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Effect Intercropping and Weed Control Treatments on the Productively of Maize and Sunflower

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Abstract

The present experiment was carried out in Agricultural Research Station at Giza governorate, Egypt, during 2010 and 2011 seasons to study the effect of three weed control treatments (untreated, hand hoeing twice and (Acetochlor harness herbicide) and four intercropping patterns (1:1), (2:1), (3:1) and (2:2) maize : sunflower in alternating ridges. Beside of two pure stands for both crops as recommended on weed characters and growth, yield and yield components characters of maize and sunflower in association , as well as, competitive relationships and yield advantages. A split plot design with three replications was used.

Results could be summarized as follows:

Weeds: Hand hoeing twice and harness herbicide significantly decreased all weed characters in both seasons. There is no significance between hand hoeing and harness herbicide. Intercropping pattern (2:2) was a superior pattern in reducing all weed characters in both seasons, whereas intercropping pattern (2:1) gave the highest values in both seasons. The interaction between two factors under study revealed that intercropping pattern (2:2) and using harness herbicide recorded the lowest values on weed characters, whereas intercropping pattern (2:1) with untreated treatment recorded the highest values in both seasons

Maize: Hand hoeing twice and harness herbicide significantly increased growth, yield and yield components characters compared with untreated treatment in both seasons. Intercropping pattern (1:1) recorded the highest values for yield components characters of maize in both seasons. Intercropping pattern (3:1) maize: sunflower gave the lowest values for yield components characters of maize in both seasons. Intercropping pattern (1:1) was the highest values were79.66 % and74.46 % grain yield/ fed were significantly affected by the interaction between two factors understudy in both seasons.

Sunflower: Harness herbicide and hand hoeing twice treatments gave on one hand higher values and untreated on the other hand lower values of growth, yield and yield components characters of sunflower in both seasons. Most of studied characters of sunflower significantly affected by intercropping patterns in both seasons. Intercropping pattern (2:2) recorded the highest values of seed yield/fed, whereas intercropping pattern (3:1) was the lowest values in both seasons. Head diameter and weight of head were significantly affected by the interactions between two factors.

Competitive relationship: Land equivalent ratio **(LER):** The best land usage was 1.21 in the first season, which were recorded with (2:1) pattern (67 % maize: 33 % sunflower), and 1.26 in the second seasons, which were recorded with (1:1) pattern (50 % maize: 50 % sunflower), with intercropping pattern (2:1) by Harness herbicide in the first and second seasons, respectively. Their values showed the same trend of **(RCC)** in both seasons. Aggressivity (Agg.) showed that maize was the dominant crop with the intercropping patterns which included 67 % maize + 33 % sunflower in both seasons, and sunflower was the dominated crop with the other intercropping patterns.

Total income: Economic evaluation of intercropping patterns indicated that 2:1 pattern gave the highest values of total income the pattern of 67 % maize: 33 % sunflower (5593.0 L.E.) and (5931.5 L.E.) with herbicide weed control treatments in the first and second season, respectively.

Key Words: weed, intercropping, Maize, sunflower, Harness and Total income.

Introduction

Intercropping is a way of increasing yield per unit area, practically in small farm. Agricultural intensification is considered to be one of the important ways of solving or decreasing the large gap between the production and consumption of food product. The maize is the main summer crop for grain production. Sunflower is minor crop for oil production in Egypt. Crop intensification, aims to maximize the productivity per unit area of field crops and in the meantime minimize production costs. Intercropping is defined as growing two or more crops simultaneously on the same field, as opposed to sole cropping, which is defined as growing one crop variety in pure stand **(Francis, 1989** and **Samui**

and Roy, 1990). A good intercropping of oil seeds and crops increase total production per unit area as compared to a pure crop **(Prasad and Srivastava, 1991)**. **Devidayal and Reddy (1991)** showed that groundnut-sunflower intercropping system is instrumental to maximize the oil seed production per unit and time. Intercropping patterns are more effective than mono cropping in suppression of weeds, but their effectiveness varies greatly **(Girjesh and Patil, 1991)**. **Da Silva et al (1992)** achieved best result, in farms of combined seed yields land equivalent ratio (LER) and total cash income of both crops .Use of limiting resources, reduced growth of weeds and reduced incidence of insect pests and disease. However, **Nyakatawa and Nyati (1998)**, in Zimbabwe found total yield increasing when maize and sunflower were grown together, using relay cropping maize –sunflower ,

Also, **Giri *et al.* (1998**) pointed out that intercropping has a potential to suppress weeds and it offers the possibility of capturing a greater share of available resources than sole crop. This indicates its importance of making use of land. It is well known that the weeds interfere with crops causing serious impacts through either competition (for light, water, nutrients and space) and/or allelopathy. Weed infestation removed 48.2 kg N, 14.4 kg P/ha. In sunflower **(**Weeds cause great reduction of sunflower yield ranges from 18.6-36.3 % **(Jat and Giri, 2001** and **Singh and Giri, 2001**). **Dabbagh *et al* (2011)** studied the planting maize and sunflower in pure stands and intercrops in three intercropping ratios (33:67, 67:33 and 50:50) maize/ sunflower to determine the competition between the two species and the advantage of intercropping systems they found that dry mater yields of maize and sunflower in mono and intercropping systems were significantly affected by intercropping ratio .Yield response to plant density of sunflower and maize influenced LER. The response to plant density of intercropped sunflower and maize grain yield followed the same pattern than that in a sole crop, and grain yield of intercropped sunflower or maize were lower than those for the sole crops at each plant density except at the lowest sunflower plant density **(Echarte *et al*., 2011)**.

Sunflower was more competitive than maize especially in intercrops with 67 %sunflower. Sunflower had a higher relative crowding coefficient than intercropped maize. Intercropping with 67 % maize had the highest land equivalent ratio (LER) (1:1) and relative methane yield advantage. **Ahmad *et al* (2013)** found that the effective practice in maize production which not only helps reduce the available space for weed growth but also increase the production per unit area. **Din *et al* (2013)** reported that beans and sunflower intercropping impact was not that effective and sunflower crop though performed well in weed suppression in the early stages and affected maize performance at the same time , which indicated that there could have been competition for space between maize and sunflower plants in the later stages ,and the beans intercropping suppressed weed growth to some extent however their growth was also suppressed by maize crop. **Hussain *et al* (2013**) studied influence of intercropping in maize in performance of weed and the associated crops, the intercropping treatment resulted in 35-56 % reduction in weed population .All intercropping patterns showed 6.46 to 23.93 % increase in the yield of maize over weedy check sole maize, and the computed LER ranged between 1.023 – 1.294 . Similarly, the cost benefit ratios ranged between 1.27 – 1.67.Accordingly, it is essential to control weeds in maize and sunflower fields. Herein, agricultural methods of weed control, such as intercropping are considered the best now, especially after the contraction of herbicides compounds volume because they have negative environmental effects, but it is indispensable. Keeping these points in mind, this investigation was planned to study the effect of some weed management practices under intercropping patterns of maize and sunflower on yield and associated weeds.

