Effect of Irrigation and Fertilizers on Diseases Incidence and Agronomic Characters of Sunflower in El- Behera Governorate

Morsy. S.M[1]., Elham.A.D.[2] and Abd-Elbaky, A.A[1]

ABSTRACT

Field experiments were conducted to determine the effect of irrigation intervals combined with different types of fertilizers on the incidence of damping-off and charcoal-rot, percentage of fungi in rhizosphere and rhizoplane, yield and oil content of sunflower. Application of irrigation intervals combined with different types of fertilizers significantly affected incidence of diseases and density of fungi in the soil. The irrigation at 20 days intervals combined with gypsum as a fertilizer, significantly decreased incedence of damping-off and charcoal–rot diseases 4.66%, and 31.66%, respectively, followed by the same irrigation treatment combined with phosphoren 5.66% and 38.31%, respectively in the two successive growing seasons 2007 and 2008.

The irrigation interval treatments combined with farmyard manure stimulated the growth of some fungi in the rhizosphere and rhizoplane of sunflower plants compared to other fertilizers. Meantime, gypsum as fertilizer application under the irrigation intervales conducted decreased the percentage of micro-organisms in rhizosphere and rhizoplane, 42.8% and 40.8%, respectively, compared with other fertilizers. *Penicillium sp*. and *Fusarium sp*. were the dominant fungi in all tested rhizosphere and rihzoplane samples of sunflower. Also, irrigation at 20 days intervales combined with each fertilizers improved sunflower growth, yield and increased oil as well.

INTRODUCTION

Sunflower (*Helianthus annuus L*.) is the second top ranking oil crop after soybean (Fick, 1989). Sunflower seeds contain high percentage of oil which ranged between 30% and 50% (Weiss, 2000; Krizmanic *et al*., 2004 and Morsy, 2005). Oil quality is also hygienically superior as well as other edible oil. Production of sunflower in Egypt was about 1581 tons in the year 2007. El-Behera Governorate was a major area for sunflower cultivation (Dep. of statistics, Ministry of Agric., El-Giza, Egypt). Besides, there is an urgent need to increase the oil production in Egypt to cover about 90% of the annually oil importation for the local market. Unfortunately, sunflower yield is negatively affected with several diseases in Egypt especially the damping–off in the early stages and charcoal–rot in the late stages of growth (Sackston, 1978 and Ahmed, *et al*., 1994).

Currently, there are no cheap and effective measures available for controlling damping-off and charcoal-rot on sunflower in Egypt. There is no sunflower hyprids highly resistant for some diseases (Mousa *et al*., 2006).

Soil borne diseases are still a major threat to sunflower cultivation in Egypt and all over the world due to the wide host range of the pathogens and their persistent survival ability in the soil (Mousa *et al*., 2006 and Bokor, 2007). Chemical control was massively applied however, to the cope with increasing public appeal to disunsh the fungicide using, alternative control methods are strongly desired for sustainable agriculture in which organic amendments play an important role (Workneh and Van Bruggen, 1994 and Lazarouits, 2001). The use of various alternative methods were suggested world-wide for controlling both these soil borne diseases. Irrigation intervals combined with different fertilizers types are effective cultural practices for reducing disease incidence. Irrigations intervals affected the development of the plants as well as the damping-off and charcoal-rot and percentage of microbile in soil (Abou-Zeid *et al*., 1997 and 2003; Hussein *et al*., 2000 and Ismail and Abd El Momen, 2007).

MATERIAL AND METHODS

Two fields experiments were carried out at Itay-El-Behroud Agricultural Research Station in El-Behera Governorate during the two successive, 2007 and 2008 growing seasons of sunflower. The experiments were designed to study the effect of irrigation intervals combined with different types of fertilizers on damping-off, charcoal-rot, soil microflora, growth parameter, yield and oil content of sunflower plants.

Experimental unit comprised 5 ridegs (each 6m long and 0.7m wide = 21m^2 in area). Sunflower sown in 25 May in 2007 and 30 May 2008. While, hills (one plant/hill) were spaced at 20cm apart. Treatments were carried out in a split block design.

Irrigation intervals

Irrigation intervals, *i.e*., 10, 20 and 30 days for the first irrigation after sowing.

