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RESPONSE OF TOMATO PLANTS TO SOME AGRICULTURAL AND CHEMICAL TREATMENTS ON FRUIT YIELD AND ITS QUALITY RELATION TO *TUTA ABSOLUTA* (MEYRICK) AND *BEMISIATABACI* (Genn.) INFESTATION

[42]

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ABSTRACT

An experiment was carried out to study the effect of some agricultural and chemical treatments on two serious insects i.e. leaf miner, *Tuta asoluta* **(Meyrick)**, and the cotton whitefly *Bemisia tabaci* **(Genn.)** that infest tomato plants, as well as the influence on the growth, fruit yield and its quality were evaluated. The trail was carried out in a sandy soil at Amoun Agricultural Association, Eltal El Kabier, Ismailia Governorate, Egypt during two autumn seasons of 2013 and 2014. The experiment included 7 treatments as follows: covering tomato plants with agryl, white and green net as a row covering tunnels, dusting with Sulfur (repellent the insect) as the safety material for human and environmental comparing chemical pesticides i.e. Actara using it as foliar spraying or soil drench and untreated control. The results showed that the all treatments induced significant positive impact for all infest status which reduced the incidence of the two serious insects' i.e. *T. asoluta* and *B. tabaci* on tomato plants than the control treatment during the first and second seasons. Data also showed that the all treatments were infested by tomato leaf miner (eggs and larvae stage) with low numbers of eggs under the tested conditions during the two seasons except of covering with Agryl, white net and green net which were free from any tomato leaf miner. In addition, soil treatment (soil drench) application was the most potent treatment in protecting tomato plants from the whitefly immature stages, but the lowest percentage of plants exhibiting virus symptoms (TYLCV) recorded by covering with white net treatment compared with untreated (control) during the two tested seasons. Concerning the effect of using some agricultural and the chemical treatments on horticultural characters of tomato plant, the obtained results indicated positive effect on the all studied parameter of tomato i.e. vegetative growth characters, physical and chemical fruit characters, flowering characteristics and yield components during the two seasons. The data showed that the rows covering with white net was the best potent treatment safety treatment for human healthy followed by foliar spraying with Actara 25% WG (Thiamethoxam) 20g./100 of water as chemical treatment on yield, which recorded (41.7 and 43.2), (30.32 and 32.13) tons per feddan during the first and second seasons respectively compared with other treatments. Moreover the covering with white net also recoded the first ranking in economic study which recoded the best value (34200 and 35700) Egyptian pound on total income without addition the cost of agriculture practices during the first and second seasons respectively. For that it can recommend by covering tomato plants with white net followed by covering with agryl especially at heavy infection seasons with the serious insects as *T. asoluta* and *B. tabaci* for producing high tomato yield with best quality, in addition safety human health and environment without using pesticide.

INTRODUCTION

The tomato (*Solanum lycorpersicum* L.) is considering one of the most economically important vegetables in Egypt as well as in the world. Tomato find numerous uses as fresh and processed forms **(Kacsjan-Marsic et al 2005)** in the human

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diet and it is an important source of micronutrients, notably lycopene, ß- carotene, a-tocopherol, phenol compounds, as well as certain minerals (notably potassium) and carboxylic acids, including ascorbic, citric, malic, fumaric and oxalic acids **(Caput et al 2004)** all that showing beneficial effects on human health.

The tomato quality is influence by genetic and environmental factors such as climatic conditions; temperature and light and cultural practices **(Caliman et al 2010)**.

Plastic nets in the form of covering materials are widely used for different purposes in the agricultural sector. For example, it used to protect the crops from hail, strong wind, snow, heavy rainfall, insects, animals and birds (**Al-Helal and Abdel-Ghany, 2010**). Moreover **Abdrabbo, et al (2013)** studied the growth behavior of potato under different net color as well as in open field, they reported that the highest temperature was recorded in the open field treatment followed by white net, while the lowest temperature was gained by black net. Maximum temperatures tended to be lower under the blue and black net by 3°C in comparison with the open field, while average relative humidity increased with the use of all net color by 4-8% compared to the open field **(Wilson and Rajapakse, 2001).**

Sulfur is a useful preventative against the diseases and some pest problems which the tomato is consider susceptible. Certain pest infestations also can be treating with sulfur. Sulfur protects the new growth from further damage by pests or diseases. Sulfur also is responsible for producing organic compounds that give tomatoes their tart but sweet flavor. Sulfur, along with other nutrients, such as nitrogen, potassium and boron, contribute to high-yielding, with healthy plants. **Lai-jk, et al (2000)**, reported that sulfur element play a great role in plant metabolism and applying it to the soil caused reduction in the soil pH consequently enhance the solubility and availability of many elements. **Camille, et al (2012)**, stated that early marketable fruit weight increased sharply when plants were treated with sulfur at least 25 lb/acre in comparison with the non-treated control. Early fruit weight of extra-large and all marketable grades increased by 1.5 and 1.7 tons/acre, respectively, with the application of 25 lb/acre from sulfur.

