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EFFECT OF SOIL SOLARIZATION USING DIFFERENT TYPES OF POLYETHYLENE SHEETS ON GROWTH YIELD, DAMPING-OFF, AND WILT DISEASES OF CANTALOUPE IN UPPER EGYPT

El-Sheshtawi, M.[1] and M. S. Mohamed[2]

[1] Plant Pathology Dept., Faculty of Agriculture, Mansoura Univ. m_elsheshtawi@yahoo.com

[2] Protected Cultivation Res. Dept., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

Soil solarization as a clean natural physical source was proposed in this trial to control cantaloupe damping-off and wilt diseases affecting cantaloupe (*Cucumis melo* var *reticulatus*) produced for export and local consumption, such diseases in the experimental area at Qena governorate, Isna region in upper Egypt caused by pathogenic soilborne fungi mainly *Fusarium* spp. and *Rhizoctonia solani*. In this soil solarization experiment to control these pathogens, three types of polyethylene (PE) plastic sheets were used as soil mulching for about 7 weeks during summer (July-August-September), started on July 20th. Treatments concerned, UVI sheets of 200 micron in thickness; 60 micron transparent, 30 micron black and un-covered control treatment for two growing seasons of 2003/2004 and 2004/2005. Meteorological data were recorded during solarization period. The used cantaloupe F1 hybrid was Ideal. Data indicated that the 200 micron transparent plastic sheets treatment followed by the 60 micron mulch gave better results which reflected on cantaloupe yield and fruit quality beside the parameters of soil infection with mentioned pathogens i.e., damping-off of cantaloupe seedlings %, mortality % at the end of harvesting period

INTRODUCTION

Most researches on soil solarization in Egypt were done in the Northern regions. Solarization is the term coincided for heating soil using polyethylene to trap solar energy during summer period. Nowadays Soil solarization is gradually becoming one of the recognized control strategies of soil borne pathogens, weeds and arthropods, Stapleton and Devay (1986), and . Abdallah, (1991). Studies, particularly in hot climate areas, demonstrated effectiviness of this method with many vegetables, field crops, fruit trees, ornamental plants and nursery transplants. Soil solarization causes chemical, physical and biological changes in the soil that improve plant growth and development and often results in substantial yield increases. In some parts of the world, pre-planting solarization is substituting for chemical control or actively integrated in IPM programs in greenhouse and open field production systems. Cantaloupe (*Cucumis melo* var reticulatus) is one of the important vegetable crops in Egypt for local markets and exportation. The development of solarization for soil disinfection was reported by (Katan *et al.*, 1979) and DeVay, (1991) opening a new perspective in soil disinfection. Soil solarization resulted in better germination of seeds and higher seedling emergence compared to nonsolarized soils, Abdallah (1998) on onion, Abdallah (2000) on tomato and Zahran (2001) on cantaloupe. Soil solarization for 6-8 weeks affected plant growth i.e. (plant length, number of leaves and number of branches) which was found by Zahran (2001) on

cantaloupe and EL-Haddad *et al.* (1998) on cucumber and pepper. Abu-Gharbieh *et al.* (1991) found that solarized soil using transparent or black polyethylene increased tomato yield by 79% and 65% respectively over the nonsolarized soil. Same results were found by Musallam and Abu-Gharbieh (1998) on muskmelon and by solarized soil by transparent polyethylene only on watermelon, Jimenez – Diaz *et al*. (1991), on melon by Jimenez and Chew (1996) and on cantaloupe by zahran (2001). Long time ago the " SHARAQI" system happened through soil solarization of lands in Egypt during Summer season (July - August) , when fields were not grown before the annual flooding with river Nile water, it was relatively effective against many soilborne pathogens, between them the dangerous casual organism of onion white rot (*Sclerotium cepivorum*), *Fusarium* spp. and others, this system was not applicable since the building of the high dam in Aswan which provides water for cultivation in all Egypt all over the year round and now no chance for doing SHARAQI. The presented solarization trial depends on soil solarization in desert areas used for producing for export and local markets, the aim of this trial was to test the efficiency of various types of polyethylene plastic sheets on soilborne diseases as well as yield and fruit quality of cantaloupe.

