height, number of leaves/plant, stem diameter and head diameter of sunflower plants as affected by irrigation intervals and intercropping patterns in 2003 and 2004 seasons

Treatments	Plant height (cm)		Number of leaves/plant		Stem diameter (cm)		Head diameter (cm)	
	2003	2004	2003	2004	2003	2004	2003	2004
Irrigation interval								
I_{14}	165.78	174.19	24.86	25.95	2.07	1.99	18.98	17.96
I_{28}	154.60	158.92	20.97	20.83	1.82	1.79	17.28	16.93
L.S.$D_{0.05}$	8.39	10.77	2.18	3.95	NS	NS	NS	NS
Intercropping patterns								
100%+100%	154.71	160.27	19.48	20.87	1.78	1.66	16.73	15.41
2 : 2	159.23	165.57	20.93	22.98	1.87	1.81	17.55	16.53
2 : 4	161.82	169.35	23.50	23.29	1.97	1.93	18.59	18.53
4 : 2	154.90	161.22	21.44	21.77	1.87	1.75	16.74	16.12
Pure stand	170.31	176.38	29.22	27.55	2.24	2.29	21.04	20.70
L.S.$D_{0.05}$	13.76	14.02	6.79	5.02	0.27	0.46	3.85	2.11

Table 7. Average values of 100-seed weight, seed yield/plant, seed yield/fad. and seed oil content of sunflower plants as affected by irrigation intervals and intercropping patterns in 2003 and 2004 seasons

Treatments	100-seed weight (g)		Seed yield /plant (g)		Seed yield /faddan (kg)		Seed oil content (%)	
	2003	2004	2003	2004	2003	2004	2003	2004
Irrigation interval								
I_{14}	6.59	6.93	55.09	48.02	686.74	705.05	40.82	40.03
I_{28}	6.29	6.09	47.65	42.53	541.88	591.27	40.11	39.96
L.S.$D_{0.05}$	NS	NS	2.54	3.34	57.29	49.36	NS	NS
Intercropping patterns								
100%+100%	5.20	5.70	47.13	39.98	520.50	568.93	39.98	40.12
2 : 2	6.06	6.26	49.45	43.87	591.11	640.70	39.97	40.01
2 : 4	6.79	6.98	51.41	47.03	764.55	714.55	40.41	39.76
4 : 2	5.97	6.17	47.43	40.37	375.49	394.96	40.76	40.43
Pure stand	8.17	7.44	61.46	55.15	869.89	906.58	41.21	39.65
L.S.$D_{0.05}$	1.13	1.03	5.18	7.44	68.73	64.36	0.83	0.42

Table 8. Average values of plant height, number of leaves/plant, stem diameter and head diameter of sunflower plants as affected by interaction between irrigation intervals and intercropping systems in 2003 and 2004 seasons

Irrigation interval	Intercropping systems	Plant height (cm)		Number of leaves/plant		Stem diameter (cm)		Head diameter (cm)	
		2003	2004	2003	2004	2003	2004	2003	2004
I_{14}	100%+100%	160.31	169.31	20.33	22.61	1.84	1.67	17.63	15.84
	2 : 2	164.53	174.83	21.68	25.84	2.00	1.93	18.36	16.75
	2 : 4	167.78	175.29	25.73	25.63	2.11	2.09	19.75	19.19
	4 : 2	159.48	168.11	23.96	23.78	1.96	1.87	16.83	16.48
	Pure stand	176.84	183.45	32.61	31.92	2.45	2.39	22.33	21.57
I_{28}	100%+100%	149.11	151.24	18.64	19.13	1.73	1.65	15.83	14.99
	2 : 2	153.94	156.32	20.18	20.12	1.75	1.70	16.75	16.32
	2 : 4	155.86	163.42	21.27	20.96	1.84	1.77	17.44	17.87
	4 : 2	150.32	154.33	18.93	19.76	1.78	1.64	16.66	15.76
	Pure stand	163.79	169.32	25.84	23.19	2.03	2.19	19.76	19.84
$L.S.D_{0.05}$		17.29	16.49	8.74	7.10	N.S	N.S	N.S	N.S

