Minufiya J. Agric. Res. Vol. 32 No.2: 405 - 417 (2007)

EFFECT OF DIFFERENT PROTECTED CULTIVATION METHODS ON YIELD AND QUALITY OF AUTUMN TOMATO

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(Received: Dec., 26, 2006)

ABSTRACT: ***A trial was carried out at Borollous site, Kafr EL-Sheikh Governorate, North Nile Delta region during Autumn season of 2003 and 2004 to study the effect of different protected cultivation methods on tomato yield, quality and residual effect of insecticides. Different shading materials for protection against insects were used. Control was uncovered but it was daily sprayed with insecticides.***

The results can be summarized as follows:-

- Plant height and dry matter percentage of tomato plants were increased due to shading materials, whereas number of branches and number of leaves per plant were decreased by using the same treatments.

- Average fruit diameter and fruit length was increased with the lowest shading level.

- The highest yield was obtained by the lowest level of shading i.e. 40% black nets.

- The results showed that the storage at room temperature of the treated breaker stage fruits of tomato is a useful idea for suppressing the pesticide residues before marketing.

***Key Words**: Tomato, Shading, black nets, insecticides, protected cultivation, Low tunnel, Profenofos.*

INTRODUCTION

In Egypt, tomato is sown in the open field in four seasons, i.e., early summer, summer, autumn and winter. The reduction in tomato yields were noticed in autumn season because of high temperature during this period and infected plants with virus disease caused by whitefly. In Egypt farmers at autumn season spray tomato fields with insecticides daily against the whitefly to decrease the infection by viruses. Tomato yellow leaf curl virus (TYLCV) is the most serious and damaging disease of autumn tomato in Egypt.

The virus is transmitted by whitefly (Bemisia tabaci) which is highly spread in this period. The virus has a stunting effect on tomato and seriously affects flower and fruit production and finally resulting in poor yields in autumn seasons. Effective control of whitefly is no longer possible due to

development of resistance of the insect to commonly used insecticides. Numerous studies were carried out in different locations proved that the plants were mostly taller when grown under shading (Sayed(1983), Ryiski and Spigelman(1985),EL-Aidy *et al., (*1983); EL-Gizawy *et al.,* (1992a) and EL-Abd *et al.,* (1994) on tomato and cucumber. Kaname and Itagi, (1970) found that shading cucumber plants by black cloth which reduced light intensity by 50% depressed the number of lateral shoots.

With respect to number of leaves, the results were conflicting as there was evidence from some experiments that the number of leaves was decreased under shading (EL-Gizawy *et al.,* (1992)a and EL-Abd *et al.,* (1994) on tomato). Some investigators reported that shading increased the fresh and dry weight of plant, (Schach, (1972), Waly and Abd EL-Aal, (1983), Fayez, (1989)all on pepper and Russo, (1993) on tomato).

Regarding the effect of shading on yield Sagi (1979) showed that the maximum yield of tomato in the summer season was achieved with shade of 22%. El-Aidy at el (1983) found also that shading of tomato plants by 40% was the most effective in producing the highest yield. EL-Gizawy *et al*. (1992a) concluded that there were significant increases in yield and number of tomato fruits per plant by shading. The maximum fruit yield was obtained by plants grown under 35% shade followed by 51% and then 63%. Similar trend was obtained on tomato in recent study (EL-Abd *et al.,* 1994). EL-Gizawy *et al*. (1992b) showed that the highest weight, length and diameter of tomato fruits were obtained from plants grown under 35% shade. Al-Zidjali and Moghal, (1995) showed that covering tomato plants with agryl increased, fruit diameter (28-75%), fruit number, fruit weight and yield by over 100%.