MATERIALS AND METHODS

Two field experiments were carried out in naturally infested area with soilborne pathogenic fungi at a private farm located at Isna, Qena governorate, in Upper Egypt during 2003/2004 and 2004/2005 seasons. Seeds of F_1 hybrid Ideal cantaloupe were used in both seasons to investigate the effect of soil solarization using three types of polyethylene plastic sheets on vegetative growth, yield, damping-off and wilt infection of cantaloupe plants. Treatments were as follows:-

Plastic sheets of UV-inhibitor (UVI) polyethylene 200 micron thick and 6 meters wide.

2- Transparent plastic sheets with 60 micron thickness and 140 cm. wide

3- Black plastic sheets with 30 micron thickness and 140 cm. width

4- Control without soil solarization.

The experimental plots were covered with polyethylene sheets on the July 20th till the September 5th in both seasons after preparing the soil by adding chicken manure and chemical fertilizers as recommended by Ministry of Agriculture, wetted the soil by means of drip irrigation system. The plastic sheets of the first treatment stayed till the end of the cantaloupe growing season and used only for one season, meanwhile the plastic sheets of the 200 micron treatment were removed after cantaloupe harvest and stored for using to solarize the soil in the second season. The experimental plots of the third treatment were mulched with black polyethylene of 30 micron thickness before sowing. The treatments were arranged in a randomized complete block design with three replications, every replicate had three beds with 1.5 m in width and 30 m un length and every bed had 60 plants. Seeds of cantaloupe were sown on September 5th in both seasons. The data were subjected to proper statistical analysis according to Snedecor Cochran (1980).

Evaluation parameters:-

1- Vegetative growth:

Randomized samples of 10 plants from each plot were collected at the flowering stage and the following data were recorded.

- Plant length (cm.) was determined from the cotyledon up to the highest growing tip.
- Number of leaves / plant.
- Number of branches / plant.

2- Yield and its components:

- Fruit length (cm.)
- Fruit diameter (cm.)
- Flesh thickness (cm.)
- Total soluble solids (T.S.S.), was recorded using hand refractometer.
- Average fruit weight (g.)
- Total yield / plant (kg.)
- Total yield / feddan (kg) (Feddan had 5600 plant).

3- Cantaloupe damping-off and wilt diseases evaluation:

Density of soil infestation with wilt pathogens after solarization during the duration of the trial: Soil samples were collected monthly from the different treatments, then investigated in the Plant pathology Dept. labs, Faculty of Agriculture, Mansoura University to determine the density of the soilborne pathogenic fungi causing cantaloupe wilt mainly (*Fusarium* spp. and *Rhizoctonia solani*), isolation of soilborne pathogenic fungi was done According to standard method of (Warcup 1950).

Damping-off and wilt diseases incidence: These two parameters were achived through visual and laboratory tests on agar media.

RESULTS AND DISCUSSION

Vegetative growth:

Data in Table (1) show the response of plant vegetative growth of cantaloupe to solarization with different types of polyethylene plastic sheets compared with non-solarized soil bare soil (control) in both seasons of 2003/2004 and 2004/2005. Vegetative growth, i.e. plant length, number of leaves per plant and number of branches per plant were significantly affected by solarization with different types of polyethylene plastic as compared with non-solarized soil, except the number of branches per plant in the first season which did not reach the significant level. Solarization with plastic sheets of 200 µm thick gave the highest value of all vegetative parameters and all these values exceeded the significant level than the other treatments and the control in both seasons. In general the obtained vegetative growth results strongly indicated the changes in soil properties and conditions created by solarization had an immediate effect on cantaloupe plant growth. The re-changes may include release of mineral nutrients, leaching of saline around the root zone, growth factors, nullification of toxins (chemical) as well as elimination of pathogens and stimulation of beneficial microorganizms (biological) which contribute to increase growth response. These results are in agreement with Zahran (2001) on Cantaloupe, and Abdallah (2000) on tomato.

Table (1): Effect of soil solarization with different types of polyethylene sheets on vegetative growth characteristics of cantaloupe grown at Isna in 2003/2004 and 2004/2005.

Season / Treatments	First season			second season		
	Plant Length (cm.)	Number of leaves / plant	Number of branches / plant	Plant Length	Number of leaves / plant	Number of branches / plant
UVI polyethylene 200 micron	122.3	112.7	4.7	145.8	130.7	5.9
Transparent 60 micron	116.0	107.0	3.7	132.2	122.3	4.0
Black polyethylene 30 micron	106.7	85.3	3.0	120.1	101.4	3.6
Control without solarization (bare soil)	100.7	76.3	2.7	112.7	86.3	3.0
L.S.D. 5%	1.8	1.1	0.6	4.2	7.4	0.2

Yield and its components:-

1- Fruit characteristics:

Data in Table (2) showed that there were significant differences between treatments in fruit length, fruit diameter and fruit flesh thickness in both seasons. Significant increase in fruit length, fruit diameter and fruit flesh thickness were obtained by covered treatment with polyethylene sheets of 200 micron in both seasons.