The aim of this investigation is to effect of weed control treatments of intercropped maize and sunflower yield and yield components of both crops.

Materials and Methods

A field experiment was carried out at Giza, Agric. Res. St. during 2010 and 2011 summer seasons to study the effect of weed control treatments and intercropping patterns on weeds, growth, yield and yield components of maize and sunflower. The soil texture was clay and the preceding crop was wheat in both seasons.

Table 1. Physical and chemical analysis of the experimental soil during **2010 and 2011 seasons.**

Physical and chemical	2010	2011
Sand	10.72	11.16
Silt	23.58	23.24
Clay	65.70	65.60
Soil texture	Clay	Clay
Organic matter	1.86	1.84
PH	7.7	7.8
Available N (ppm)	31.15	30.70
Available P (ppm)	13.54	13.50
Available K (ppm)	216	212

*A available N, P and K were determined according to Black (1965).

The experiment included 12 treatments which were the combinations of three weed control treatments and four intercropping patterns on growth, yield and yield components of maize and sunflower, as well as, growing pure stand of both crops as check plots. Experimental design was split plot design with

three replications was used. The main plots were devoted to weed control treatments. Whereas, the sub- plots were allocated four intercropping patterns. The experimental sub plot area was 25.2 m^2 included twelve ridges 3.0 m long x 0.7m width (12ridges).

A- Main plot (weed control treatments):

1- Untreated (check).
2- Hand hoeing twice at 30 and 45 days after sowing (DAS).
3- Acetochlor, Harness (84% EC), 2-chloro-N-ethoxymethyl-6´- ethylated- 0 -toluidine}at the rate of 1.0 l/fed. Was sprayed immediately before the sowing irrigation (pre-emergence).

B- Sub plot (Intercropping patterns):

1- 50 % maize + 50 % sunflower {intercropping one ridge from maize: one ridge from sunflower (1: 1)}.
2- 67 % maize + 33 % sunflower {intercropping two ridges from maize: one ridge from sunflower (2: 1)}.
3- 75 % maize +25 % sunflower {intercropping three ridges from maize: one ridge from sunflower (3: 1)}.
4- 50 % maize + 50 % sunflower {intercropping two ridges from maize: two ridges from sunflower (2: 2)}. Beside of pure stands of maize and sunflower as recommend.

Maize (cv. Giza 122) was sown on May 4^{th,} while sunflower variety Sakha 53 was sown on May 20thduring the two seasons, respectively .Calcium super phosphate (15.5 % P_2O_5) was applied during land preparation at the rate of 30 kg/fed. Nitrogen fertilizer was divided into two equal doses with the first and second irrigations at the rate of 90kg/fed. Harvesting took place on Sep. 10th and 15thin for sunflower and maize, the first and second seasons, all agricultural practices of maize and sunflower were calculated as recommended.

Studied characters:

1-Weed characters:

Weeds were hand pulled from one square meter of each subplot at 90 days from sunflower sowing then dry weights of grasses; broad-leaved as well as total weeds were calculated and weighted. The Weeds were identified and their dry weights were recorded.

2-Maize characters:

After maturity, a sample of ten maize plants were randomly chosen and harvested from each subplot to measure: -plant height (cm), stem diameter (mm), leaf area of topmost ear (cm^2), ear diameter (cm), ear length (cm), number of rows/ ear, number of grains/ row. Weight of 100- grains and grain yield/ fed. (ardab).

3-Sunflower characters:

Sunflower plants were harvested from one middle ridge of each subplot to estimate plant height (c m), stem diameter (mm), number of leaves/ plants, head diameter (cm), weight of head (g), weight of seeds / head (g), (shelling %)and seed yields/fed.(Kg). Oil percentage of sunflower was measured by extraction using Sechelt Apparatus with hexane as an organic solvent according to **(A.O.A.C., 1980)**.

4- Competitive relationships, yield advantages and total income:-

a- 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 Rao, 1980)**. Land Equivalent Ratio (LER) was determined according to the following formula:

$$LER = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}}$$

Where

Yaa = Pure stand yield of maize.

Ybb= Pure stand yield of sunflower.

Yab= Mixture yield of a when combined with b.

Yba = Mixture yield of b when combined with a.

b- Aggressivity (Agg.)

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

$$A_{ab} = \frac{Y_{ab}}{Y_{aa} \times Z_{ba}} - \frac{Y_{ba}}{Y_{bb} \times Z_{ab}}$$

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)

An aggressively 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.

c- Relative Crowding Coefficient (RCC)

RCC was proposed according to **Dewit (1960).** 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) .

$$K_{ab} = \frac{Y_{ab} \times Z_{ba}}{(Y_{aa} - Y_{ab}) \times Z_{ab}}$$

$$K_{ba} = \frac{Y_{ba} \times Z_{ab}}{(Y_{bb} - Y_{ba}) \times Z_{ba}}$$

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).

If a species has a coefficient less than, equal to, or greater than 1, it means it has produced fewer yields, 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×Kba.

1- Total income:

The total income /fed was caffeinated for each treatment in Egyptian pounds using the average frame gate of the two seasons for maize at farm gate of L.E.300 / ardab and for seeds of sunflower L.E.3415 /ton .The average of maize and sunflower yields were presented by **Agriculture statistics (2013)** was used . Total income of intercropping cultures = price of maize grain yield + price of sunflower seed yield.

2- Monetary advantage index (MAI):

MAI suggests the economic assessment should be in terms of the value of land saved; this could probably by most assessment on this basis of the rentable value of this land. MAI was suggested by Willy (1979) and calculated according to the formula: MAI = (value of combined intercrops x LER – 1) / LER

Statistical analysis:

The collected data were exposed to the proper statistical analysis of variance according to **Snedecor and Cochran (1980)** and the L.S.D. at 0.05 level of significance was used for the comparison between means.