The need for efficient treatments for minimizing or removing the residues of pesticides became invaluable because of the intensive use of chemical insecticides. EL-Tantawy *et al*. (1992) found that residues of Profenofos in potatoes were well below the permissible limit in fresh and processed potatoes during storage. Washing of tomatoes fruits in a steam of water and heating together with sterilization reduced the residues of Dimethoate and Pirimiphos-methyl to a great extent (Ramadan *et al*. ,1992).

The objective of this study was to find out an efficient method to increase vegetative growth, yield, and fruit quality and decrease insecticide residues caused by intensive use of insecticides in autumn tomato crop.

MATERIALS AND METHODS

An experiment was conducted at Borollous site, Kafr EL-sheikh governorate, North Nile Delta in two successive seasons of 2003 and 2004. Seeds of tomato cv. Castle Rock. were sown in the nursery in June15th in both seasons and the seedlings were transplanted in 12th of July in the field under drip irrigation system, The distance between laterals was 1.5m and the distance between plants within the rows was 50 cm., every row had 40 plants.

Base dressing was added and agricultural practices were confided according to the recommendations of Ministry of Agriculture.
The treatments were arranged as follows:

1- **Covering the plants with low tunnel of black shade nets of 40% shading soon after transplanting until flowering stage.**
2- **Same as the first treatment but using 51% shading.**
3- **Same as the first treatment but using 63% shading.**
4- **Covering the tomato seedling with agryl using low tunnel soon after transplanting until flowering stage.**
5- **Control: tomato plants were sprayed daily after transplanting, till harvest against the whitefly using Admire 20% Sc (imidaclopid) and Celecron 72% Ec (Profenofas) alternatively as insecticides.**

The previous treatments were arranged in four replicates using complete randomized block design. Each replicate contained 5 plots representing the treatments. Each plot contained 3 rows. Each row contained 40 plants.

Measurements were as follows:

1- Vegetative growth

Random samples of ten plants from each replicate were chosen at the flowering stage and the following data were recorded:-

A- **Plant height (cm.) was determined from the cotyledons up to the highest growing tip.**
B- **Number of branches / plant.**
C- **Number of leaves / plant.**
D- **Stem diameter (cm.).**
E- **Plant dry matter percentage: sample of fresh plants were weighed and dried at 105°C. until reached a constant weight and percentage of dry matter was calculated.**

2- Yield and its components:

Random samples of ten fruits from each replicate were chosen at harvesting period and the following data were recorded:-

A- **Fruit length (cm.).**
B- **Fruit diameter (cm.).**
C- **Average fruit weight (gm.).**
D. **Total yield / plant (kg.).**
E- **Total yield / feddan (ton). All fruits harvested from each treatment along the harvesting period were weighed to calculate the total yield/plant and total yield per feddan.**

Obtained data were statistically analyzed for variance and the mean values were compared at 5% levels of LSD according to Snedecor and Cochran (1982).

3- Residue analysis:

Samples of pesticide treated fruits were collected at random one hour after plant treatment from different plots at two stages. The first sample was at the red ripe development stage and residue analysis was undertaken. The second sample was taken at breaker stage and stored for 7 days at room temperature until changing the colour of the fruits to the red ripe development stage. Then the fruits were transferred to the laboratory for residue analysis at Pesticide Residue Analysis and Environmental Pollution Department, Central Agricultural Pesticides Laboratory (CAPL), Agriculture Research Center (ARC) to carry out the residue analysis, According to Blass (1990) for Imidacloprid and Mollhaff (1975) for Profenofos.

Pecticide residue analysis

1- Imidacloprid

The method of Blass (1990) was followed for the residue analysis of Imidacloprid residues on and in tomato fruits as follows:

1- Extraction

Distilled methanol was used for extraction instead of acetonitrile. Then extract was partioned with n-hexane which was discarded, then the aquous layer was partioned three times with Methelene chloride which was then evaporated.

2- Cleaning up

The extract was then chromatgraphed through 5% moisture florisil column and Imidacloprid was eluted from the column with acetonitrile HPLC grade.

