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EFFECT OF SOIL SOLARIZATION ON VEGETATIVE GROWTH, YIELD, DAMPING OFF AND WILT INFECTION OF EXPORT CANTALOUPE IN UPPER EGYPT

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ABSTRACT

This study was carried out during the two successive seasons of 2002/2003 and 2003/2004 in Upper Egypt at Draw-Benban Bahary, Aswan Governorate. The aim of this study was to find out safe and economic modified techniques for the control of soil borne pathogenic fungi causing damping off and wilt diseases affecting the export cantaloupe production by means of using the soil solarization during summer time (June- July – August), where the average of day temperature is extremely high. This direction is to avoid the use of the globally, un-recommendable, soil fumigant; the methyl bromide. The parameters of evaluation were concerned with the effect of soil solarization on plant growth, yield and quality beside the two parameters related to damping off and wilt percentage. Taking into consideration that these trails were done as comparative treatments in virgin, one year, two years, and three years previously planted soils concerning covered and non –covered treatment with transparent 80 microns plastic sheets.

The results could be summarized as follows:-

1- Soil solarization increased the soil maximum temperature at 20-10 cm depth up to 10-12 ^{0}C respectively compared with non solarized

2- Soil solarization reduced all soil borne pathogens to lower values, almost similar to virgin soil.

3- It was noticeable that after solarization there was complete control at all kinds of weeds.

4- The best cantaloupe emergence percentage was obtained from sandy virgin soil followed by the treatment of soil solarization of one season previously planted soil, taking into consideration that the multiple cantaloupe planting in the same soil leads to increase in wilt infection.

5- The highest values of vegetative growth, physical characteristics of fruits and total yield per plant or per feddan obtained with soil solarization and virgin soil.

6- The highest values of exportable yield was obtained by soil solarization and virgin soil, which was the main goal of this study, especially that area concerned with planting the cantaloupe for export.

INTRODUCTION

Cantaloupe (*Cucumis melo* var. *reticulates*) is one of the most important vegetable crops in Egypt for local market and export. Soil borne fungi cause serious losses in this crop if the planting is undertaken in fields previously planted for with this crop one year or more . Soil solarization technique has been used to control soil pathogens and reduced damping off and wilt diseases (*Katan* (1997), and *Elmore et al* (1997). *Mohamed* (1990) in Upper Egypt, found that mulching wet soil with plastic sheets for 45 days from first of August to 15

September, increased soil temperature by 9.2 ^{0}C to 10 ^{0}C at depth of 10 cm. *Al-Masoum et al* (1998) in UAE, found that solarization significantly increased soil temperature under the transparent plastic mulch as compared to the uncovered control. *EL-Manzalawy (2001)* found that soil solarization with and without organic manure significantly reduced *Fusaruim* spp. and total fungi and bacteria infestation. He also reported that soil solarization of open field for 6 weeks during summer resulted in maximum averages in soil temperature to be 60,49,43 and 33 ^{0}C at 0,5,10 and 15 cm depth respectively .

Katan et al (1983) studied the effect of short and long term treatments with soil solarization on fusarium wilt of cotton plants through two field experiments where the soil was mulched with transperant polyethylene sheets (40 μ thick) for seven weeks. They found that solarization during the summer increased temperatures and affected pest control and reduced pathogen population in the soil, also they stated that disease incidence in the untreated fields was significantly negatively correlated with yield. *Stapleton and Devay (1984), Tjamos and Paplomatas* (1988) reported that the efficiency of solarization in controlling many soilborne pathogens is due to the fact that the majority of these pathogens are mesophyllic and high temperature of solarized soil affects their growth and development badly. *Stapleton and Devay (1986)* reported that solarization causes changes in soil biota and substrate that provides environment with colonization by microorganisms with greater competitive ability, these organisms are usually saprophytes rather than phytopathogens which tend to have more specialized growth requirements. Many of these fungi, saprophytes may subsequently inactivate surviving phytopathogenic fungi bacteria and nematodes that were damaged or weakened by solarization.