Table (2) Effect of soil solarization with different types of polyethylene sheets on Fruit characteristics of cantaloupe grown at Isna in 2003/2004 and 2004/2005 seasons.

Season / Treatments	First season				Second season			
	Fruit length (cm.)	Fruit diameter (cm.)	Flesh Thickness (cm.)	Average fruit weight	Fruit length (cm.)	Fruit diameter (cm.)	Flesh thickness (cm.)	Average fruit weight
UVI polyethylene 200 micron	12.2	12.3	3.8	916.7	12.8	13.0	3.8	1102.4
Transparent 60 micron	11.0	11.5	3.1	833.3	11.6	11.7	3.2	980.6
Black polyethylene 30 micron	10.5	11.6	3.2	783.3	10.8	11.1	3.2	805.2
Control without solarization (bare soil)	10.8	11.2	3.1	708.3	11.2	11.3	3.5	780.3
L.S.D. 5%	0.7	0.6	0.4	47.9	0.02	0.07	0.04	15.4

As for Total Soluble Solids (T.S.S) there was no significant difference between solarization treatments and control in both seasons and the best treatment was solarization with polyethylene sheets of 200 micron in both seasons.

Similar results were obtained by Hartz, *et al.* (1985), Zahran (2001) and Jimenez and Chew (1996) in cantaloupe. In terms of average fruit weight (g.), data in Table (2) cleared that all soil solarization treatments increased significantly the average fruit weight of cantaloupe fruit than the control treatment in both seasons and the best treatment was of the polyethylene sheet of 200 micron followed by 60 micron and black sheet of 30 micron respectively.

2- Total yield per plant and per feddan:

The data of both seasons showed that all soil solarization treatments increased the total yield of cantaloupe per plant and feddan as compared with control treatment (Table 3). Soil solarization with polyethylene of 200 micron showed the highest total yield per plant and feddan in the first and second seasons respectively (2.8 kg, 3.2 kg 15.733 ton and 16.337 Ton). The total yield of solarization with polyethylene sheets increased by 158%, 152% and 133% in the first season and by 171%,150% and 137% in the second season for solarization with polyethylene sheets of 200, 60 and 30 micron respectively than control treatment (unsolarized soil). The increase in cantaloupe total yield per plant and per feddan with soil solarization may be due to the negative impact of soil solarization on weeds and /or on soil borne pathogens (Katan 1997 and Zahran 2001).

be explained by the positive impact of soil solarization on mineral nutrients availability for the growing plants, particularly during plant early stages of growing and development (Zahran, 2001). It may also be explained by the positive impact of soil solarization on mineral nutrients availability for the growing plants, particularly during plant early stages of growing and development (Zahran, 2001). It may also be explained by the positive impact of soil solarization on mineral nutrients availability for the growing plants, particularly during plant early stages of growing and development (Zahran, 2001). It may also be explained by the positive impact of soil solarization on mineral nutrients availability for the growing plants, particularly during plant early stages of growing and development (Zahran, 2001).

Table (3) Average effect of soil solarization with different types of polyethylene sheets on T.S.S. and yield of cantaloupe grown at Isna in 2003/2004 and 2004/2005 seasons.

Season	First season	Second season

Treatments	T.S.S.	Total yield Per plant (Kg)	Total yield per feddan (Ton)	T.S.S.	Total yield Per plant (Kg)	Total yield per feddan (Ton)
UVI polyethylene 200 micron	15.0	2.817	15.733	14.1	3.200	16.337
Transparent 60 micron	15.0	2.703	15.139	14.0	2.801	15.742
Black polyethylene 30 micron	14.3	2.377	13.309	13.8	2.562	13.809
Control without solarization (bare soil)	14.3	1.783	9.987	14.0	1.874	10.809
L.S.D. 5%	M.S.	0.152	0.849	N.S	0.294	0.831

- **Feddan = 5600 plant**

The reduction in vegetative growth and yield in solarization with polyethylene of 30 an 60 micron than the 200 micron may be due to the tearing in plastic of 30 micron thick during the solarization period and hence encourage some weeds to grow. As for plastic sheets of 60 micron there were some weeds grew under it during the growing season of cantaloupe, this may affected the growth and yield of both these two treatments than the solarization with polyethylene sheets of 200 micron. It can be concluded here that for using simple method, cheep, save and without using any toxic materials to obtain high quality and quantity of cantaloupe for exportation in Upper Egypt, we recommended the use of soil mulch with polyethylene sheets of 60 micron or more for 6-8 weeks during summer season.