[1]Plant Path. Res. Inst., Agric. Rec. Center, Giza
[2]Field Crops Dept. Nuclers Rec. Center, Anshas
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Fertilizers

- Phosphoren or cerealin as biofertilizers were added to the soil at rate of 1g/hill. The biofertilizers were obtained from Agriculture Research Center, Giza, Egypt.
- Phosphorus was added before sowing at rate of (150kg/ feddan) as calcium super phosphate (15.5 $\%P_2O_5$).
- Farmyard manure was added before sowing to the soil at the rate of $30m^2$/fed.
- Gypsum is hydrated calcium sulfate ($CaSO_4.2H_2O$) was added to soil before sowing at rate of 1000 kg/fed. obtained from Ministry of Agriculture.

Cultivar :

Sunflower c.v Vedok was obtained from Field Crops Research Institute, A.R.C., Giza, Egypt.

Microbiological analysis

This study was carried out to investigate the microflora in rhizosphere and rhizoplane of Vedok tested cultivar under field conditions. One gram of the root system with the remaining adjacent soil particles was transferred to a wide–mouth glass reagent bottle containing 99 ml sterile distilled water. The bottles were shaken thoroughly for 5 minutes. One loopful was taken and streaked on PDA medium, three replicates were carried out for each sample. The microflora of rhizosphere were examined by transferring one gram of each of representative soil sample to a glass bottle containing 99 ml sterile distilled water. Soil extracts were treated as previously mentioned in case of rhizoplane soil and placed on Petri-dishes containing PDA medium.

Petri-dishes were then, incubated at 25±2?c for 4 days while, the developed fungal colonies were counted and frequency of each fungus were calculated. The sterilized portions were then plated on PDA medium and incubated at 25C. the developed colonies were then purified using hyphal tip or single spore techniques Tuilte, (1969). Identification of the fungi detected was conducted according to (Booth, 1971, Barnett, 1972 and Ramirez, 1982). Samples of microflora in rhizosphere and rhizoplane of the tested cultivar were taken periodically at 25, 50 and 75 day after sowing.

Oil content:

Dried mature seeds were ground to a fine powder to determine oil content using Soxhelt method with Hexan-N as a solvent (A.O.A.C., 1980)

Statistical analysis: -

Data obtained were subjected to statistical analysis according to the procedures outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

I) Effect of irrigation date combined with different types of fertilizers on diseases incidence.

a) Effect on damping - off

Data obtained in Table (1) indicate that percentages of damping-off plants (45days after sowing) differed according to the different of irrigation intervals and the combination with different fertilizers. Generally, the use of irrigation after 20 days intervals combined with the different types of fertilizers significant decreased percentage of damping-off compared with irrigation after 10 or 30 days and the same fertilizers. Percentages of damping-off developed under the irrigation after 20 or 30 days were as low as 10.77% and 13.49% respectively, compared 19.77 % for the irrigation of 10 days, combined with different types of fertilizers, over the two seasons of the study.

Meantime, farmyard manure as fertilizer application under the different irrigation intervals conducted increased the development of damping-off. The range was 14.325–32.99% for irrigation intervals 10, 20 and 30 days while the range was 4.66%–17.33% for the other fertilizers under the different irrigation intervals. The most pronounced effect 3.99 – 16.66% was recorded in case of 20 days of irrigation combined with different types of fertilizers. Gypsum was the best fertilizer in reducing damping-off incidence, 9.99, 4.66 and 5.99% combined with the different irrigation intervals, 10, 20 and 30 days, respectively. Therefore, it could be concluded that increasing irrigation 10 days intervals increased the soil infestation pathogenic fungi and the incidence of sunflower diseases. These results are in agreement with these obtained by (El-Din *et al*., 1984; Arafa, 1985; El-shabrawy *et al*., 1987, and Abou-Zeid *et al*., 1997 and 2003).

b) Effect on charcoal - rot:

Data in Table (2) indicated that percentages of charcoal-rot plants (90 days after sowning) differed according to the different irrigation intervales and in combination with different types of fertilizers. Generally, the use of irrigation after 20 days combined with the different type of fertilizers significantly decreased percentage of charcoal-rot (43.21%) compared with irrigation after 10 or 30 days (51.34 and 58-78%) with the same fertilizers. Gypsum was the best application under the irrigation after 20 days intervals, decreased the developed charcoal-rot as 31.66% followed by phosphoren fertilizer 38.31% under the same time of irrigation during the two growing seasons, 2007 and 2008.