Cartia (1989) found that covering the soil with transparent polyethylene film during the summer, destroyed many soil borne pathogens generally and significantly reduced populations of *F. Oxysporum* compared with the control in greenhouse and field experiments. *Mahmoud (1996)* indicated that soil solarization for 5 and 10 weeks caused obvious reduction in total numbers of bacteria and fungi. *Jimenez and Chew (1996)* found that soil solarization for 4 weeks in Mexico, with or without fertilizer, reduced *F. oxysporum* populations by 99-100% at 10 and 20 cm soil depth.

Abu-Gharbieh et al (1991) in Jordan reported that solarization alone increased tomato plant height by 28%.Over the control. *Abdallah and Dahrowski (1998)* in the Sudan, found that solarization for 7 weeks during September and November increased tomato plant growth by 59% (plant height) 56% (number of branches), and 132% (number of leaves) as compared with control treatment. *Jimenez-Diaz et al* (1991) reported that soil solarization increased watermelon fruit number and yield over the non-solarized soil, respectively by 30% and 132% (for one month solarization) and by 175% and 392% (for two months solarization) *Jimenez and Chew (1996)* reported that solarization for 2 and 4 weeks increased average melon yield by 31% and sugar content by 14 % .*Musallam* and *Abu-Gharbieh (1998)* in Jordan, found that the marketable yield of muskmelon was significantly increased in solarized plastic house over the non-

solarized treatment by 73% and 91% for transparent and black plastic respectively.

MATERIALS AND METHODS

Two field experiments were conducted for two successive growing seasons 2002/2003 and 2003/2004 at Benban Bahary –Draw- Aswan Governorate, Egypt. The objectives of these experiments were to determine the effect of soil solarization and mulching on cantaloupe (*Cucumis melo* var. *reticulates*) growth, yield and quality of fruits beside damping off and wilt infection. The used cantaloupe cultivar was Ideal F_1 hybrid. Sowing was done in the first week of September in the two seasons. The experiment included 6treatments as follows:-

1-Virgin sandy soil. (V)
2- Soil previously planted for two seasons without solarization (2P-N-SOL.)
3- Soil previously planted for three seasons without solarization (3P-N-SOL.)
4- Soil previously planted for one season then solarized (1P-SOL)
5- Soil previously planted for two seasons then solarized. (2P-SOL)
6-Soil previously planted for three seasons then solarized. (3P-SOL)

The experimental plots for solarization were covered with clear polyethylene sheets of 80 μ thickness from the first week of July to 15th of August where was irrigated daily for 30 minutes in the morning before 9 am through drip irrigation system .The other plots were non-irrigated. After soil solarization with a period of (6weeks), all experimental plots prepared for planting at the beginning of September, then all plots were covered with plastic mulch after fixing the drip lines .Treatments were arranged in a randomized complete block design with three replicates, each replicate consisted of three rows each row was 25m X 1.8m, planting distance was 50cm. Each replicate planted with 50 seeds of the used cantaloupe hybrid. Preparation of soil before planting concerning the chicken manure and other chemical fertilizers was applied as recommended.

Soil temperature was measured every hour daily during solarization between 8.0am till 4 pm, at different soil depths, namely, 10 and 20 cm in solarized and non- solarized soils, the maximum day temperature was recorded. Soil thermometers were used for measuring soil temperature and max. Air temperature was also, measured by using air thermometer.

Determination of soil borne pathogenic fungi, *Fusaruim oxysporum* f. sp. *melonis*; *F. solani* and *Rhizoctonia solani* (colony forming unit per gram of dry soil cfu/g.) was done at the end of soil solarization period at the laboratory of Plant Pathology Department, Mansoura University. Isolation was done on potato dextrose agar (PDA) using standard isolation techniques. *Warcup (1950).*

Cantaloupe data recorded:-

a) Damping off percentage after ten days from sowing.
b) Percentage of living plants at the end of the season.

Random samples at 10 plants from each plot were collected at harvesting stage , and the following data were recorded:

a) Plant length (cm)
b) Number of branches/ plant.

c) Number of leaves / plant.
d) Leaf area; it was recorded for the fourth expanded leaf using a digital leaf area meter (LI-300 portable area meter)

Fruit physical quality:-

The following characters were recorded on 5 mature cantaloupe fruits.