Tomato plants are subjected to several pests such as insects which may cause decreasing in yield by impeding plant growth, retarding flowering, sucking juice, destroying leaf area and transmit viral diseases. One of the most serious insect pests is the tomato leaf miner *Tutaabsoluta* (Meyrick) especially its larvae mine plant leaves producing large galleries and burrow into fruits causing considerable losses of tomato production in either protected or open field plantation, damage may lasting to 100%. This pest occurs damages during the growing cycle of tomato and has a very high reproduction capability. Plants can be attacked from seedling stage to mature fruit stage, in tomato infestation occurred on apical buds, leaves, stems, flowers and fruits **(Khidr et al 2012)**. In addition, tomato yellow leaf curl virus (TYLCV) disease is one of the most devastating viral diseases affecting tomato crops worldwide. This disease is caused by several begomoviruses (genus Begomovirus, family Geminiviridae), such as Tomato yellow leaf curl virus (TYLCV), that are transmitted in nature by the whitefly vector *Bemisiatabaci*. In additions in Egypt, little studies were conducted about the new introduced insect *T. absoluta* **(Amer, et al 2012)**.Now the most common practical method for controlling tomato from YLCV infection is depended on chemical control, or covering plants with Agryl or nets, or new physiological methods either in activating virus itself or by reducing the host susceptibly or inducing certain level of tolerability, **(Fathy and Khedr, 2005)**.

Hegab, et al (2013) studied the effect of different programs against the new introduced tomato leaf miner *Tuta absolute*, the whitefly and mite pests, they found that, positive effect of all the investigated programs to reduce infestation of the important insect and mite pests on tomato plants than the control treatment and they indicated that, positive effect of all the treatments on tomato vegetative growth characters(plant height, number of branches, leaves, fresh and dry weight of plants), fruit characters (length, diameter, weight, number of locules and firmness) and total yield per plant during the two studied seasons comparing with the untreated plants(control).

Mason et al (2000) found that drench application to tomato plant using the new neonicotinoid insecticide (Thiamethoxam) provided a good protection from the whitefly, aphids infestation and the TYLCV infection.

The objective of this research is to investigate the effect of some treatments on protecting the tomato plants from some dangerous effect such as pests as well as leaf miner *Tuta absoluta* (Meyrick) and the whitefly vector *Bemisia tabaci* by covering Agryl, White and Green net, Sulfur dusting as a safety material for human health comparing with chemical pesticides by using Actara as foliar spray-

ing or soil drenches as well as without using any protection treatment on some horticultural characters of tomato plant and its productivity as well as reducing infestation of the serious insect pests.

MATERIALS AND METHODS

Two field experiments were carried out at Amoun Agricultural Association, El-Tal El-Kabier (76 km from Cairo), Ismailia Governorate during the two successive autumn plantation seasons of 2013 and 2014 to study the effect of some covering treatments by (Agryl, White and Green net), dusting with Sulfur as a safety material comparing with using chemical pesticides i.e. Actara (as foliar spraying or soil drench) on some horticultural characters tomato plant and its productivity as well as reducing infestation of the serious insect pests. Seeds of tomato cv. Agiad F_1 hybrid (produced by Development of the Main Vegetable Crops and Hybrid Production Project. Horticulture Research Institute.) were sown at the nursery in seedling foam trays under Net-house condition on 25th and 28th of July, and the transplanting took place on 25th and 30th of August in the two seasons of 2013and 2014, respectively in complete randomize blocks design with three replicates. The area of each experimental plot consisted of three rows each row15m long and 1.25m width with spacing of 40cm between plants. The type of the soil was sandy, drip irrigation was used for irrigate the plants with equal amount of water. Fertigation system and other cultivation practices were done as the recommendation for tomato planning program under sandy soil.