Therefore, it could be concluded that increasing irrigation intervals from 10 or 30 days increased

infestation by pathogenic fungi and the incidence of sunflower diseases. This result are in line with those obtained by (Zazzerini *et al*., 1985) who found that disease incidence increased with increasing rainfall, temperature, crop density, irrigation and N fertilizer and herbicide application. Also these results are in harmony with (Shalaby,1998). Moreover, generally calcium has a critical metabolic role in carbohydrates removal, cell wall deposition and formation of pectates in the middle lamella (Engelhard, 1993). Also, (Fahim, *et al.,* 2006) found that gypsum at 750Kg/fed. followed by sulphur at 200 Kg/fed. gave the highest percentage of healthy survival peanut plants.

Effect of irrigation intervals combined with different types of fertilizers on microflora in rhizosphere and rhizoplane of sunflower.

Data in Table (3) show that the effect of irrigation intervals and the combination with different types of fertilizers on percentage of the fungi in rhizosphere and rhizoplane of sunflower plants. Generally, the use of irrigation after 10 days intervals combined with the different fertilizers increased percentage of fungi, 70.52 and 63.3% compared to 57.08 and 58.86% for the 20 days of irrigation and 51.6 and 53.68% for the 30 days irrigation in the rhizosphere and rhizoplane, respectively. Meantime, gypsum as fertilizer application under the different irrigation intervals conducted decreased the microflora in rhizosphere and rhizoplane. This range was 42.8–55.6% during the two growing seasons 2007 and 2008. While, the use of farmyard manure increased percentage of fungi under the different irrigations intervals compared with other fertilizers. This range of was 66.00 – 90.3 % for the farmyard manure compared to 42.8–68.00% for the other fertilizers. However, *Pencillium* sp. was the highest dominant fungus in rhizosphere or rhizoplane followed by *Fusarium* sp.. The highest occurrence of *Pencillium* sp. and *Fusarium* sp. 25.28 and 13.54% in rhizosphere and 21.7 and 17.7% in the rhizoplane, respectively. These results are in agreement with those obtained by (Morsy, 2004) for sunflower.

Accordingly, combined use management of irrigation at 20 days intervales and gypsum as fertilizer especially for sunflower might contribute positively to even higher degree of tolerance and subsequently increased yield.

Table1. Effect of irrigation intervals combined with different types of fertilizers on damping-off disease incidence of sunflower plants

Irrigation intervals	Fertilizers	Mean percentage of damping-off		Mean
		Season		
		2007	2008	
10 days	Farmyard manure	39.99	25.99	32.99
	Super phosphate	11.33	23.33	17.33
	Phosphoren	12.66	16.66	14.66
	Cerealin	10.66	14.66	12.66
	Gypsum	9.99	9.99	9.99
	Control	31.33	30.59	30.96
Mean		19.33	20.2	19.77
20 days	Farmyard manure	16.66	11.99	14.33
	Super phosphate	9.99	7.99	8.99
	Phosphoren	6.66	4.66	5.66
	Cerealin	9.33	8.66	8.995
	Gypsum	5.33	3.99	4.66
	Control	23.32	20.66	21.99
Mean		11.88	9.66	10.77
30 days	Farmyard manure	21.33	19.33	20.33
	Super phosphate	8.66	11.13	9.895
	Phosphoren	8.66	7.99	8.325
	Cerealin	9.33	6.66	7.995
	Gypsum	7.99	3.99	5.99
	Control	27.33	28.66	27.995
Mean		13.88	13.1	13.49
L.S.D at 0.05	for irrigation	3.17	2.79	
	for fertilizers	4.49	3.94	

Table 2. Effect of irrigation intervals combined with different types of fertilizers on charcoal-rot diseased incidence of sunflower plants

Irrigation intervals	Fertilizers	Mean percentage of charcoal-rot disease incidence		Mean
		Season		
		2007	2008	
10 days	Farmyard manure	50.66	60.80	55.73
	Super phosphate	39.99	52.66	46.33
	Phosphoren	42.66	53.33	47.99
	Cerealin	40.65	55.99	48.32
	Gypsum	36.66	51.99	44.33
	Control	62.66	67.99	65.33
Mean		45.55	57.13	51.34
20 days	Farmyard manure	44.66	55.98	50.32
	Super phosphate	42.66	36.66	39.66
	Phosphoren	31.30	45.32	38.31
	Cerealin	39.33	47.99	43.66
	Gypsum	31.98	31.33	31.66
	Control	47.99	63.33	55.66
Mean		39.65	46.77	43.21
30 days	Farmyard manure	67.99	58.93	63.46
	Super phosphate	51.33	59.99	55.66
	Phosphoren	55.33	61.13	58.23
	Cerealin	49.33	59.33	54.33
	Gypsum	43.99	55.33	49.66
	Control	71.99	70.66	71.78
Mean		56.66	60.90	58.78
L.S.D at 0.05 for irrigation		6.61	6.36	
for fertilizers		9.34	8.898	