1- Fruit length (cm)
2- Fruit diameter (cm)
3- Flesh thickness (cm)
4- Fruit firmness (pound / inch^2)

Fruit chemical quality:-

1- Total Soluble Solids (T.S.S.) was recorded using a hand refeactometer.

Yield and components:-

1- Average fruit weight (g)
2- Total yield / plant (kg)
3- Total yield (ton/ fed.)
4- Exportable yield (ton/fed.)

Statistical analysis:-

The data were exposed to proper statistical analysis of variance of a randomized complete block design *(Snedecor and Cochran 1980)*.

RESULTS AND DISCUSSION

1-Effect of solarization on soil temperature:-

Data in Table (1) showed that solarization treatment increased soil temperature under the transparent mulch as compared with the uncovered plots, covering soil with transparent (80 μ thick plastic sheets) during solarization period raised soil temperature from 10-12^{0}C at 10 cm depth compared with the uncovered plots, the same results were clear at 20 cm depth .Soil temperature was decreased with increasing soil depth. Such temperature increase, obtained from solarization treatments agreed with *Sarhan (1991),Stapleton et al (1991), Katan (1997)* and *Abdallah (2000a)* who obtained 5-19 ^{0}C in soil temperature by means of soil solarization.

Table (1) Maximum air and soil temperature (^{0}C) at various soil depths for solarized and non- solarized during two seasons from first July to mid of August.

Weeks		1	2	3	4	5	6
		First season					
Air temp.		39	43	43	44	43	41
Solarized	10cm	50	52	55	58	54	51
	20cm	48	50	48	56	49	49
Non-solarized	10cm	40	45	44	46	44	42
	20cm	39	43	42	44	42	40
		Second season					
Air temp.		40	42	44	44	46	44
Solarized	10cm	51	56	56	57	57	54
	20cm	48	55	54	55	54	51
Non-solarized	10cm	40	43	50	46	45	45
	20cm	39	39	49	42	43	42

2-Effect of solarization on soil pathogenic fungi:-

It was noticed that serious decrease in soil infection with pathogenic soil borne fungi (*Fusaruim oxysporum* f. sp. *melonis*; *F. solani* and *Rhizoctonia solani*) was happened after solarization treatment (see table 2), these results were in agreement with those obtained by *Mahmoud (1996)*, *EL-Manzalawey(2001) Irmaileh, (2003.)* and Shlevin *et al (2004)* .

Table (2) Effect of solarization on population densities of; *F. solani* and *R. solani* (cfu /1 g dry soil)

Season	First season			Second season		
fungi / Treatments	*F. oxysporum* f. sp. *melonis* cfuX10 ^{4}	*F. solani* cfuX10 ^{4}	*R. solani* cfuX10 ^{4}	*F. oxysporum* f. sp. *melonis* cfuX10 ^{4}	*F. solani* cfuX10 ^{4}	*R. solani* cfuX10 ^{4}
V	0.0	0.2	0.0	0.1	0.4	0.0
2P-N-S	13.3	14.1	0.5	15.3	14.4	0.7
3P-N-S	19.1	6.8	0.9	20.3	5.7	0.8
1P-SOL.	2.2	2.8	0.1	4.1	3.6	0.4
2P-SOL.	9.6	5.1	0.4	11.2	6.4	0.5
3P-SOL.	10.2	5.7	0.5	11.7	4.0	0.4
L.S.D at 0.05	0.42	0.33	0.43	0.64	1.07	0.29

3- Effect of soil solarization on damping off and Living plant number of cantaloupe.

Results shown in (Table 3) proved that soil solarization decreased the percentage of cantaloupe damping off seedlings, while the number of living plants ratio at harvesting time was seriously increased when compared with the un-covered treatments. Similar results were obtained by *Mahmoud (1996)*, *Irmaileh, (2003.)* and Shlevin *et al (2004)* .

Table (3) Effect of soil solarization on damping off disease and total living plants of cantaloupe.