Results and Discussion

I- Weed control:

1-1: Effect of weed control on number and fresh weight of weeds

The problematic weeds found in the experimental sites during the two years study were *Echinochloa colonum* (jungle rice) *Eleusine indica* (goose grass), *Digitarias anguinalis* (large crabgrass), , *Dactyloctenium aegyptium* (crowfoot grass), and *cenchrus biflorusroxb* (field sandbur) as annual grassy weeds, *portulaca olerace* (purslane), *Amaranthus caudatus* (livid amaranthus) as annual broad-leaved weeds.

Data presented in Table (2) indicated that weed control treatments significantly affected on number and weight of weeds/m^2 in both seasons. Harness and hand hoeing twice were the. Superior treatments in reduce number and fresh weight/m^2 of broad and narrow weeds in both seasons.

Table 2. Effect of weed control treatments on number and fresh weight of weeds (g/m^2) in 2010 and 2011 seasons.

Weed control treatments	Number of broad weeds	Number of narrow weeds	Number of total weeds	Weight broad weeds/m^2	Weight narrow weeds/m^2	Weight of total weeds/m^2
2010 season						
Hand hoeing twice	8.0	4.5	12.4	79.6	42.1	120.7
Harness	7.5	4.7	12.2	83.2	42.3	124.8
Untreated	19.9	10.2	30.1	148.4	59.1	208.1
$L.S.D_{0.05}$	1.08	0.49	0.70	19.40	3.85	17.53
2011 season						
Hand hoeing twice	7.7	3.9	11.6	73.8	32.7	106.4
Harness	7.4	4.0	11.4	77.9	37.4	115.3
Untreated	17.0	7.8	24.8	124.2	50.4	174.5
$L.S.D_{0.05}$	0.90	0.35	1.10	20.40	4.55	15.60

Superior treatments in reduce number and fresh weight/m^2 of broad and narrow weeds in both seasons. Data in Table (2) clearly show a significant difference in decreasing both numbers and weights of broad and narrow weeds in both seasons. Hand hoeing and harness were the best treatments compared with untreated. There is no significant difference between hand hoeing twice and harness in both seasons. Decreasing fresh weights g/m^2 by 46.36 and 43.93 % for broad and 28.76 and 28.42 % for narrow weeds in the first season, respectively and 40.98 and 37.27 % in the second season, respectively, compared with untreated. Similar results were obtained by **Rao (2000) and Din *et al* (2013)**.

1-2: Effect of intercropping patterns on weed characters:

Table (3) shows that the intercropping patterns significantly affected on numbers and weights of

broad and narrow weed as well as weight of total weeds in both seasons. Intercropping pattern (2 : 2) maize / sunflower was superior treatment in reducing numbers, weights of broad and narrow weeds as well as weight of total weed followed by (1 : 1) followed by (3 : 1) and (2 : 1) maize / sunflower was the latest in both seasons.

This result may be due to severe competition because of intra-competition between maize, sunflower or weeds for nutrients, water and light – etc. especially with intercropping patterns which included 50 % maize compared other intercropping patterns. Similar results were obtained by **Hussain *et al* (2013)**.

1-3: Interaction effect:

Data presented in Table (4) shows that numbers and weights of fresh weeds either broad or narrow as well as weight of total fresh weight were significantly affected by the interaction between weed control treatments and intercropping patterns in both seasons.

The interaction between untreated treatment and (2: 1) maize / sunflower intercropping patterns recorded the highest values for all characters of weeds in both seasons. Whereas, using harness herbicides as weed control with (2: 2) maize / sunflower showed the lowest values for these characters in both seasons, except weight of total weeds which the lowest values recorded with (2: 2) maize / sunflower intercropping pattern under hand hoeing twice in both seasons. Similar results were obtained by **Rao (2000)**.

Table 3. Effect of intercropping patterns on number and fresh weight of weeds (g/m^2) in 2010 and 2011 seasons.

Intercropping patterns	Number of broad weeds	Number of narrow weeds	Number of total weeds	Weight broad weeds	Weight narrow weeds	Weight of total weeds
			2010 season			
1 MZ : 1SF	9.6	5.8	15.7	80.4	35.3	115.7
2 MZ : 1SF	10.9	6.6	17.3	100.8	47.0	183.9
3 MZ : 1SF	12.5	6.3	18.7	106.2	51.6	156.8
2MZ : 2SF	14.4	6.9	21.3	127.6	57.5	115.9
$L.S.D_{0.05}$	0.83	0.36	1.13	4.80	3.94	6.10
Maize sole crop	18.3	9.6	27.9	154.4	93.0	247.4
Sunflower sole crop	16.9	7.5	24.4	131.8	67.1	198.9
			2011 season			
1 MZ : 1SF	8.8	4.5	13.4	68.0	27.5	95.5
2 MZ : 1SF	9.8	5.3	15.1	87.7	38.3	126.3
3 MZ : 1SF	20.0	5.2	25.2	94.9	45.4	139.9
2MZ : 2SF	13.2	5.8	19.0	117.2	49.4	166.4
L.S.D at 0.05	0.55	0.28	0.63	4.95	3.50	4.60
Maize sole crop	18.3	9.6	27.9	154.4	93.0	247.4
Sunflower sole crop	16.9	7.5	24.4	131.8	67.1	198.9

Table 4. Effect of interaction between weed control treatments and intercropping patterns on number and fresh weight of weeds (g/m^2) in 2010 and 2011 seasons.