3- Determination

Agrilent 1100 series HPLC (by Hewlett Packard) equid with photo-diode arry Uv-detector was used at 270nm wave length.

The column used was Nucleosil 100-5 C18 5µm (4.0 x 250mm) Mobil phase: acetonitrile: water 9 : 1
Flow rate: 1 ml / minute
Retention time for Imidacloprid: 3.5 minutes

By using the previously mentioned method the rate of recovery (at 1ppm level) was 100%.

2- Profenofos

Extraction

The method of Mollhoff (1975) was followed for extraction of Profenofos residues from tomato fruits but distilled methanol was used instead of acetone. Then the extract was partioned three times with Methelene chloride which was evaporated to dryness.

Cleaning up was carried out according to Abu-Zahw (1980) using 2% deactivated silica gel chromatographic column eluted with n-hexane: acetone (95/5).

Determination

Hp 6890 series GC system equipped with FPD operated on the phosphorus mode. The capillary column DB-1701 (30m x 0.32 mm x 0.25 mm) was used.

N_2 flow rate 3 ml/min
H_2 " " 75 ml/min
Air flow rate 100 ml/min
Injection port temperature 250°C
Oven " 230 °C
Detector " 250 °C
Retention time 3.88 minutes

The rate of recovery of Profenofos in tomato fruits using these methods (t 1ppm level) was 77.9%.

RESULTS AND DISCUSSION

1- Vegetative growth:

Plant height (cm.)

Data in Table (1) showed that there was a significant effect for shading materials on this trait in both seasons. All shading materials significantly increased the plant height of tomato than the control ,the greatest increase was obtained by shading with 63% followed by 51%, 40% and Agryl, respectively. The increase in tomato plant height under shading treatments than control may be attributed mainly to the greater elongation of the internode, rather than increasing intrnode number (Sayed , 1983 and Rylski and spigelman, 1985).

Number of branches

Significant effect was recorded on the impact of shading rates on number of branches of tomato plants. All shading treatments resulted in significant reduction in number of tomato branches in both seasons Table (1). The highest reduction of branche number was due to the encourage of a strong apical growth under shading which reduced the side shoot sprouting and development (Rylski and Spigelman, 1985 ; Rylski, 1986 and Kname and Ltagi,1970)

Number of leaves

Data presented in Table (1) cleared that all shading treatments significantly decreased the number of tomato plant leaves than the control plants in both seasons. This may have happened as a result of the reduction which occurred in the development of lateral shoots on the plant main stem(El-Gizawy *et al*,1992a and El-Abd *et al,* 1994)

Stem diameter (cm.)

Data tabulated in Table (1) indicated that there was a significant reduction in stem diameter under shading treatments than the control in both seasons of study. The reduction in tomato stem diameter increased with increasing shading density. This may be attributed to the increase of cell division and cell expansion (Schoch ,1972).

Dry matter percentage

The presented data in Table (1) showed that all shading treatments significantly increased dry matter of tomato plants than the control in both seasons. These results are in agreement with Schoch (1972) on pepper, Waly and Abd EL-Aal (1983) on pepper, Fayez (1989) on pepper and Russo (1993) on tomato.

2- Yield and its components:

Fruit length (cm.)

The impact of shading level on fruit length of tomato was significant (Table 2). However, low shading level resulted in significantly longer fruits than the high level in both seasons. Same results were reported by EL-Gizawy *et al*. (1992b) who found that the highest length, diameter and weight of tomato fruits were obtained from plants grown under 35% shade.

Fruit diameter (cm.)

The average diameter of tomato fruit during the two seasons under shading treatments is shown in Table (2). Significant effect of shading levels on fruit diameter was observed. The fruit diameter obtained from the lowest shading level was significantly greater than control. Same results were found by Rylski (1986) on pepper and EL-Gzawy *et al.* (1992b) on tomato.