Season	First season		Second season	
Treatments	Damping off seedlings (%)	Living plants (%)	Damping off seedlings (%)	Living plants (%)
V	0.67	97.56	1.56	96.00
2P-N-S	5.11	81.1	6.89	80.44
3P-N-S	12.22	75.5	14.22	70.89
1P-SOL.	2.44	90.44	4.00	89.11
2P-SOL.	4.00	87.33	5.33	85.78
3P-SOL.	7.78	79.56	8.89	78.78
L.S.D at 0.05	0.82	0.91	1.48	3.09

4-Effect of soil solarization on growth of cantaloupe plants.

Concerning the Effect of soil solarization on growth of cantaloupe plants, data in Table (4) showed clearly that plant length increased by solarization and virgin soil .Replanting the soil more than one time significantly reduced the length of plants in both seasons. Treatments 2 and 3 in the virgin soil and 5 and 6

treatments in the soil solarization have similar trend in both seasons. These results were observed also for number of branches, number of leaves per plant and leaf area.

Table (4) Effect of soil solarization on growth of cantaloupe plants

Season	First season				Second season			
Treatments	Plant Height (cm)	No. of branch/ Plant	No. of leaves/ Plant	Leaf area (cm^2)	Plant Height (cm)	No. of branch/ Plant	No. of leaves/ Plant	Leaf area (cm^2)
V	130.7	5.6	120.3	132.3	139.6	5.9	131.2	131.2
2P-N-S	126.3	4.2	102.1	127.5	131.5	4.1	101.6	126.6
3P-N-S	107.2	3.1	95.6	118.9	112.3	2.9	100.1	111.5
1P-SOL.	128.7	5.1	115.7	129.2	140.1	5.7	142.2	130.1
2P-SOL.	125.6	4.2	101.4	125.4	129.6	3.9	117.6	124.2
3P-SOL.	117.4	2.9	95.2	122.2	112.2	3.3	92.2	120.7
L.S.D at 0.05	3.5	0.8	4.1	1.9	2.8	0.6	3.3	3.2

In general the obtained growth results strongly indicated that the changes in soil conditions created by solarization have a direct effect on cantaloupe plant growth .The rechanges many include release of mineral nutrients , growth factors , nullification of toxins (chemical) as well as elimination of pathogens and stimulation of beneficial microorganisms (biological) which contribute to increase growth response .These results agree with those reported by *Katan (1997)* and *Abdallah (2000a*)

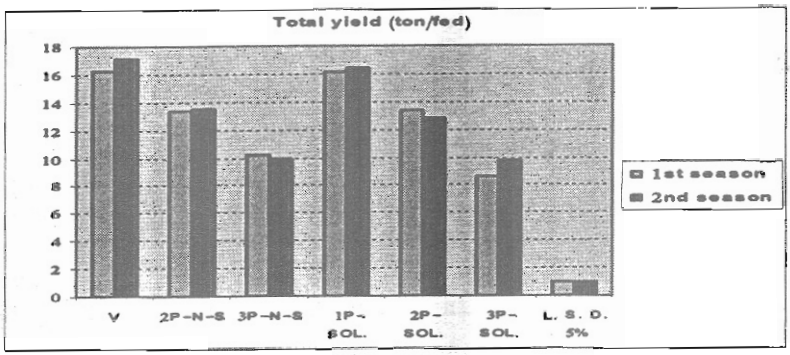
5- Effect of soil solarization on cantaloupe yield and its components:-

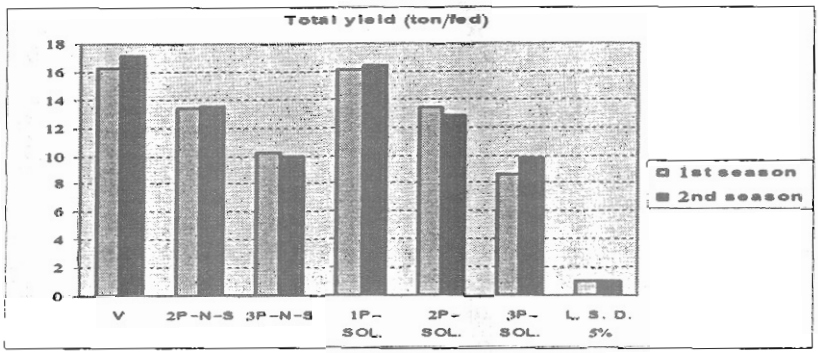
Data in Table (5) showed that virgin soil and soil solarization increased significantly average fruit weight compared with second and thirdly planted either in virgin soil or in soil solarization in both growing seasons. This results showed with total yield per plant ,total yield (ton/ fed.) and exportable yield .The lowest values obtained with the third planted after solarization.