The temperature degrees were recorded every week and the average of its were calculated at months from cultivation till the end of harvesting in **Table (1).**

Table 1. Monthly maximum temperature degrees under the conditions covering and without covering of tomato plants during the seasons of 2013-2014 and 2014-2015.*

Months	Temperature Max °C			
	2013/2014		2014/2015	
	Covering	Without covering	Covering	Without covering
July	36.5	41.2	36.0	39.9
August	36.0	40.0	35.0	38.6
September	34.5	37.5	35.0	38.1
October	30.5	33.5	30	32.5
November	30.0	31.5	29.5	30.5
December	26.5	28.5	23.5	25.5
January	24.5	27.5	21.5	24.0

The experiment included 7 treatments as follows:

1. Covering with Agryl under rows tunnel (length 15m, width, 1.25 m, height 0.70 m).
2. Covering with white net(50 mesh per inch) under rows tunnel (length 15m, width, 1.25 m, height 0.70m).
3. Covering with green net (30% shade) under rows tunnel (length 15m, width, 1.25 m, height 0.70m).
4. Dusting with agricultural sulfur 98 % D at the rate of 155kg/ feddan every 7 days from transplanting alternatively every 7 days until beginning of coloring in tomato fruits.
5. Foliar spraying by Actara 25 % WG (Thiamethoxam) 20 g./ 100 l. of water after 7 days from transplanting alternatively every 7 days until beginning of coloring in tomato fruits.
6. Soil treatment (soil drench) with application by Actara 25 % WG (Thiamethoxam) 20 g./100 l.. of water (350 g / feddan) after 7 days from transplanting alternatively every 7 days until beginning of coloring in tomato fruits .
7. Control without treating.

The following data were recorded

1. Insects infestation

1.1. Numbers of insects' infestation and tunnels

Samples of the plant leaves were taken after 7 days from transplanting alternatively every 7 days until beginning of coloring in tomato fruits. 20 leaves from each replicate were randomly taken. The collected leaves samples were transferred to the laboratory in paper bags for inspections. The upper and lower surfaces of each leaflet were examined carefully by using binocular microscope and the number of *T. absoluta* (tunnels, larvae and eggs) and whitefly [eggs and moving immature stages (nymphs and pupae)] were counted and recorded as numbers and Percentage of occurrence. % of occurrence = (No. per treatment /total numbers per all treatments) x 100.

1.2. The percentage of the number of tomato plants exhibiting with virus symptoms (TYLCV)

The virus symptoms expressed as cumulative numbers were estimated three times, every 15 days after 45 days from transplanting. Symptoms

were evaluated morphologically. The percentage of the number of plants exhibiting virus symptoms was recorded and percent plants showing virus symptoms estimates visually and calculated according to the following equation.

$$\text{Plants showing virus symptoms \%} = \frac{\text{Plants showing virus symptoms as cumulative numbers}}{\text{Number of total plants}} \times 100$$

2. Horticultural characters

2.1. Vegetative growth

- After 65 days from transplanting (at the beginning of fruiting stage), plant height (cm^2), number of branches, number of leaves, fresh weight (g), dry weight (g) were determined in 3 plants from each plot then the average per plant was calculated.
- Total leaf chlorophyll content was measured using Minolta chlorophyll meter SPAD-50 I as SPAD units.

2.2. Flowering characteristics and Yield components

- Flowering date: Number of days from transplanting till 50% flower an thesis per plot was calculated as index of flowering date.
- Clusters number / plant were counted at the beginning of fruit maturity stage.
- Fruit setting percentage was calculated by average of three clusters after the forth node on the main stem according to the formula:

$$\text{Fruit setting percentage} = \frac{\text{No. of setted fruits /cluster}}{\text{No. of total flowers / cluster}} \times 100$$

- Early yield of tomato fruits expressed as weight of the first three pickings.
- Total yield as the weight of fruits of all pickings as kg/ plot, then were summated and calculated as ton/ fed.
- Average fruit fresh weight (g) was determined theoretically by dividing total fruit weight on the total fruit number.

2.3. Fruit quality

2.3.1. Physical fruit Characters

Sample of 10 fruits from each plot was randomly chosen at the red stage from the third picking to determine fruit length (cm^2), fruit diameter (cm^2), average fruit weight (g), No. of locules/fruit and fruit firmness(kg/cm^2) were recorded.

2.3.2. Chemical fruit characters

- The percentage of total soluble solids (T.S.S%) in fruit juice was determined by a hand refractor meter according to the methods mentioned in **A.O.A.C. (1980).**
- The total acidity of fruits juice was determined using a pH meter.

III-Economic analysis

Studies of economic analysis gain for different treatments were estimated by subtract the price of total yield and cost of treatments to obtained the income with Egyptian pounds.

IIII-Statistical analysis

The data obtained were subjected for analysis of variance (ANOVA) to test the significance of the observed differences using the Cost at program. The differences between treatments were evaluated using LSD at $p<0.05$.