Table 9. Average values of 100-seed weight, seed yield/plant, seed yield/faddan and seed oil percentage of sunflower plants as affected by interaction between irrigation intervals and intercropping systems in 2003 and 2004 seasons

Irrigation interval	Intercropping systems	100-seed weight (g)		Seed yield /plant (g)		Seed yield /faddan (kg)		Seed oil (%)	
		2003	2004	2003	2004	2003	2004	2003	2004
I_{14}	100%+100%	5.17	6.12	49.51	40.31	590.31	620.56	39.78	39.85
	2 : 2	6.12	6.53	52.13	46.76	680.29	693.14	40.18	40.18
	2 : 4	6.93	7.64	55.76	49.32	812.75	778.96	41.65	39.75
	4 : 2	6.01	6.33	51.30	42.56	400.79	432.45	40.87	40.19
	Pure stand	8.73	8.05	66.78	61.18	949.57	1000.18	41.65	40.19
I_{28}	100%+100%	5.23	5.19	44.75	39.65	450.70	517.31	40.18	40.39
	2 : 2	6.01	5.99	46.78	40.98	501.94	588.27	39.76	39.85
	2 : 4	6.66	6.33	47.06	44.75	616.35	680.33	39.18	39.78
	4 : 2	5.94	6.01	43.56	38.18	350.19	357.48	40.65	40.68
	Pure stand	7.61	6.84	56.14	49.12	790.22	812.99	40.78	39.11
$L.S.D_{0.05}$		2.01	2.13	8.23	9.65	84.56	93.56	NS	NS

Table 10. Effect of irrigation intervals and intercropping patterns on land equivalent ratio (LER), relative crowding coefficient (RCC) and aggressivity of soybean and sunflower yields in 2003 and 2004 seasons

Irrigation intervals	Nitrogen levels (kg/fed.)	LER		RCC		Aggressivity			
						2003		2004	
		2003	2004	2003	2004	ASC	ACS	ASC	ACS
I_{14}	100%+100%	1.22	1.23	2.46	2.53	0.02	-0.02	0.02	-0.02
	2 : 2	1.20	1.22	1.69	2.37	0.23	-0.23	0.14	-0.14
	2 : 4	1.19	1.16	3.68	2.13	0.24	-0.24	0.02	-0.02
	4 : 2	1.11	1.18	1.67	2.39	0.24	-0.24	0.19	-0.19
Mean		1.18	1.20	2.37	2.35	0.18	-0.18	0.09	-0.09
I_{28}	100%+100%	1.26	1.23	3.42	2.62	0.14	-0.14	0.04	-0.04
	2 : 2	1.20	1.23	1.76	2.70	0.06	-0.06	0.21	-0.21
	2 : 4	1.16	1.19	2.22	2.87	0.01	-0.01	0.17	-0.17
	4 : 2	1.18	1.14	2.30	1.84	0.24	-0.24	0.28	-0.28
Mean		1.20	1.20	2.42	2.51	0.11	-0.11	0.17	-0.17

It is clear that the actual productivity was higher than expected productivity. Intercropping soybean with sunflower (100% + 100%) and irrigation every 28 days gave highest value of LER was (1.22 and 1.23) in the two seasons, respectively as compared to 4:2 ratio in the two seasons. These results could be due to higher competition between soybean and sunflower for light, water and nutritive elements. Similar results were reported by **Assey *et al* (1983) and Abdel-Gawad *et al* (1989b)**.

2. Relative crowding coefficient (RCC)

Results in **Table (10)** showed that relative crowding coefficient for both crops, i.e., soybean and sunflower was larger than one. The values of RCC were greater when intercropping at 2:4 ratio with irrigation every 14 days than at 4:2 ratio with irrigation every 14 days (was 3.68) in the first season. The same table indicated that the highest value of RCC was from (100% + 100%) ratio with irrigation every 28 days (was 3.42) in the first season. Also, the highest value of RCC was from 2:4 ratio with irrigation every 28 days in the second season. These results could be due to higher competition between soybean and sunflower for light, water and nutritive elements. Similar results were reported by **Umrani (1987), Abdel-Gawad *et al* (1989) and Varughese & Iruthayaraj (1996)**.