Table (5) Effect of soil solarization on cantaloupe yield and its components.

Season	First season				Second season			
Treatments	Average fruit weight (g)	Total yield/ Plant (kg)	Total Yield ton/fed.	Exportable Yield (ton/fed.)	Average fruit weight (g)	Total yield/ Plant (kg)	Total Yield (ton/fed.)	Exportable Yield (ton/fed.)
V	990	2.970	16.249	4.875	992	3.115	17.113	5.134
2P-N-S	890	2.670	13.322	3.331	892	2.672	13.496	3.374
3P-N-S	800	2.462	10.243	2.253	799	2.341	9.897	2.177
1P-SOL.	987	2.961	16.166	4.850	985	3.024	16.443	4.932
2P-SOL.	891	2.673	13.337	3.334	892	2.517	12.756	3.189
3P-SOL.	772	2.116	8.674	1.908	781	2.322	9.791	2.154
L.S.D at 0.05	9.3	0.273	1.004	0.548	10.6	0.094	1.027	0.481

The increase in cantaloupe average fruit weight , total yield per plant ,total yield (ton/fed) and exportable yield obtained with virgin soil and soil solarization once planted may be due to the negative impact of solarization on weeds and soil borne disease


Total yield (ton/fed)
18
16
14
12
10
8
6
4
2
0
V
2P-N-S
3P-N-S
1P-SOL.
2P-SOL.
3P-SOL.
L. S. D. 5%
1st season
2nd season


Total yield (ton/fed)
18
16
14
12
10
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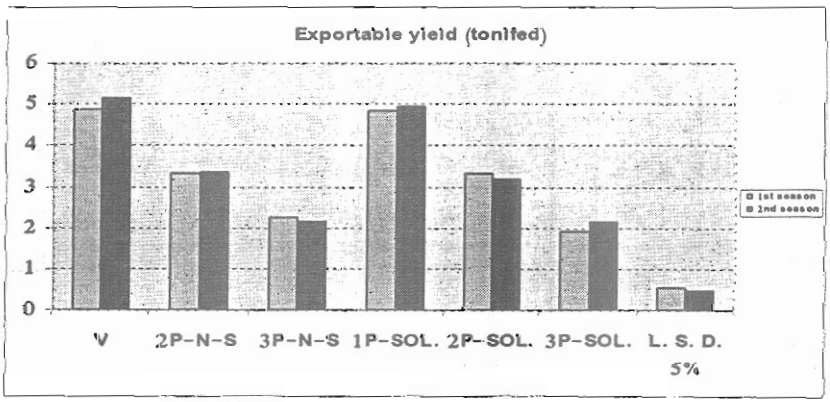
V
2P-N-S
3P-N-S
1P-SOL.
2P-SOL.
3P-SOL.
L. S. D. 5%
1st season
2nd season


Exportable yield (ton/fed)
6
5
4
3
2
1
0
V
2P-N-S
3P-N-S
1P-SOL.
2P-SOL.
3P-SOL.
L. S. D. 5%
1st season
2nd season

especially Fusaruim wilt (Table2) while virgin soil did not content this factors these results were similar to those obtained by *Abu- Gharbieh et al (1991), Stapleton et al (1991), Abdalla and Dabrowski (1998), Jiminez and Chew (1996)*and *Musallam and Abu- Gharbieh (1998)*

6-Effect of soil solarization on fruit physical quality of cantaloupe fruits:-

The data in Table (6) of both seasons showed that the highest values of cantaloupe fruit length and diameter was obtained by virgin soil and soil solarization once planted compared with other treatments , on the other hand data in Table (6) showed that no significant effect on flesh thickness was recorded in both growing seasons .