Cantaloupe damping-off and wilt diseases evaluation :-

Results from Table (4) show that the 200 micron. Treatment gave significant results in case of controlling damping-off after having the first true leaf when compared to the control treatment giving zero % infection, similar result was obtained by treatments of 60 micron. Black polyethylene mulch 30 micron, did not differ significantly from control treatment in this concern. In case of mortality % , the 200 micron and the 60 micron treatments gave the best values of reducing wilt percentage to become 5.87 and 5.96 % respectively giving significant differences when compared with the black polyethylene mulch 30 micron or control (see Table 4), in the main time black polyethylene mulch 30 micron reduced significantly wilt percentage compared with control.

Table (4): Average of damping-off and wilt disease incidence infecting cantaloupe in Upper Egypt (Isna, Qena governorate) through the two excessive seasons.

Treatments	* Damping-off %	** Mortality %
UVI polyethylene 200 micron	0.00	5.87
Transparent 60 micron	1.60	5.96
Black polyethylene 30 micron	2.50	8.65
Control without solarization (bare soil)	5.83	11.36
L.S.D. 5%	4.17	1.86

*** After having the first true leaf. ** During the end of fruit ripening stage**

Density of soil infection with the main pathogenic fungi:-

Data in Figures 1,2 showed that the best treatment in reducing the density of soilborne pathogenic fungi caused cantaloupe damping-off and wilt (*Fusarium* spp. and *Rhizoctonia solani*) was Yellow plastic 200 micron treatment in all samples collected through the duration of the experiments. It was followed by treatment with Transparent plastic 60 micron then black plastic 30 micron when compared with non-treated control. These results was due to temperature in the first three covered treatments. These results came in agreement with Martyn, and Hartz. (1986), Giacomo and Valentino (2006) and Porras *et al.* (2007)

T5

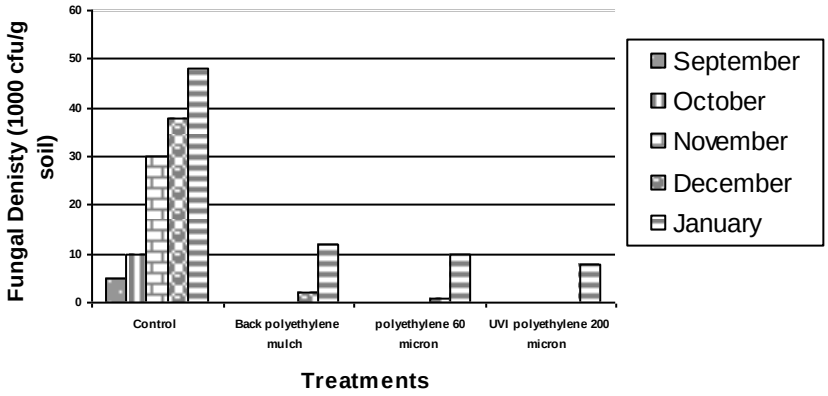

Fig (1): Density of *Fusarium* spp. in soil samples collected from various treatments during the experimental period

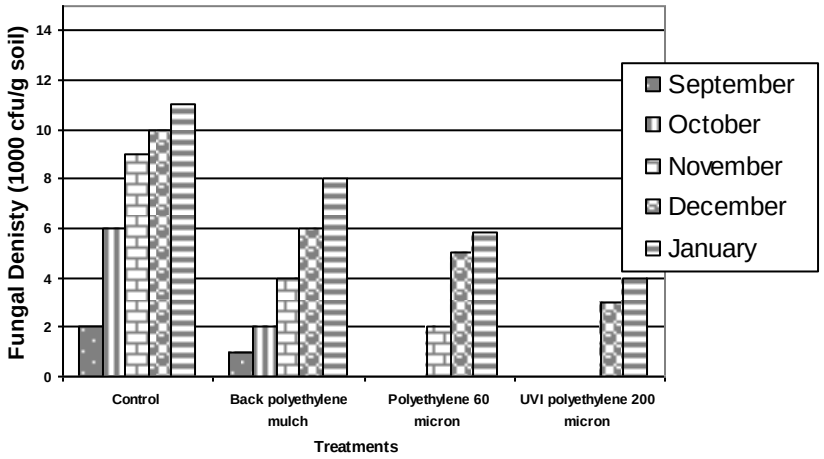

Fig (2): Density of *Rhizoctonia solani* in soil samples collected from various treatments during the experimental period

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تـأثير التعقـيم الشمسـي باسـتخدام انـواع مختلفـة مـن البـولي إيثيلـين علـي النمـو والمحصول وموت البادرات وأمراض الذبول في الكنتالوب المنزرع في صعيد مصر.