3. Aggressivity (Ag)

Data presented in **Table (10)** showed that aggressivity values were larger than zero when intercropping soybean with sunflower under irrigation intervals with intercropping patterns. The highest value of aggressivity was at 2:4 ratio (0.24). Also, at 4:2 ratio with irrigation every 14 days, in the first season. Also, at 4:2 ratio with irrigation every 28 days in the two seasons soybean was dominated crop (negative values), whereas sunflower was the dominant crop (positive values). These results could be due to higher competition between soybean and sunflower plants on light, water and nutritive elements. Similar results were reported by **Abdel-Gawad *et al* (1989c), Dhingra *et al* (1991) and Varughese & Iruthayaraj (1996)**.

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مجلة اتحاد الجامعات العربية
للعلـــــوم الزراعيـــــة
جامعة عين شمس ، القاهـــرة
مجلد(١٦)، عدد (١)، ٧١-٨٣، ٢٠٠٨

تأثير فترات الرى ونظم التحميل على المحصول ومكوناته لمحصولى فول الصويا وعباد الشمس فى الأراضى الجديدة

[٥]

فتحى رجب رمضان نوار[١]

١- قسم بحوث التكثيف المحصولي - معهد بحوث المحاصيل الحقليّة - مركز البحوث الزراعية - الجيزة - مصر

المقدمـــــه

أجريت هذه الدراســـة بمحطـــة البحوث الزراعية بالنوبارية خلال موسمـــــى ٢٠٠٣ و ٢٠٠٤ لدراسة تأثير فترات الرى (الرى كل ١٤، ٢٨ يوم) وستة نظم لتحميل هـــــى: (١) زراعة فول الصويا منفردة في جـــور على مسافة ١٠ سم والخف علي نباتين في الجورة والمسافة بين الخطوط ٦٠ سم. (٢) زراعة عباد الشمس منفرد في جور على مسافة ٣٠ سم بين الجور والخف علي نبات واحد/جورة. (٣) زراعة فول الصويا على أحد جانبى الخط على مسافة ١٠ سم والخف نباتين/جورة وزراعة عباد الشمس على الجانب الآخر. (٤) زراعة فول الصويا مع عباد الشمس بنسبة (٢ : ٢). (٥) زراعة فول الصويا مع عباد الشمس بنسبة (٢ : ٤). (٦) زراعة فول الصويا مع عباد الشمس بنسبة (٤ : ٢)، والتفاعل بينهم والعلاقات التنافسية بين محصولى فول الصويا وعباد الشمس. وكان التصميم المستخدم قطع منشقة فى قطاعات كاملة العشوائية. وأوضحت النتائج مايلى:

بالنسبة لفول الصويا

- أثرت فترات الرى معنوياً على ارتفاع النبات وعدد القرون/نبات وحاصل البذور/فدان ومحتوى البذور من الزيت.
- أثرت نظم التحميل معنويا على كل الصفات التى تحت الدراسة أثناء موسمي الزراعة ماعدا النسبة المئوية للزيت والبروتين كما أعطت الزراعة المنفردة أعلى حاصل بذور بالمقارنة بكل نظم التحميل.

بالنسبة لعباد الشمس

- أثرت فترات الرى معنويا أثناء موسمي الزراعة على ارتفاع النبات وعدد الأوراق وحاصل النبات وحاصل الفدان.
- أثرت نظم التحميل معنوياً في الموسمين على كل الصفات المدروسة لعباد الشمس.
- أعطت الزراعة المنفردة أعلى حاصل عن كل نظم التحميل.
- كان أعلى حاصل لمحصولى عباد الشمس وفول الصويا عنـــد الـــرى كل ١٤ يـــوم مع الزراعة المنفردة فى كلا الموسمين.

تحكيم: أ.د توكـــل يـــونس رزق
أ.د إبراهيم رزق عايدي