Table (6) Effect of soil solarization on fruit physical quality of cantaloupe fruits:-

Season	First season					Second season				
Treatments	fruit length (cm)	fruit diameter (cm)	flesh thickness (cm)	T.S.S. (%)	firmness (pound/ inch^2)	Fruit length (cm)	fruit diameter (cm)	flesh thickness (cm)	T.S.S. (%)	Firmness (pound/ inch^2)
V	11.9	12.0	3.9	14.1	25.1	12.1	12.3	3.9	14.0	25.2
2P-N-S	11.2	11.3	3.5	13.8	24.2	11.8	11.8	3.6	13.7	23.1
3P-N-S	10.3	10.5	3.1	12.8	21.0	10.5	10.7	3.2	12.5	21.2
1P-SOL.	12	12.2	3.7	13.9	24.9	12.0	12.2	3.9	13.9	24.7
2P-SOL.	11.7	11.9	3.6	13.8	23.9	11.6	11.7	3.7	13.5	23.9
3P-SOL.	10.1	10.4	3.3	12.7	22.1	10.1	10.2	3.2	12.2	21.1
L.S.D at 0.0	0.3	0.63	N.S	1.1	0.78	0.4	0.31	N.S	0.5	0.83

While T.S.S and firmness of cantaloupe fruits data indicated that these characters were not effected by different all treatments included in this study in both seasons .Perhaps these results may be explained through gene-environment interaction where gene action in this cultivar may has greater effect than environment . These results are in harmony with those obtained by *Jiminez and Chew (1996)*

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تأثير التعقيم الشمسي على النمو الخضرى والمحصول ومقامة أمراض سقوط البادرات والذبول فى محصول الكنتالوب المنتج للتصدير فى مصر العليا

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**** قسم بحوث الزراعات المحمية – معهد بحوث البساتين- مركز البحوث الزراعية- الجيزة**

أجريت هذه الدراسة فى عامين متتاليين٢٠٠٢/٢٠٠٣،٢٠٠٣/٢٠٠٤ بمنطقة بنبان بحري – درلو- محافظة أسوان.

وكان موضوع الدراسة هو استخدام التعقيم الشمسي لتطهير التربة بدلاً من استخدام المواد الكيماوية التى عادة ما تكون عالية الثمن كما أنها تسبب مشاكل التلوث للإنسان والحيوان والبيئة. بالإضافة لاختبار تأثير التعقيم الشمسي على نمو ومحصول وجودة محصول الكنتالوب بالإضافة الى السيطرة على المسببات المرضية بالتربة وقد أوضحت النتائج ما يلي:-

١- أدى التعقيم الشمسي الى زيادة درجات الحرارة تحت الغطاء البلاستيكي الشفاف من ١٠ -١٢ درجة على أعماق ٢٠ -١٠ سم على التوالي مقارنة بالتربة الغير معقمة.

٢- أعاد التعقيم الشمسي تقريبا التربة المنزرعة أكثر من مرة الى مستوي الأرض البكر التي تزرع لأول مرة من حيث محتواها من أفات التربة الممرضة.

٣- تلاحظ بعد عملية التعقيم الشمسي خلو التربة من جميع أنواع الحشائش.

٤- كان اقل عدد للشتلات الغائبة بعد ١٠ أيام من الزراعة وكذلك اكبر عدد من النباتات الحية خلال الموسم قد تلاحظ مع الارض البكر التى تزرع لأول مرة وكذلك مع التربة التى زرعت لأول مرة بعد التعقيم الشمسي.كما حدثت زيادة فى أعداد الكائنات الممرضة بالتربة وكذلك عدد الشتلات المفقودة والنباتات المصابة بالامراض بزيادة عدد مرات الزراعة فى نفس التربة.

٥- كانت أعلى زيادة فى النمو الخضرى والصفات الطبيعية للثمرة وكذلك المحصول الكلى للنبات أو الفدان مع الارض البكر والتربة المعقمة حديثا.

٦- لوحظ أن أعلى القيم بالنسبة للمحصول القابل للتصدير كانت مع الارض البكر الجديدة والمعقمة بالطاقة الشمسية حديثا وهى أهم نقاط الدراسة بالنسبة لهذا المحصول وهذة المنطقة التى تزرع الكنتالوب أساسا من اجل التصدير للخارج.