RESULTS AND DISCUSSION

The effect of six treatments compared to the control on infestation of tomato plant with two main pests and yield was studied at Ismailia Governorate during the two successive seasons. The obtained results can be arranged and discussed as follows:

I- Insects infestation

1.1. Tomato leaf miner, *Tuta absoluta* (Meyrick)

1.1.1. Eggs stage

Data compiled in **Table (2**) showed that the all treatments were infested at eggs with low numbers of eggs during the two seasons except of agryl, white net and green net which were free from any

Table 2. Effect of some agricultural and chemical treatments on mean numbers of *Tuta absoluta* (Eggs, Larvae and Tunnels) and its relative percentage of occurrence (Occ %) of tomato plant during the two successive seasons of 2013 and 2014

Treatment	First season						Second season					
	Eggs		Larvae		T*unnels*		Eggs		Larvae		T*unnels*	
	Average	--Occ %.	Average	Occ %.	Average	Occ %.	Average	Occ %.	Average	Occ %.	Average	Occ %.
Covering with Agryl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Covering with White net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Covering with Green net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dusting with sulfur	0.14	4.75	0.28	9.76	0.32	9.75	0.11	3.85	0.11	5.13	0.11	4.65
Foliar spraying Actara	0.39	13.20	0.81	28.50	0.88	26.69	0.89	31.08	0.61	28.21	0.67	27.91
soil drench with Actara	0.36	12.26	0.50	17.64	0.51	15.66	0.42	14.57	0.44	20.51	0.44	18.60
Untreated control	2.06	69.78	1.25	44.10	1.57	47.90	1.44	50.51	1.00	46.15	1.17	48.84
F. test	**		**		**		**		**		**	
LSD p>0.05	0.1785		0.1534		0.2649		0.2232		0.2223		0.0735	

****= Highly significant--Occ %=**percentage of occurrence

eggs of tomato leaf miner. Results indicated that during the two seasons of investigation, the numbers of eggs on tomato leaflets were significantly influenced with seven tested treatments showing average numbers ranged between 0.14 to 2.06 in 2013 season and 0.11 to 1.44 eggs / 20 leaflets in 2014 season. It is obvious that untreated appeared high numbers during first and second seasons, represented by 69.78 and 50.50 % occurrence / 20 leaflets, respectively. But % occurrence in case of dusting with sulfur, foliar spraying application and drench application with Actara were 4.75, 13.20; 12.26 and 3.85, 31.08; 14.57 in the first and second seasons, respectively.

1.1.2. Larvae stage

The data presented in **Table (2)** clearly reveal that in both 2013 and 2014 seasons, seven treatments proved to have highly significant impacts on the population density of tomato leaf miner larvae. It is worthy to mention that, tomato leaves of plants transplanting under treatments of agryl, white and green net were free from any larvae of tomato leaf miner. In the first season of 2013, plants transplanting under untreated treatments harbored the greatest numbers of individuals of 1.25and 1.0 larvae / 20 leaflets with % occurrence of 44.10 and 46.15 in the first and second seasons, respectively. In the other hand, dusting with sulfur treatment harbored the lowest numbers of individuals of 0.28 and 0.11 larvae / 20 leaflets with % occurrence of 9.76 and 5.13 in the first and second seasons, respectively. But, tomato leaves under treatments of spraying application and drench application with Actara were recorded 0.81 with 28.50 and 0.50 larvae / 20 leaflets with 17.64 % occurrence in the first season and 0.61 with 28.21 and 0.44 larvae / 20 leaflets with 20.51 % occurrence, respectively.

1.1.3. Numbers of leaf miner tunnels

It is well known that the leaves is one of the elements responsible for plant nutrition, especially at the stage of vegetative growth and any harm for leaves result in a loss of the plant, especially fruits.

The numbers of tunnels expressed as cumulative numbers **(Table 2).** As clearly shown from the present results that, treatments of cover tomato plants row with agryl, cover tomato plants row with white net and cover tomato plants row with green

net were free from any tunnels during two seasons. But the highest average percentage of 100 % was recorded with untreated treatment followed by the spraying application, drench application with Actara and dusting with sulfur which showed the descending average numbers of 47.90, 26.69, 15.66; 9.75 in the first season and 48.84, 27.91, 18.60; 4.65 in the second season, respectively.

These results partial agree with **Hegab, et al (2013)** who recorded that, the lower mean number of *Tuta absoluta* (immature stages) were found when plants were covered with agryl compared with chemical treatments.

2. Cotton whitefly, *Bemisia tabaci* (Genn.)

2.1. Eggs stage

Data in **Table (3)** revealed that Soil treatment (soil drench) with Actara was the most potent treatment in protecting tomato plants from the whitefly immature stages during the two tested seasons.

Data indicate highly significant wide rating in average numbers of whitefly eggs on tomato leaves between the seven tested treatments.