Average fruit weight (gm)

Data in Table (2) cleared that all shading treatments significantly increased average fruit weight of tomato in both seasons. The large average of fruit weight was obtained from the lowest shading level. Same results were found by Schoch (1972); Rylski (1986) and Fayez (1989) on pepper and EL-Gizawy *et al*. (1992b) on tomato.

Total yield kg. / plant

Total yield per plant was significantly affected by shading treatments in both seasons (Table 2). The highest yield per plant was obtained under the lowest shading level. The dramatic reduction in tomato yield in the Autumn plantation has been well documented in many studies where high temperature increased the flowering, reduced fruit set, and produced small fruits. This effect led to the previous decrease in the yield Shelby *et al.* (1978). The obtained results concerning the favorable effect of shading were in line with those reported on Tomato by Sagi (1979); EL-Aidy *et al*. (1983); EL-Gizawy *et al*. (1992b); EL-Abd *et al.* (1994) and Shehata (1996).

Shading material in Autumn season play double role; the first is decrease reduction of the harmful effect of high temperature, and the second one is preventing white fly from attacking tomato plants. Thus the shading material is used as a barrier against white fly which transmit the yellow leaf curl virus (TYLCV).

Total yield (ton)/feddan

The calculated total yield of tomato per feddan showed a significant increase in tomato yield per feddan under all shading treatments than control in both seasons (Table 2). The best treatment was 40% black nets, Agryl, 51% black nets and followed by 63% black nets, respectively. The increase reached 19% for 40% shading martial over control. This is true in both seasons.

3- Residual effect:

Tomato plants were sprayed daily with Imidaclobrid (Admire 20% SC) and Profenofes (Selecron 72% EC) at the recommended rates of 50 and 270g a.i per feddan, respectively for controlling of whiteflies.

Samples of treated tomato fruits were collected from plots (that contained different stages of fruits development on the same plant). The initial samples, taken by random one hour after plant treatment containing red or breaker stage of tomato development, were taken immediately for residue analysis. Another part of tomato samples were taken at the same time but only at breaker stage tomato fruit development, then kept stored for 7 days at room temperature until changing the fruit colour to red.

The results obtained are shown in Table (3). Although all the detected amount of insecticide residues did not exceed the MRLs established by Codex for both the two insecticides on tomato fruits a marked loss in the pesticide residues was noticed when the treated breaker stage fruits were kept under storage at room temperature for 7 days where average loss of 33.99 and 76.49% of the initial deposits of Imidacloprid and Profenofos were removed, respectively.

It can be concluded that the storage of the treated breaker stage fruits of tomato is a useful idea for suppressing the pesticide residues before marketing. These results are in agreement, to a great extent, with that obtained by Zidan et al. (2001) who found that procymidone fungicide residues were below its established limit (2ppm) in tomato 6 days after storage. Nasr and Hegazy (2003) found that the initial deposits of profenofos were 2.45ppm in tomato fruits with residue half-life of 23 hours.

Abou-Arab (1999) found that freezing as well as juicing and peeling were necessary to remove pesticide residues from the tomato fruit skin. Sohoo *et al*. (2004) reported that the use of Profenofos at the minimum effective dosage (500g/ha) does not seem to cause any hazards to the consumers if a waiting period of 3 days was achieved.

Table (3): Effect of storage on the residues of Imidacloprid and Profenofos insecticides on two different stages of tomato fruits development.

Sample type	Imidacloprid		Profenofos	
	Residues in ppm	% loss	Residues in ppm	% loss
Initial sample * containing different developing Stages (Red and breaker stage)	0.203	0.00	3.02	0.00
breaker stage stored for 7 days at room temperature After fruit picking	0.134	33.99%	0.71	76.49%
MRL in tomato fruits (ppm)	0.3***		2	

* Samples were taken one hour after plant treatment.
** Each figure is an average of three replicates.
*** Israeli Directory of pesticides (2001).