Weed control	Inter. pattern	Number of broad weeds		Number of narrow weeds		Number of total weeds		Weight of broad weeds		Weight of narrow weeds		Weight of total weeds	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Hand hoeing Twice	1MZ :1SF	8.0	7.7	5.1	4.5	13.1	12.2	83.6	73.6	45.3	33.0	128.9	106.6
	2MZ :1SF	9.4	9.1	4.2	3.9	13.6	13.0	95.5	90.1	49.6	40.0	145.1	130.1
	3MZ :1SF	8.0	7.6	4.2	3.5	12.2	11.1	85.7	83.6	43.5	36.9	129.2	120.5
	2MZ :2SF	6.5	6.4	4.1	3.5	10.6	9.9	56.1	50.5	30.0	24.9	83.7	75.5
Hamess	1MZ :1SF	7.8	7.4	4.8	4.3	12.6	11.7	83.5	77.8	45.6	38.7	129.1	116.5
	2MZ :1SF	9.1	8.8	4.7	4.2	13.8	13.0	104.4	99.7	49.0	45.2	153.4	144.9
	3MZ :1SF	7.8	7.5	4.5	4.3	12.3	11.8	88.9	83.6	44.9	40.7	133.8	124.3
	2MZ :2SF	6.1	5.9	4.0	3.3	10.1	9.2	53.8	47.7	29.9	20.8	86.0	75.4
Untreated	1MZ :1SF	16.9	14.4	9.1	7.1	26.0	21.5	135.5	111.6	50.2	43.1	185.7	154.7
	2MZ :1SF	24.7	21.6	11.6	9.4	36.3	31.0	183.0	161.8	73.8	63.1	256.8	224.9
	3MZ :1SF	21.6	17.8	9.9	7.9	31.5	25.7	144.0	117.5	66.4	58.5	210.4	176.0
	2MZ :2SF	16.4	14.2	10.0	6.9	26.4	21.1	131.2	106.0	46.2	36.7	177.4	142.7
L.S.D 0.05		2.4	1.91	2.5	2.6	2.7	3.14	7.93	6.5	6.38	5.80	10.08	6.90

2-Maize:

2:1-Effect of weed control on growth, yield and yield components characters:

Data presented in Table (5) shows that all studied characters of maize were significantly affected by weed control treatments in both seasons, except ear diameter was significant affected in one season out of two and no. of rows / ear was not significantly affected in both seasons.

Growth characters of maize i.e. plant height, stem diameter and ear leaf area of topmost ear recorded the highest values with hand hoeing twice followed by treated by harness and the lowest value was showed with untreated treatment in both seasons. This result may be due to leave weeds control caused reduce growth character of maize because of intraspecific competition between weed and maize plants to nutrients, water, ear characters of maize i.e. ear diameter, ear length, no. of grains and number of rows / ear were significantly affected by weed control treatment in both seasons, except number of rows / ear in both seasons as shown in Table (5).

Table 5. Effect of weed control treatments on growth, yield and yield components of maize in 2010 and 2011 seasons.

Weed control treatments	Plant height (cm)	Stem diameter (cm)	Ear leaf area	Ear diameter (cm)	Ear length (cm)	No. of row/ ear	No. of grains/ ear	W.100 grains	Yield ard./ fad.
2010 season									
Hand hoeing twice	331.6	2.13	728.7	4.72	19.5	13.7	44.6	41.7	13.18
Harness	322.3	2.06	704.9	4.87	19.1	14.5	44.3	38.9	13.04
Untreated	320.6	1.88	578.9	3.65	17.6	14.5	40.6	35.4	10.63
$L.S.D_{0.05}$	6.7	0.36	33.4	0.44	0.24	NS	0.56	1.17	0.90
2011 season									
Hand hoeing twice	311.9	1.92	744.0	4.83	19.7	13.9	45.0	39.1	13.74
Harness	325.2	2.15	726.0	4.98	19.3	15.0	44.6	39.4	13.40
Untreated	315.0	2.09	604.4	3.69	17.9	14.7	40.9	35.8	11.50
$L.S.D_{0.05}$	4.4	0.34	23.0	NS	0.30	NS	0.24	0.45	0.36

Hand hoeing twice and harness gave a satisfactory weed control and significantly increased maize ear characters as compared with untreated, but the increasing of no. of rows / ear was not significantly affected which rarely affected by the agricultural treatments. Similar results were obtained by **Nyakatawa and Nyati (1998)**.Weight of 100–grain was significantly affected by weed control in both seasons as shown in Table (5) Untreated as a check control recorded the lowest values compared with hand hoeing twice and harness herbicide treatments which recorded higher values.

2-2: Effect of intercropping patterns on growth yield and yield component characters:

Results in Table (6) indicated that maize plant height was significantly affected by intercropping patterns in both seasons. This character recorded the lowest value in intercropping patterns compared with maize pure stand. The intercropping pattern (1: 1) maize / sunflower recorded the highest value followed by (2: 1) followed by (2: 2) and (3: 1) showed the lowest value in the seasons. This result may be due inter-specific competition between maize plants for light and nutrient. Similar results were obtained by **Hussain *et al* (2013)**.

Data in Table (6) revealed that (1: 1) maize / sunflower gave the highest values followed by (2: 2) followed by (2: 1) and (3: 1) gave the lowest values. This was completely true for each stem diameter, leaf area of topmast, ear diameter, ear length, no. of rows/ear, no of grains/row and 100- grain weight.

The marked reduction in these traits when maize was, intercropped at high population density is mainly due to the great increase in intraspecific competition among maize plants. On the other hand, when maize was intercropped at 50 % of its pure stand density an increase in these traits were recorded due to the fact that interspecific competition is lower than intraspecific competition. Maize grain yield/fed was significantly affected by intercropping patterns in both seasons as shown in Table (6). The highest maize intercropped yield was obtained with the intercropping pattern which including 50 % maize + 50 % sunflower, followed by 67 % maize + 33 % sunflower followed by (2: 2) and (3: 1) gave the lowest values in both seasons, respectively.

Table 6. Effect of intercropping patterns on growth, yield and yield components of maize in 2010 and 2011 seasons.