Effect of irrigation intervales combined with different types of fertilizers on the growth parameters, yield and oil content of sunflower.

a- Effect on growth parameters:

Data in Table (4) show that the tested irrigations intervals combined with different types of fertilizers had significant effect on plant hight, stem diameter and number of leaves. The highest value of plant hight was obtained when sunflower irrigated after 20 day intervals combined with the different sources of fertilizers (166.5 and 162.2cm). However, the same irrigation intervales combined with farmyard manure as fertilizer gave the highest plants (174.8 and 169.8cm) during 2007 and 2008 growing seasons, respectively.

Stem diameter was significantly increased by irrigations intervals at 20 days combined with different sources of fertilizes in both growing seasons 2007and 2008. Also, results indicated that the highest number of leaves/ plant (23.4 and 23.2) were obtained from sunflower plants irrigations at 20 day intervals combined with farmyard manure followed by the same irrigation period and cerealin as fertilizer (22 and 21.4 leaves/plant) during 2007-2008 season, respectively. The lowest number of leaves/plant (15.7 and 16.5) was obtained when sunflower irrigation was at 10 days intervals.

Seed yield/plot was significantly affected by irrigation intervals combined with different fertilizers tested in both the two growing seasons. Highest values 6.37 and 6.15 Kg/plot was obtained when sunflower irrigation was after 20 days intervals combined with different sources of fertilizers. Meantime, the irrigations after 20 days combined with gypsum as fertilizer gave high values 7.07 and 6.86kg/plot during seasons 2007 and 2008. While, it gave 6.86 and 6.86 kg/ plot at the same irrigation combined with farmyard manure and superphosphate. These results are agreement with those obtained by Thakuria *et al.,* (2004) who found that sunflower crop irrigated seedling, buttoning flowering and seed developing stages recorded better results in respect of plant high stem girth, leaf number, dry matter accumulation, leaf area index and crop growth rate at various periodical interval up to harvest, the antitranspirant treatments didn't influence significantly any of the parameters.

b- Effect on oil content:

Results in Table 5 reflect the two-year combined data which indicate that irrigation at 20 days intervals

Table 3. Effect of irrigation intervals combined with different types of fertilizers on percentage of the isolated fungi from rhizosphere and rhizoplane of sunflower