The mean numbers of eggs recorded 23.83, 41.67, 112.78, 36.11, 19.89, 5.61, 126.61 and 13.28, 46.56, 111.50, 17.50, 7.72, 4.28, 134.11 eggs / 20 leaflets by Agryl, white net, Green net, dusting with sulfur, foliar spraying, drench application with Actara and untreated control in the first and second seasons, respectively.

It is important to mention that, soil drench with Actara recorded low % occurrence of the deposited eggs / 20 leaflets for anther treatments. The treatments could be arranged in a descending order as follows: non treated control>covering green net >covering white net>dusting sulfur>Agryl>foliar spraying >soil drench application during two seasons with occurrence % of 34.55> 30.77> 11.37> 9.85> 6.50> 5.43> 1.53 and 40.04> 33.29> 13.90> 5.22> 3.96> 2.31> 1.28 during first and second seasons, respectively.

2.2. Moving immature stages (nymphs and pupae)

Concerning with individuals of whitefly in the first season, also statistical analyses **(Table, 3)** showed highly significant differences between mean numbers. It is obvious that, Soil drench application with Actara had adverse effect on life of individuals (6.78 individuals/20 leaflets represent 1.68 % occurrence) followed by foliar spraying > (13.00 individuals/20 leaflets represent 3.22% occurrence)and covering with Agryl (22.33 individuals / 20 leaflets represent 5.54 % occurrence). On the contrary, the untreated (check) had the highest mean numbers of nymphs and pupae (153.83 individuals / 20 leaflets represent 38.13 % occurrence) followed by covering with Green net (125.67 individuals/20 leaflets represent 31.15 % occurrence), covering with white net (44.39 individuals / 20 leaflets represent 11.00 % occurrence) and dusting with sulfur (37.44 individuals / 20 leaflets represent 9.28 % occurrence).In the second season, results showed the same level in the first season recording average numbers of 5.39, 7.94, 9.94, 12.44, 42.67, 89.50 and 130.00 individuals / 20 leaflets with % occurrence of 1.81, 2.67, 3.34, 4.18, 14.32, 30.04and 43.64 by treatments of soil drench application, Foliar spraying application, with Actara covering with Agryl, dusting with sulfur, covering with white net, covering with green net and untreated control, respectively.

Hegab et al (2013), recorded that, Agryl tunnels was the most potent treatment in protecting tomato plants from the whitefly immature stages (nymphs and eggs) during the tested season followed by mineral oil foliar spray and dusting with sulfur. Also **Afsah (2015)**, showed that dusting with sulfur caused minimizing the population of the whitefly (immatuare stages) compared with untreated.

2.3. Percentage of the number of tomato plants exhibiting virus symptoms (TY-LCV)

Concerning percentage of plants exhibiting virus symptoms the **Figure (1)** showed that the use of protection by covering with Agryl, white and green net and dusting with sulfur as safety on human health compared with chemical pesticide foliar spray and soil drench with Actara compared the control.

The **Figure (1)** indicted that all the investigated protection, materials were found effective to reduce virus symptoms on tomato plants than the control treatment during the first and second seasons. The lowest value of percentages of virus symptoms were recorded with covering the plants by white net which 7.6 and 8.5 % Meanwhile, the highest values of infection symptoms were recorded with the control plants (49.6 and 53.2) during the first and second seasons respectively.

Table 3. Effect of some agricultural and chemical treatments on mean numbers of whitefly *Bemici tabaci* (Eggs and moving immature stages) and its relative percentage of occurrence (Occ%) of tomato plant during the two successive seasons 2013 and 2014

Treatment	First season				Second season			
	Eggs		Moving immature stages		Eggs		Moving immature stages	
	Average	--Occ %	Average	Occ %	Average	Occ %	Average	Occ %
Covering with Agryl	23.83	6.50	22.33	5.54	13.28	3.96	9.94	3.34
Covering with White net	41.67	11.37	44.39	11.00	46.56	13.90	42.67	14.32
Covering with Green net	112.78	30.77	125.67	31.15	111.50	33.29	89.50	30.04
Dusting with sulfur	36.11	9.85	37.44	9.28	17.50	5.22	12.44	4.18
Foliar spraying Actara	19.89	5.43	13.00	3.22	7.72	2.31	7.94	2.67
Soil drench with Actara	5.61	1.53	6.78	1.68	4.28	1.28	5.39	1.81
Untreated control	126.61	34.55	153.83	38.13	134.11	40.04	130.00	43.64
F. test	**		**		**		**	
LSD p>0.05	9.3255		16.689		19.092		18.339	