Intercropping patterns	Plant height (cm)	Stem diameter (cm)	Ear leaf area	Ear diameter (cm)	Ear length (cm)	No. of rows/ ear	No. of grains/ear	W.100 grains	Yield ard./fad.
2010 season									
1 MZ : 1SF	334.2	2.08	718.6	4.29	19.2	15.1	43.0	37.5	13.66
2 MZ : 1SF	327.4	2.03	680.9	3.99	18.3	13.8	41.4	40.5	13.10
3 MZ : 1SF	320.6	2.01	660.8	4.58	18.1	14.0	43.8	38.0	10.46
2MZ : 2SF	317.1	1.97	623.1	4.81	19.4	14.5	44.5	38.6	12.00
$L.S.D_{0.05}$	3.11	0.24	21.2	0.81	0.27	NS	0.19	2.9	0.75
Maize sole	338.6	2.51	620.3	7.25	17.6	14.8	44.9	42.1	21.19
2011 season									
1 MZ : 1SF	326.0	2.12	734.2	4.98	19.6	15.2	44.8	38.9	14.44
2 MZ : 1SF	320.1	2.07	702.0	4.62	19.4	14.0	44.1	38.3	13.52
3 MZ : 1SF	313.6	2.04	684.1	4.39	18.6	14.6	43.4	37.8	12.49
2MZ : 2SF	309.7	1.99	645.6	4.01	18.3	14.3	41.8	37.3	13.05
$L.S.D_{0.05}$	1.53	0.19	0.19	0.16	0.41	NS	NS	0.83	0.39
Maize sole	332.0	2.56	656.3	7.40	18.5	15.4	45.7	41.2	21.70

Maize grain yield/fed of these intercropping patterns were 64.46, 61.82, 49.36 and 56.63 % of its pure stand in the first season, respectively; and were 66.54, 62.30,57.55 and 60.13 % in the second season, respectively.

The reduction in maize intercropped grain yield is mainly due to the reduction in area grown which are 50 to 75 % of it's the pure stand area. This result is in line with those obtained by **Dabbagh *et al* (2011)**.

2-3: Interaction effect:-

The interaction effects between weed control and intercropping patterns were not significant on all characters studies except 100 – grain weigh and yield / fad as shown in Table (7) Intercropping pattern (3: 1) maize /sunflower with untreated weed control gave the lowest values for 100 –grain weight, whereas intercropping pattern (1: 1) under hand hoeing twice gave the highest values for this character in both seasons, values for 100–grain weight, whereas intercropping pattern (1: 1) under hand hoeing twice gave the highest values for this character in both seasons.

Table 7. Effect of interaction between weed control treatments and intercropping patterns on some characters of maize in 2010 and 2011 seasons.

Weed treatments	Intercropping pattern	100- grain weight		Yield ard./fad.	
		2010	2011	2010	2011
Hand hoeing twice	1 MZ : 1SF	39.8	40.1	14.85	15.43
	2 MZ : 1 SF	39.2	39.5	13.91	14.47
	3 MZ : 1 SF	37.4	38.6	10.84	13.07
	2 MZ : 2 SF	39.0	39.3	14.25	14.75
Harness	1 MZ : 1SF	39.4	39.1	14.49	14.82
	2 MZ : 1 SF	39.0	39.3	13.94	14.33
	3 MZ : 1 SF	38.5	39.9	11.08	11.31
	2 MZ : 2 SF	39.8	38.2	12.85	13.12
Untreated	1 MZ : 1SF	35.1	35.1	11.83	11.49
	2 MZ : 1 SF	35.8	36.0	11.17	11.76
	3 MZ : 1 SF	34.5	35.1	9.47	10.35
	2 MZ : 2 SF	36.4	36.7	10.07	10.81
$L.S.D_{0.05}$		0.87	1.21	0.70	0.56

Results in Table (7) showed that intercropping pattern (3:1) maize/sunflower and a check weed control gave the lowest values for grains yield/fed. Whereas intercropping pattern (1: 1) maize / sunflower and hand hoeing maize plants twice recorded the highest values for maize grain yield/fed in both seasons.

3. Sunflower:

3-1: Effect of weed control on growth, yield and yield components:

Results showed that plant height was significantly affected by weed control in both seasons; no. of leaves / plants and stem diameter was significant in one season as shown in Table

(8).Herbicide harness and hand hoeing twice as weed control treatments gave on the one hand higher value compared to untreated treatment on the other hand lower value. This was completely true for each of plant height, stem diameter and no. of leaves in both seasons (Table 8). This result may be due to sever competition between such results are in accordance with those obtained by **Galal (1998)**, **Din *et al* (2013)** and **Hussain *et al* (2013)**.

Table 8. Effect of weed control treatments on growth, yield and yield components of sunflower in 2010 and 2011 seasons.

Weed control treatments	Plant height (cm)	Stem diameter (cm)	No. of leaves / plant	Head diameter (cm)	Weight of head (g)	Weight of seeds /head (g)	Shelling %	Oil %	Seed Yield /fad. (Kg)
2010 season									
Hand hoeing twice	147.2	2.31	26.2	14.5	61.4	35.7	58.2	35.5	429.9
Harness	145.0	2.27	26.0	15.2	61.1	35.3	58.0	35.0	425.9
Untreated	142.3	2.23	25.9	13.7	60.0	32.9	54.8	34.9	403.3
$L.S.D_{0.05}$	0.85	NS	NS	0.32	0.57	0.48	NS	0.17	13.4
2011 season									
Hand hoeing twice	138.7	2.40	25.6	15.3	61.5	36.1	58.7	35.7	443.8
Harness	137.6	2.33	25.3	14.9	61.2	35.7	58.5	35.8	433.7
Untreated	135.6	2.25	23.4	13.8	60.1	33.1	54.9	35.1	417.1
$L.S.D_{0.05}$	1.10	0.16	NS	0.35	0.75	0.29	NS	0.24	13.7

Yield component characters of sunflower i.e. head diameter, weight of head and weight of seeds/heed followed by hand hoeing twice, whereas untreated treatment gave the lowest value for these characters in both seasons. The serious reduction in untreated can be considered as a good indication for the competition resulting from inter-specific competition between sunflower and different weeds. Similar results were obtained by **Hussain *et al* (2013).**

Shelling % was not significant affected by weed control treatment in both seasons (Table 8). This trait is mainly considered as an inheritance character for a certain variety and is not affected by cultural treatments. Oil % was significantly affected by weed control treatments in both seasons (Table 8). Hand hoeing twice achieved the highest value for oil% followed by harness herbicide and then untreated (check treatment) gave the lowest for this trait in the first season, whereas herbicide harness gave the highest value followed by hand hoeing twice and untreated value gave the lowest value in the second season. Regarding seed yield /fed, results in Table (8) clearly indicated that seed yield/fed was significantly affected in both seasons. Data showed that seed yield/fed behaved the same trend of yield component characters in both seasons. Also, data revealed that seed yield/fed was most significantly affected between hand hoeing twice and herbicide harness in both seasons. These results are in agreement with those obtained by **Din *et al* (2013).**

3-2: Effect of intercropping patterns of growth, yield and yield component characters:

Data in Table (9) revealed that all studied characters of sunflower were significantly affected by intercropping patterns in both seasons, except shelling %, except oil % was significant affected in one season out of two was not significantly affected in both seasons. Plant height was significantly affected by intercropping patterns in both seasons as shown in Table (9). Plant height was reduced when sunflower and maize were intercropped at maize densities. So, the reduction in plant height of sunflower is mainly due to the increase in inter-specific competition resulting from maize plants through their shading effect. Similar results were obtained by **Dabbagh *et al* (2011).**

Results shown in Table (9) indicated that when sunflower intercropped at (2: 2) pattern gave the highest value followed by (1: 1) followed by (2: 1) maize / sunflower; simultaneously the lowest value was due to (3: 1) maize / sunflower. This was completely true for stem diameter, no. of leaves / plant, head diameter, weight of head and weight of seeds / head. It is clear that a gradual decrease in these traits when sunflower intercropped with the increase in maize population density under intercropping patterns (3 : 1) or (2 : 1) maize/sunflower than (2 : 2) or (1 : 1) patterns which recorded increase in these traits.

The serious reduction in yield components of sunflower are mainly due to the reduction in sunflower growth characters i.e. plant height, stem diameter and no. of leaves/plant. Shelling %, results in Table (9) showed that shelling % was not significantly affected by intercropping patterns in both seasons.

Table 9. Effect of intercropping patterns on growth, yield and yield components of sunflower in 2010 and 2011 seasons.

Intercropping pattern	Plant height (cm)	Stem diameter (cm)	No. of leaves / plant	Head diameter (cm)	Weight of head (g)	Weight of seeds /head(g)	Shelling %	Oil %	Seed Yield /fad. (Kg)
2010 season									
1 MZ : 1SF	141.0	2.22	26.2	14.1	59.5	34.6	56.6	35.4	493.6
2 MZ : 1SF	143.3	2.23	26.2	14.3	60.1	34.0	56.5	35.2	85.2
3 MZ : 1SF	148.1	2.31	26.0	14.7	61.5	34.7	56.9	35.0	300.4
2 MZ : 2SF	147.0	2.37	25.8	15.1	62.2	35.4	58.1	35.6	503.7
$L.S.D_{0.05}$	1.85	0.23	0.28	0.12	1.21	0.18	NS	0.11	8.20
Sunflower sole crop	153.2	2.19	27.4	14.2	61.8	35.1	56.8	35.9	994.0
2011 season									
1 MZ : 1SF	131.8	2.27	25.4	14.2	59.6	34.9	57.0	35.6	505.3
2 MZ : 1SF	134.9	2.27	24.9	14.4	60.2	34.3	56.8	35.4	389.5
3 MZ : 1SF	142.4	2.36	24.5	14.8	61.5	35.0	57.3	35.3	302.7
2 MZ : 2SF	139.5	2.41	24.2	15.2	62.4	35.7	58.5	35.8	516.9
$L.S.D_{0.05}$	13.5	0.21	0.17	0.11	1.15	0.44	NS	NS	8.83
Sunflower sole crop	145.2	2.14	26.1	14.2	61.7	35.9	58.1	35.6	974.0

This result indicated that shelling % is greatly influenced by the genetically makeup of the variety. Similar results were obtained by **Echarte *et al*. 2011).** Results in Table (9) showed that oil % of sunflower was significantly affected by the intercropping patterns in the first season. Significant differences between intercropping patterns were too slight to reach the level of significance. Similar results were obtained by **Abd EL-Zaher *et al* (2009)**. Sunflower seed yield/fed was significantly reduced by intercropping patterns compared with sole sunflower in both seasons as shown in Table (9).The highest sunflower intercropped yield was produced with (2 : 2) pattern followed by (1 : 1) followed by (2 : 1) maize/ sunflower and the lowest value was (3 :1) maize/sunflower pattern in both seasons. The seed yield of these traits were 57.16 , 56.20 , 45.94 and 37.91 % in the first season, respectively; and were 59.62 , 58.69 , 47.31 and 38.92 % of its pure stand in the second season, respectively, the seed yield reduction is quite expected due to the competition of maize plants and the shading effect depressed most of the yield components of sunflower plants. Also, it is worth mentioning here that the area practically growth with sunflower were 50 % in the first and fourth patterns and were 33 and 25 % in the second and third patterns of sole cropping area and seed yield is quite expected. Similar results were obtained by **Dabbagh *et al* (2011).**

3-3: Interaction effect:-

The interaction effects between weed control treatments and intercropping patterns was significant for head diameter, weight of head and seed yield/fed as shown in Table (10). Head diameter, results in Table (10) clearly indicated that the highest value was achieved with harness herbicide treatment under intercropping pattern (2: 1) maize / sunflower, whereas the lowest value was showed with untreated treatment under intercropping pattern (3: 1) maize / sunflower in both seasons. Regarding weight of head, data revealed that the highest value was obtained by hand hoeing twice and intercropping patters (3: 1) maize / sunflower in both seasons as shown in Table (10). The interaction effects were significant on seed yield/fed as shown in Table (10).

Intercropping pattern (1: 1) maize /sunflower with hand weeding twice weed control gave the highest values for seed yield/fed, whereas intercropping pattern (3: 1) under untreated gave the highest values for seed yield/fed this character in both seasons.

4. Competitive relationships and yield advantage of intercropping:

4-1: Land Equivalent Ratio (LER)

Land Equivalent Ratio, results indicate that maize and sunflower proved advantageous in all intercropping patterns in the first and second seasons as shown in Table (11). The best land usage was 1.21in the first season, which were recorded with (2:1) pattern (67 % maize: 33 % sunflower), and 1.26 in the second seasons, which were recorded with (1:1) pattern (50 % maize: 50 % sunflower). Whereas, the lowest land usage was 1.01 and 1.04 with (3:1), which (75 % maize +25 % sunflower) in both seasons. In (1:1) and (2:2) intercropping patterns, maize was the higher contribute with higher (Lm) values compared with (Ls) values of sunflower. In (2:1) and (3:1) intercropping patterns, sunflower was the higher contribute with higher (ls) values compared with (Lm) values of maize. Similar results

were obtained by **Dhima *et al* (2007)** and **Abd El- Zaher and Shams (2012)**.

Table 10. Effect of interaction between weed control treatments and intercropping patterns on some characters of sunflower in 2010 and 2011 seasons.