CONCLUSION

From this experiment for obtaining high total yield with best quality without any residue effect of insecticide from Autumn season of tomato in Egypt by preventing and suppressing the virus infection and its spread, promoting the growth and development of tomato, shading by net of 40% shading is the best under local conditions. More research is needed to determine how many days exactly for tomato sprayed with insecticides to get rid of the residue contaminating tomato fruits.

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تأثير طرق الحماية المختلفة على المحصول والجودة للطماطم الخريفى

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الملخص العربى

أجريت التجربة فى منطقة البرلس – محافظة كفر الشيخ بشمال الدلتا أثناء الموسم الخريفى فى عامى ٢٠٠٣، ٢٠٠٤ لدراسة تأثير الطرق المختلفة من الحماية على المحصول والجودة والأثر المتبقى للمبيدات فى الطماطم الخريفى.

وكانت أهم النتائج المتحصل عليها هى :-

- أن جميع مواد التظليل أظهرت زيادة فى طول النباتات وكذلك النسبة المئوية للمادة الجافة بينما ادت بعض طرق الحماية إلى نقص فى عدد الأفرع والأوراق للنبات.
- المعدلات الأقل من التظليل أدت إلى زيادة فى قطر وطول ثمار الطماطم الخريفى.
- التغطية بالشبك الأسود ٤٠% تظليل أعطى أعلى محصول للنبات وبالتالى أعلى محصول للفدان.
- اظهرت النتائج ان تخزين ثمار الطماطم فى مرحلة بداية التلوين حتى اكتمال التلوين فى درجة حرارة الغرفة ادى الى تقليل الاثر المتبقى للمبيدات بالثمار.

Table (1): Effect of different shading treatments on vegetative growth of tomato plants in both seasons of 2003 and 2004.

Treatments	First season					Second season				
	Plant height (cm.)	Number of branches	Number of leaves	Stem diameter (cm.)	Dry Matter %	Plant height (cm.)	Number of branches	Number of leaves	Stem diameter (cm.)	Dry Matter %
Black nets 40%	72.33	6.00	96.00	1.07	20.03	70.33	5.67	93.00	1.07	20.63
Black nets 51%	79.00	5.33	85.00	0.97	20.67	76.67	5.00	81.33	0.97	21.27
Black nets 63%	85.00	4.67	75.67	0.73	21.67	81.67	4.67	71.33	0.77	22.93
Agryl	71.33	5.67	95.00	1.10	19.97	69.67	5.67	91.33	1.03	20.50
Control	50.33	7.67	113.00	1.33	15.93	48.00	7.33	118.67	1.27	16.33
L.S.D.	1.40	0.97	1.35	0.09	0.18	1.59	1.06	1.06	0.05	0.63

Table (2): Effect of different shading treatments on yield and fruit characteristics of tomato in both seasons of 2003 and 2004.

Treatments	First season					Second season				
	Fruit length (cm.)	Fruit diameter (cm.)	Ave. fruit weight (gr.)	Total yield/ plant (Kg.)	Total yield / feddan (ton)*	Fruit length (cm.)	Fruit diameter (cm.)	Ave. fruit weight (gr.)	Total yield/ Plant (Kg.)	Total yield / feddan (ton)*
Black nets 40%	5.10	6.17	118.00	8.18	45.80	5.03	6.03	114.33	8.04	45.00
Black nets 51%	4.80	5.87	110.33	7.77	43.53	4.73	5.73	109.00	7.74	43.33
Black nets 63%	4.60	5.73	103.00	7.46	41.77	4.50	5.53	101.00	7.51	42.03
Agryl	5.00	6.07	115.67	7.95	44.50	4.93	5.93	112.67	7.82	43.77
Control	4.27	5.40	95.67	6.72	37.63	4.20	5.30	88.33	6.52	36.50
L.S.D.	0.05	0.13	1.67	0.05	0.26	0.06	0.11	2.09	0.08	0.43