Irrigation intervals	Fertilization	Percentage of the isolated fungi from Rhizosphere							Rhizoplane						
		Aspergillus sp.	*Fusarium sp.*	*Macrophomina phaseolina*	*Rhizoctonia solani*	*Sclerotium rolfsii*	*Penicillium sp.*	Total	*Aspergillus sp.*	*Fusarium sp.*	*Macrophomina phaseolina*	*Rhizoctonia solani*	*Sclerotium rolfsii*	*Penicillium sp.*	Total
10 days	Farmyard manure	16.2	19.3	8.2	15.6	3.7	27.3	90.3	14.0	19.2	9.5	10.3	7.4	25.6	71.0
	Super phosphate	10.1	12.4	7.5	9.2	2.8	26.0	68.0	11.3	20.3	2.1	5.0	5.0	20.0	63.7
	Phosphoren	9.3	11.5	6.2	10.0	3.0	27.1	67.1	7.7	18.9	5.5	7.1	6.3	21.4	66.9
	Cerealin	12.0	14.2	9.0	7.1	4.0	25.3	71.6	9.2	16.2	4.1	5.5	5.7	20.0	60.7
	Gypseum	9.1	10.3	5.4	6.5	3.6	20.7	55.6	7.2	13.9	4.2	3.1	6.9	19.0	54.2
	Mean	11.34	13.54	7.26	9.68	3.42	25.28	70.52	9.88	17.7	5.08	6.2	6.26	21.2	63.3
20 days	Farmyard manure	12.4	19.0	8.2	10.9	3.3	25.6	79.4	12.5	18.9	8.0	4.1	2.7	26.6	77.8
	Super phosphate	10.0	11.2	2.3	4.0	2.5	26.2	56.2	11.0	11.7	2.0	4.9	2.0	22.2	57.5
	Phosphoren	9.0	11.0	4.1	3.8	3.0	22.0	52.9	10.0	10.2	4.3	4.5	1.5	21.5	53.3
	Cerealin	8.6	10.9	5.0	6.7	4.6	18.3	54.1	7.0	14.2	2.3	4.1	3.6	20.7	56.9
	Gypseum	7.9	6.2	4.0	4.5	3.2	17.0	42.8	6.6	8.1	2.5	2.9	3.1	17.6	48.8
	Mean	9.78	11.86	4.72	5.98	3.32	21.82	57.08	9.42	12.62	3.82	5.1	2.58	21.72	58.86
30 days	Farmyard manure	11.2	14.0	8.1	9.5	2.5	20.7	66.0	12.1	14.6	6.2	8.6	3.3	22.7	67.5
	Super phosphate	7.0	9.3	4.5	4.0	2.7	19.1	46.6	8.1	9.0	5.2	3.8	3.9	20.0	50.5
	Phosphoren	5.0	10.2	3.3	3.2	3.8	22.6	48.1	5.3	9.8	4.7	3.0	3.3	21.5	47.6
	Cerealin	6.3	11.2	3.7	6.2	4.4	21.4	53.2	8.0	11.1	5.5	6.4	4.0	20.2	55.2
	Gypseum	6.7	6.4	4.8	3.0	5.1	18.1	44.1	5.7	7.0	4.3	5.6	5.0	20.0	47.6
	Mean	7.24	10.22	4.88	5.18	3.7	20.38	51.6	7.84	10.3	5.18	5.48	3.9	20.88	53.68

Table 4. Means of sunflower characters, as affected by irrigation intervals combined with different types of fertilizers during 2007 and 2008 growing seasons

Irrigation intervals	Fertilization	Plant hight (cm)		Stem diameter (cm)		No. of leaves (Leave/plant)		Seed yield (kg)/ plot	
		2007	2008	2007	2008	2007	2008	2007	2008
10 days	Farmyard manure	157.0	152.8	1.5	1.44	16.6	16.4	5.3	3.03
	Super phosphate	149.6	156.8	1.56	1.22	15.0	14.6	5.77	5.36
	Phosphoren	152.2	153.6	1.54	1.3	17.0	18	5.87	5.63
	Cerealin	158.8	159.8	1.4	1.34	17.6	19	6.1	5.7
	Gypsum	160.6	162.4	1.56	1.36	15.8	17.4	5.7	5.36
	Control	147	142.8	1.32	1.84	12.0	13.4	3.6	3.73
	Mean	152.2	145.7	1.45	1.29	15.7	16.5	5.39	4.8
20 days	Farmyard manure	174.8	169.8	2.16	2.12	23.4	23.2	6.77	6.86
	Super phosphate	165.8	164.6	1.92	2.06	21.0	20	6.87	6.86
	Phosphoren	165.6	158.8	1.78	1.76	22.0	21.4	6.7	6.27
	Cerealin	171.6	163.8	1.95	1.78	22.0	20.8	7.07	6.5
	Gypsum	167.0	162.8	1.7	1.96	21.6	20.4	6.4	6.5
	Control	154.4	153.4	1.56	1.54	12.2	15.2	4.1	3.9
	Mean	166.5	162.2	1.84	1.8	20.7	20.16	6.31	6.15
30 days	Farmyard manure	162.0	157.4	1.74	1.66	19	18.2	4.17	3.53
	Super phosphate	155.4	155.2	1.6	1.54	19.8	17.6	3.03	3.23
	Phosphoren	159	156	1.48	1.42	18.6	17.6	3.17	3.1
	Cerealin	160	159.6	1.76	1.48	20.2	18.2	4.1	4.07
	Gypsum	162.6	158.4	1.66	1.54	19.8	17.2	3.47	3.57
	Control	151	147	1.36	1.3	14.6	15	3.93	3.13
	Mean	158.33	155.87	1.57	1.49	18.6	17.3	3.645	3.38
L.S.D at 0.05% for fertilization		4.92	4.55	0.153	0.142	1.62	1.53	0.517	0.650
for irrigation		4.420	4.40	0.129	0.08	1.44	1.02	0.523	0.83