**= Highly significant--Occ %= percentage of occurrence

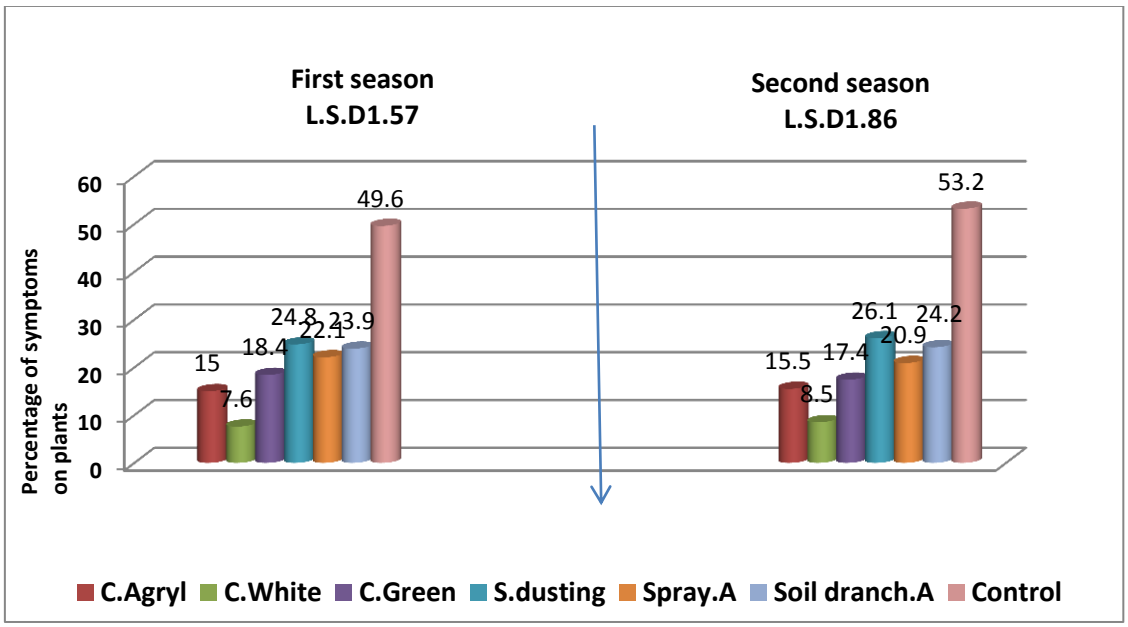

Fig. 1. Effect of some agricultural and chemical treatments on the percentage of the number of tomato plants exhibiting with virus symptoms (TYLCV) during the two successive seasons 2013 and 2014

2. Horticultural characters

2.1. Vegetative growth

Data presented in **Table (4)** illustrated that vegetative growth parameters of tomato plants showed significant differences according to the treatments that used in this investigation; however, the plants protected with covering treatments were characterized by vigorous in their vegetative growth compared with other treatments. The highest values of vegetative growth were recorded with the plants covered by white net expressed by plant height (100.0, 110.0), number of branches(9.0, 9.3), number of leaves per plants (48.0, 53.3), fresh weight (235.3, 288.3), dry weight (34.4, 37.9) and high concentration from leaves chlorophyll (48.3, 50.3). Meanwhile, the lowest value was recorded with the control plants.

These results are in agreement in the two seasons of 2013 and 2014 respectively. The superiority of the white net may be due it is suitable to enhancing the environmental conditions (temperature) for tomato during the growing period. However, the previous treatments led to a reduction in the temperature (2-4°C) around the plants as mentioned before in **Table (1).** Since high temperature causes an increase in respiration, and that is well be affecting the rate of photosynthesis which that is means reduction in the products of photosynthesis. Several investigate are come to the same results by **Wilson and Rajapakse (2001), Al-Helal & Abdel-Ghany (2010) and Zakher & Abdrabbo (2014). T**hey found that, the improvement in vegetative growth evidenced as plant height, number of branches, chlorophyll content and number of leaves per plant with the superior treatment, i.e. covering with white net may be due to the favorable weather conditions happened by net covering protection i.e., the increase in relative humidity, reduce the high temperature and light irradiance, and finally lower wind speed in comparison with the weather under open field conditions. Other possibility may be increasing plant ability to uptake water and nutrients which ultimately accelerated the rate of vegetative growth **Cerny, et al *(*2003)**. Beside the previous discussion, tomato plants grown under net covering obtained the lowest percentage symptoms of whitefly *Bemicitabaci* infestation as recorded in **Figure (1**). This in turn reduce the risk of plant pathogen development as mentioned by **Fatnassi, et al (2002)** who found that the use of netting with fine mesh smaller than 0.5 mm against whiteflies reduce the ventilation and tend to increase the risk of plant pathogen development and at the same time was sufficient to gave the vigorous vegetative plant growth.