Weed treatments	Intercropping pattern	Head diameter (cm)		Weight of head (g)		Seed Yield /fad. (Kg)	
		2010	2011	2010	2011	2010	2011
Hand hoeing twice	1 MZ : 1SF	14.5	14.6	61.0	61.1	531.6	536.6
	2 MZ : 1 SF	15.1	15.2	62.1	62.2	405.5	412.0
	3 MZ : 1 SF	15.4	15.5	62.5	62.8	320.7	323.9
	2 MZ : 2 SF	14.1	14.3	60.0	60.0	457.2	462.8
Harness	1 MZ : 1SF	14.9	15.1	59.9	60.0	549.3	554.4
	2 MZ : 1 SF	15.4	15.5	61.9	62.0	412.2	419.7
	3 MZ : 1 SF	15.6	15.7	62.2	62.3	327.0	331.6
	2 MZ : 2 SF	14.8	14.9	59.9	60.0	430.0	469.8
Untreated	1 MZ : 1SF	13.6	13.6	59.4	59.6	505.0	521.0
	2 MZ : 1 SF	13.6	13.7	60.5	60.5	380.9	396.7
	3 MZ : 1 SF	14.3	14.4	61.8	62.0	298.4	312.4
	2 MZ : 2 SF	13.3	13.4	58.6	58.8	428.9	438.1
$L.S.D_{0.05}$		0.40	0.28	1.14	1.30	15.3	14.2

Table 11. Effect of intercropping patterns on competitive relationships and yield advantages in 2010 and 2011. seasons.

Characters / Treatments		Land equivalent ratio			Relative crowding coefficient			Aggressivity	
Weed control	Intercropping pattern	Lm	Ls	LER	Km	Ks	K	Am	As
2010 season									
Untreated	1:1	0.56	0.51	1.07	1.31	1.03	1.35	+0.12	-0.12
	2:1	0.65	0.38	1.03	0.93	1.24	1.16	-0.20	+0.20
	3:1	0.68	0.33	1.01	0.71	1.28	0.91	-0.29	+0.29
	2:2	0.60	0.43	1.03	1.49	0.76	1.13	+0.34	-0.34
Harness	1:1	0.64	0.55	1.19	1.75	0.99	1.74	+0.17	-0.17
	2:1	0.79	0.42	1. 21	1.86	1.99	3.70	-0.07	+0.07
	3:1	0.83	0.33	1.16	1.66	1.47	2.44	-0.20	+0.20
	2:2	0.75	0.43	1.18	3.04	0.76	2.32	+0.64	-0.64
Hand hoeing twice	1:1	0.65	0.53	1.18	1.84	0.99	1.83	+0.24	-0.24
	2:1	0.79	0.41	1.20	1.87	2.0	3.74	-0.06	+0.06
	3:1	0.81	0.32	1.13	1.38	1.43	1.97	-0.21	+0.21
	2:2	0.74	0.46	1.20	2.76	0.85	2.35	+0.55	-0.55
2011 season									
Untreated	1:1	0.65	0.57	1.22	1.87	1.32	2.47	+0.38	-0.38
	2:1	0.66	0.41	1.07	0.99	1.38	1.37	-0.25	+0.25
	3:1	0.65	0.39	1.04	0.49	1.41	0.69	-0.53	+0.53
	2:2	0.63	0.45	1.07	0.62	0.82	1.32	+0.34	-0.34
Harness	1:1	0.73	0.53	1.26	2.68	1.15	3.08	+0.16	-0.16
	2:1	0.80	0.43	1.23	1.95	1.52	2.96	-0.13	+0.13
	3:1	0.84	0.34	1.18	1.65	2.82	4.63	-0.24	+0.24
	2:2	0.75	0.48	1.23	3.01	1.23	3.70	+0.53	-0.53
Hand hoeing twice	1:1	0.64	0.55	1.19	1.80	1.22	2.21	+0.19	-0.19
	2:1	0.79	0.42	1.21	1.83	1.47	2.68	-0.11	+0.11
	3:1	0.81	0.33	1.14	1.44	1.49	2.15	-0.25	+0.25
	2:2	0.73	0.48	1.21	2.73	0.91	2.47	+0.51	-0.51

4-2: Relative Crowding Coefficient (K)

Data revealed that intercropping maize and sunflower was advantageous in both seasons as shown in Table (11). The highest value for yield advantages was achieved with intercropping pattern (2:1) in first season and (1:1) in the second season. Whereas (3: 1) maize / sunflower pattern gave the least yield advantage value in both seasons.

A yield advantage occur because the component crops differ in their utilization of growth restores in such a way that when they are grown in association. They are able to complement each other and to make better overall use of environmental resources than when grown separately. These results are in the same line with those reported by **Dabbagh *et al* (2011).**

4-3: Aggressivity (Agg)

Data presented in Table (11) indicated that maize was the dominant intercrop component when maize and sunflower intercropped at (2: 2) and (1: 1) patterns. Smile sunflower was dominant intercrop component at (2: 1) and (3: 1) maize / sunflower patterns. Similar results are in harmony with those obtained by **Dabbagh *et al* (2011)**. It could be concluded that hand hoeing twice and (2: 2) maize / sunflower intercropping pattern to obtain the best. It could be concluded that intercropping (two rows maize: two rows sunflower) in alternating with hand hoeing twice to obtain the best productivity of both crops and land usage.

4-4: Economic Evaluation:

The evaluation of different intercropping pattern of sunflower with maize was made for the two seasons as a total income of the two components and compared with each of them as a solid crop due to market price. Data presented in Table (12) indicated that the advantage of intercropping patterns maize and sunflower as economic expresser in terms of the farmer. Total income increased in all intercropping patterns compared to total income of maize as control treatment. The highest values of net income (L.E. /fed.) could be achieved by (2:1), the pattern of 67 %maize: 33% sunflower (5593.0 L.E.) and (5931.5L.E.) with harness herbicide weed control treatments in the first and second season, respectively.

On the contrary, the lowest value of net income (L.E. /fed.) was achieved by intercropping patterns which including 75 % maize + 25 % sunflower (3936.2L.E.) and (4973.5 L.E.) with untreated treatments in the first and second season, respectively. Similar results were obtained by and **Abd El-Zaher and Shams (2012)** and **Ahamad *et al* (2013)**.