Table 5. Oil yield (Kg/plot) as affected by irrigation intervals and sources of fertilizers during 2007 and 2008 growing seasons

Irrigation intervals	Fertilizers	Oil content (kg/plot)		Mean
		Season		
		2007	2008	
10 days	Farmyard manure	1.92	1.85	1.89
	Super phosphate	2.56	2.45	2.50
	Phosphoren	2.65	2.56	2.58
	Cerealin	2.74	2.77	2.76
	Gypsum	2.54	2.60	2.57
	Control	1.69	1.60	1.65
Mean		2.34	2.3	2.33
20 days	Farmyard manure	3.15	3.18	3.17
	Super phosphate	3.10	3.20	3.15
	Phosphoren	2.98	2.77	2.88
	Cerealin	2.85	2.73	2.79
	Gypsum	3.18	3.42	3.27
	Control	1.84	1.75	1.8
Mean		2.85	2.84	2.84
30 days	Farmyard manure	1.76	1.63	1.7
	Super phosphate	1.44	1.35	1.4
	Phosphoren	1.52	1.40	1.46
	Cerealin	1.88	1.80	1.84
	Gypsum	1.62	1.95	1.79
	Control	1.30	1.15	1.23
Mean		1.59	1.55	1.57
L.S.D at 0.05% for irrigation		0.1004	0.065	
for fertilizers .		0.1419	0.134	

and different sources of fertilizers gave highest oil content (2.84 kg/plot) compared with other treatments. The various soil amendments varied significantly from each others in both seasons. The highest oil content obtained when gypsum and farmyard manure were added, singly, in both seasons. These results are in agreement with those by mentioned by (Hussein *et al*., 2000). The lowest values were recorded in the control treatment.

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الملخص العربي

تأثير فترات الري والأسمدة علي بعض الأمراض والصفات النباتية لعباد الشمس بمحافظة البحيرة

صابر محمد مرسى، إلهام عباس ضرغام، أحمد على عبد الباقي

أجريت تجربتين حقليتين بهدف تحديد تأثير طول فترات الري مع الأنواع المختلفة من الأسمدة علي العفن الطري والعفن الفحمي والفطريات في المنطقة حول الجذور والملاصقة له تماماً لنبات عباد الشمس. وجد أن تطبيق فترات الري بالتداخل مع الأسمدة المختلفة تؤثر معنوياً علي الشدة المرضية وكثافة الفطريات في التربة. حيث وجد أن الري كل٢٠يوم علي التوالي مع التسميد بالجبس الزراعي يؤدى إلى نقص معنوي لكلا من العفن الطري والعفن الفحمي بنسبة ٤,٦٦% و ٣١,٦٦ علي التوالي مقارنة بالكنترول يلي ذلك تطبيق نفس فترات الري مع الفسفورين ٥,٦٦ % و٣٨,٣١ % علي التوالي وذلك خلال موسمي الزراعة ٢٠٠٧ و٢٠٠٨.

وقد وجد أن الجمع بين فترات الري والتسميد العضوي يشجع علي نمو بعض الفطريات في الريزوسفير rhizosphere والريزوبلان rhizoplane لنباتات عباد الشمس مقارنه بالأسمدة الأخرى.

دلت النتائج على أن استخدام الجبس كسماد مع فترات الري المختلفة أدى إلي نقص أعداد الفطريات الممرضة في كل من الريزوسفير والريزوبلان ٤٢,٨% – ٤٠,٨%.

وقد وجد أن أكثر الفطريات تواجداً في عينات الريزوسفير والريزوبلان لنبات عباد الشمس هو أنواع البنسليوم والفيوزاريوم.

وقد وجد أن ري نبات عباد الشمس كل٢٠يوماً مع إضافة أي من الأسمدة المستخدمة يحسن من صفات النمو الخضري للنباتات ومحصول عباد الشمس مقارنة بالمعاملات الأخر. كما أن استخدام نفس ميعاد الرى والتسميد بالجبس الزراعي يعطى أكبر كمية من الزيت ٣,١٨ و ٣,٤٢ كجم/ معاملة مقارنة بالمعاملات الأخرى.

وتوصى الدراسة باستخدام الجبس الزراعى قبل الزراعة وتنظيم الري على فترة ٢٠ يوم لنبات عباد الشمس لتقليل ذبول البادرات والعفن الفحمي وزيادة النمو الخضري والمحصول وكمية الزيت.