2.2. Flowering characteristics and yield components

Data in **Table (5)** showed that, the all treatments used in this study gave significant positive effect on the parameters of flowering characteristics and yield components compared with the control treatment especially the treatments of net covering. The superior data of, i.e. number of days from transplanting to 25-50% flowering earliness (32.0 and 31.3 days), number of clusters (18.3 and 19.3), fruit setting (74.7% and 78.7%), early yield (13.3 and 13.6 ton / Fed.), total yield (41.7 and 43.2 ton /Fed.) and average fruit weight (130.0and 136.0 g.) were recorded with the plants covered by white net in the first and second seasons respectively. These results might be attributed to the favorable effect of temperature and the lowest percentage of pest infestation during the period of growth and reproduction process under covering by white net which possessed much shoot and leaves number per plant with high leaf chlorophyll content as mentioned before that induce more photosynthetic rates that built high yield of carbohydrates which promote cell division and enlargement inducing superiority vegetative vigorous plants. This reflect on number of cluster, fruit set% and fruit weight they produce more fruit yield than those of plants treated with the other treatments **El-zeiny (2002)**. The results were reported by those of **Hegab, et al (2013).**

2.3. Fruit quality

2.3.1. Physical and chemical fruit characters

The obtained results in **Table (6)** indicated that treated tomato with net covering led to significant increase the average fruit length, diameter, firmness, total soluble solids (TSS) and juice acidity during the two studied seasons compared with the other treatments. On the other hand the tested treatments had no significant effect on number of locules and this due character controlled with genetic factors. These results may be due to that tomato plants grown under net have a higher stomatal conductance and high contention on chlorophyll in the leaves, also produced more leaves in a short period during the growth season, so, fruit quality

Table 4. Effect of some agricultural and chemical treatments on plant height, number of branches, leaves, fresh, dry weight and Chlorophyll content of tomato plant during the two successive seasons of 2013 and 2014

Treatments	Plant height (cm)	No. of Branches/ plant	No. of Leaves/ plant	Fresh Weight (g)	dry weight (g)	Chlorophyll content (SPAD) unit
	First season 2013					
Covering withAgryl	75.3	6.0	36.0	122.3	17.6	45.4
Covering with White net	100.0	9.0	48.0	235.3	34.4	48.2
Covering with Green net	90.7	7.3	36.3	124.7	17.8	45.6
Dusting with sulfur	75.3	4.3e	33.3	93.7	17.0	45.0
Foliar spraying with Actara	68.0	5.5	23.1	81.0	13.7	42.4
Soil drench with Actara	67.7	4.7	18.5	80.3	12.3	41.5
Untreated control	57.7	3.7	17.4	46.3	7.7	42.3
LSD 5%	**3.6**	**0.815**	**3.1**	**5.8**	**2.01**	**1.93**
	Second season 2014					
Covering with Agryl	93.7	6.3	42.3	185.7	25.8	47.7
Covering with White net	110.0	9.3	53.3	288.3	37.9	50.3
Covering with Green net	100.0	8.0	42.3	229.7	28.3	41.5
Dusting with sulfur	90.7	5.7	38.8	140.7	19.4	41.4
Foliar spraying with Actara	81.7	6.2	32.8	121.3	18.4	43.8
Soil drench with Actara	76.0	5.7	24.4	115.0	16.9	39.8
Untreated control	67.0	4.0	20.7	95.0	12.7	43.7
LSD p>0.05	**4.0**	**0.984**	**3.7**	**8.1**	**2.9**	**1.74**

Table 5. Effect of some agricultural and chemical treatments on number of days from transplanting to flowering, clusters number, fruit setting%, early, total yield and average fruit weight on tomato plant during the two successive seasons of 2013 and 2014

Treatments	No. of days From transplanting to flowering	Number of clusters (plant)	Fruit setting %	Early Yield (tons/fed)	Total yield (tons/fed)	Average fruit weight (g)
	First season 2013					
Covering Agryl	33.0	12.0	70.0	10.50	32.16	95.3
Covering with Agryl	32.0	18.3	74.7	13.30	41.70	130.0
Covering with White net	30.7	12.3	70.7	11.10	35.20	105.0
Covering with Green net	39.7	7.3	56.7	8.13	27.40	84.0
Dusting with sulfur	36.7	9.0	69.2	9.14	30.32	115.0
Foliar spraying with Actara	36.7	7.5	66.0	8.40	28.80	116.7
Soil drench with Actara	47.3	5.7	43.9	3.30	12.90	60.7
LSD 5%	**1.64**	**1.142**	**2.03**	**0.521**	**1.615**	**7.2**
	Second season 2014					
Covering with Agryl	31.7	12.9	70.7	11.62	37.5	105.0
Covering with White net	31.3	19.3	78.7	13.60	43.20	136.0
Covering with Green net	31.0	13.0	76.2	11.50	37.58	120.0
Dusting with sulfur	46.3	8.3	57.5	8.40	28.14	100.0
Foliar spraying with Actara	37.0	10.3	70.3	9.71	32.13	130.0
Soil drench with Actara	37.0	8.5	66.3	9.20	30.40	131.3
Untreated control	48.0	6.3	44.3	4.10	15.20	72.7
LSD 5%	**1.21**	**1.173**	**2.3**	**0.410**	**1.333**	**8.4**