MAI suggests the economic assessment should be in terms of the value of land saved; this could probably be most assessment on the basis of the rentable value of this land. Data presented in Table (12) indicated that the advantage of intercropping patterns maize and sunflower as economic expresser in terms of the farmer. The highest values of MAI were achieved by (2:2), the pattern of 50% maize: 50 % sunflower (812.04) in the first season and (1036.00) in the second season with harness herbicide weed control treatments. On the contrary, the lowest values of MAI (54.20) in the first season and (219.07) in the second season were achieved by intercropping patterns which including (3:1) with hand hoeing twice. Similar results were obtained by **Ahmad et al. (2013).**

Table 12. Total income of maize and sunflower and monetary advantage index (AMI) of maize and sunflower as advantage of intercropping pattern and weed control during2010 and 2011 seasons.

Weed control	Inter. patterns	2010 season				2011 season			
		Maize	Sunflower	Total	MAI	Maize	Sunflower	Total	MAI
Hand hoeing twice	1:1	3252	1724.6	4976.6	325.57	3921	1779.2	5700.2	1027.90
	2:1	4173	1300.8	5473.8	159.43	4341	1354.7	5695.7	372.61
	3:1	4455	1019.3	5474.3	54.20	4629	1066.9	5695.9	219.07
	2:2	3936	1464.7	5400.7	157.30	4062	1496.1	5558.1	363.61
Harness (84% EC)	1:1	3549	1815.4	5364.4	856.50	4299	1433.3	5732.3	1182.85
	2:1	4182	1411.0	5593.0	970.68	4299	1632.5	5931.5	1109.14
	3:1	4287	1116.7	5403.7	745.33	4446	1132.4	5578.4	850.94
	2:2	3855	1468.4	5323.4	812.04	3936	1604.4	5540.4	1036.00
Untreated	1:1	3324	1875.9	5199.9	793.20	4446	1406.9	5852.9	934.49
	2:1	3351	1384.8	4735.8	789.30	3393	1893.2	5286.2	917.43
	3:1	2841	1095.2	3936.2	452.83	3393	1580.5	4973.5	610.78
	2:2	3021	1561.3	4582.3	763.71	3936	1106.2	5042.2	875.09

The price was calculated as market price, Maize= 300 L.E/ard and Sunflower = 3415 L.E/ard

Conclusion

It could be a recommended that intercropping maize with sunflower under system 2:1 with adding

Harness herbicide weed control gave the highest value of both crops.

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تأثير التحميل وطرق مقاومة الحشائش على إنتاجية دوار الشمس مع الذرة الشامية

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***المعمل المر كزى لبحوث الحشائش –مركز البحوث الزراعية –الجيزة**

أقيمت هذه التجربة في محطة البحوث الزراعية – محافظة الجيزة – مصر – خلال موسمي 2010 و 2011م لدراسة تأثير ثلاثة معاملات لمكافحة الحشائش (بدون –العز يق اليدوي مرتين –استخدام مبيد الحشائش هرنس) وأربع أنماط تحميل (1:1) ، (1:2) ، (1:3) ، (2:2) ذرة شامية : دوار الشمس بنظام الخطوط المتبادلة. بجانب الزراعة المنفردة لكل من الذرة الشامية ودوار الشمس طبقا للتوصيات الفنية، على بعض صفات الحشائش والنمو والمحصول ومكوناته لكلا المحصولين وكذلك العلاقات التنافسية والميزة المحصولية، واستخدام نظام القطع المنشقة مرة واحدة في ثلاث مكررات، ويمكن إيجاز أهم النتائج المتحصل عليها كالآتي:–

1. **الحشائش**

أدت مكافحة الحشائش سواء بالعز يق اليدوي أو استخدام مبيد الحشائش هرنس إلى نقص معنوي في قراءات الحشائش خلال موسمي الزراعة.تفوق نظام التحميل (2:2) في تقليل كل صفات الحشائش خلال موسمي الزراعة، بينما أعطى نظام التحميل (2:2) واستخدام مبيد الحشائش هرنس أقل القيم على صفات الحشاش، بينما سجلت المعاملة (1:2) وعدم مكافحة الحشائش أعلى القيم خلال موسمي الزراعة.

2. **الذرة الشامية**

أدت معاملة العز يق مرتين واستخدام مبيد الحشائش هرنس إلى زيادة معنوية للنمو والمحصول ومكوناته للذرة الشامية مقارنة بمعاملة عدم المكافحة خلال موسمي الزراعة.سجل نظام التحميل (1:1) أعلى القيم لمكونات محصول الذرة الشامية خلال موسمي الزراعة، أعطى نظام التحميل (1:1) 66. 79 %، 74.76 % من محصول الذرة الشامية المنفردة في الموسم الأول والموسم الثاني على التوالي.تأثرت كل من وزن الـ 100 حبة ومحصول الفدان للذرة الشامية بالتفاعل بين عاملي الدراسة في كلا الموسمين.

3. **دوار الشمس**

تفوقت معاملتي مكافحة الحشائش بالعريق اليدوي مرتين ومبيد الحشائش هرنس في صفات النمو والمحصول ومكوناته لدوار الشمس على معاملة عدم المكافحة خلال موسمي الزراعة.

تأثرت معظم الصفات المدروسة لدوار الشمس معنويا بنظم التحميل خلال موسمي الزراعة ، سجل نظام التحميل (2:2) أعلى القيم لمحصول البذور ، بينما سجل نظام التحميل (1:3) أقل القيم خلال موسمي الزراعة.

تأثرت كلا من قطر القرص ووزن القرص معنويا بالتفاعل بين عاملي الدراسة.

4. **التقييم الاقتصادي**

سجل معامل استغلال الأرض 1,27 ،21 ,1 مع نظام التحميل (2:1) فى الموسم الأول والموسم الثاني على التوالي، وكانتأعلى القيملمعامل الحشد النسبي لنفس النظام خلال موسمي الزراعة ، كان الذرة الشامية هو المحصول السائد مع نظم التحميل التى اشتملت 50% ذرة شامية + 50% دوار شمس سجل التقييم الاقتصاديأننظام التحميل(2:1) أعطى أعلا زيادة في العائد النقدي للمزارع بما يعادل 5593,5، 5931,5جنيها مقارنة بالزراعة المنفردة للذرة الشامية في الموسم الأول والثاني على الترتيب .