محمد الششتاوي محمد * و محمد محمود صالح**
*** قسم أمراض النبات – كلية الزراعة – جامعة المنصورة.**
**** قسم الزراعات المحمية – معهد بحوث البساتين – مركز البحوث الزراعية بالقاهرة.**

يعتبر التعقيم الشمسي للتربة من الطرق الأمنة النظيفة لمقاومة أمراض الذبول وموت البادرات في الكنتالوب المنتج للتصدير والسوق المحلي ، وقد اقيمت التجربة في محافظة قنا (مركز إسنا) في مصر العليا في تربة تحتوي علي الفطرين الممرضين الفيوزاريوم والريزوكتونيا سولاني.

في هذه التجربة تم التعقيم الشمسي للتخلص من تأثير هذه المسببات المرضية وقد أستخدم في هذه التجربة ثلاثة أنواع من شرائح البلاستيك المستخدم في تغطية التربة لمدة سبع أسابيع أثناء فصل الصيف (يوليو – أغسطس – سبتمبر) بداية من ٢٠ يوليو وقد كانت الأنواع المستخدمة هي شرائح البلاستيك الصفراء المعاملة ضد الأشعة فوق البنفسجية سمك ٢٠٠ ميكرون ، والبلاستيك الشفاف سمك ٦٠ ميكرون ، والبلاستيك الأسود سمك ٣٠ ميكرون بالإضافة لمعاملة الكنترول بدون تغطية في موسمي النمو ٢٠٠٣-٢٠٠٤ ، ٢٠٠٤-٢٠٠٥ وقد اخذت بيانات الأرصاد الجوية أثناء فترة التعقيم وكان الهجين المستخدم هو الإيديال وقد أوضحت النتائج أن البلاستيك الأصفر المعاملة ضد الأشعة فوق البنفسجية سمك ٢٠٠ ميمرون ويليه البلاستيك الشفاف بسمك ٦٠ ميكرون قد أعطيا أفضل النتائج علي التوالي من حيث كمية المحصول وصفاته وجودته في الأراضي الموبؤة حيث صار إنخفاض واضح في معدلات الإصابة بمرضي الذبول وموت البادرات وكذلك حدث تحسن في النسبة المئوية للنباتات الحية في نهاية فترة الحصاد .

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Table (5): Soil temperature at different depths of Soil solarization treatments, Isna 2004

		5 cm				10 cm				15 cm				20 cm			
		200 micron	60 micron	30 micron	Cont.	200 micron	60 micron	30 micron	Cont.	200 micron	60 micron	30 micron	Cont.	200 micron	60 micron	30 micron	Cont.
July	MAX	55.9	59.2	49.2	41.9	60	65	55	45	50	58	48	38	50	50	47	38
	MEAN	53.3	57.6	46.4	36.4	59.2	60.8	48.5	40.8	49.7	50.5	44.8	35	48.7	49	42.3	34
	D < 40^0	12	12	12	1	12	12	12	11	12	12	12	0	12	12	12	0
August	MAX	54.7	58.9	48.9	39.5	60	65	55	55	50	54	54	39	59	50	45	38
	MEAN	51.2	53.1	42.7	34.9	58	58.9	46.7	43.5	48.7	50.2	45.2	35.2	49.3	47.9	41.8	34.4
	D < 40^0	31	31	20	0	31	31	30	31	31	31	31	0	31	31	29	0
September	MAX	55.4	50.5	40.3	39.9	60	59	50	50	48	55	42	36	49	47	42	38
	MEAN	51.8	48.6	36.2	35.5	57.2	54.1	37.4	42.8	45.9	52.4	40.9	34.1	47.3	45.9	38.6	33.7
	D < 40^0	7	7	1	0	7	7	1	6	7	7	6	0	7	7	1	0

- **D > 40^0 = Days with more than 40^0C**

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