Table 6. Effect of some agricultural and chemical treatments on Fruit quality (physical and chemical characters) of tomato fruits during two successive seasons 2013 and 2014

Treatments	Fruit Length (cm^2)	Fruit diameter (cm^2)	Fruit firmness (kg /cm^2)	Number of locules per fruit	TSS %	juice acidity (PH)
	First season 2013					
Covering with Agryl	5.40	5.40	2.93	3.9	4.07	3.27
Covering with White net	5.73	5.90	3.0	4.0	3.93	3.24
Covering with Green net	4.96	5.13	2.80	3.6	4.04	3.29
Dusting with sulfur	4.4	4.90	2.30	4.0	3.13	3.29
Foliar spraying with Actara	5.40	5.70	2.43	4.0	3.53	3.31
Soil drench with Actara	5.3	5.43	2.80	3.4	4.0	3.29
Untreated control	4.40	4.70	2.60	3.7	3.70	3.39
LSD 5%	**0.81**	**0.99**	**0.56**	**0.80**	**0.90**	**0.107**
	Second season 2014					
Covering with Agryl	5.43	5.6	2.53	3.8	4.0	3.25
Covering with White net	5.53	5.63	2.90	3.8	3.8	3.21
Covering with Green net	5.43	5.40	2.80	4.2	4.0	3.35
Dusting with sulfur	5.20	5.40	2.70	4.0	3.2	3.31
Foliar spraying with Actara	5.70	6.20	2.83	4.1	3.33	3.34
Soil drench with Actara	5.53	5.70	2.80	3.53	3.33	3.31
Untreated control	4.53	4.53	2.70	4.03	3.93	3.36
LSD 5%	**0.54**	**0.60**	**0.34**	**0.30**	**0.70**	**0.103**

has been improved, however, tomato produced under net were firmer, had a lower acidity than tomato produced without net covering as mentioned by **Saidi, et al (2013).** These results are in agreement with that mentioned by **Helmy, et al (2012)** and **Hegab, et al (2013)**.

3. Economic study

The economic study was done to evaluate the costs price per feddan of tomato plants according to the different treatments. The differences were calculated in terms of Egyptian pounds either for the treatments on tomato with market prices. These values were presented in **Table (7).**

Data indicate that covering with white net was the most potent treatment on yield as well as total income followed by Agryl treatment compared with the other treatments during the two studied seasons. The total income for white net through the two seasons 2013 and 2014 was 34200 and 35700 L.E respectively followed by Agryl which was 28660 and 34000 L.E respectively. While the untreated control gave the lowest total incomes which was 12900 and 15200 L.E in the first and second seasons respectively.

CONCLUSION

In our investigation we can conclude that, it can protect tomato plants with covering as a safety treatment especially using white net type and this protection was important to reduce insect infection on tomato plants, the new introduced tomato leaf miner *Tuta absolute* and whitefly *Bemisia tabaci* instead of synthetic pesticides not only to obtain high yield with best quality in addition minimizing heat, wind injury on fruit setting as well as fruit quality, without negative effects on environment and human health, while, the new pest alternatives offer acceptable decreasing of pest population, preserving human health. Moreover reducing production costs and income.

Table 7. Economic study on the effect of some agricultural and chemical treatments on income per feddan for tomato plants during the two successive seasons of 2013 and 2014

Treatments	total yield (ton/ fed.)	Total income Egyptian pound Before treatments (yield*price)	Cost price of treatments per feddan (L.E) (Treatment + workers)	Total income after treatments without cost of agriculture practices	Ranking
	First season 2013				
Covering with Agryl	32.16	32160	3500	28660	2
Covering with White net	41.70	41700	7500	34200	1
Covering with Green net	35.20	35200	7500	27700	4
Dusting with sulfur	27.40	27400	1000	26400	6
Foliar spraying with Actara	30.32	30320	2000	28320	3
Soil drench with Actara	28.80	28800	2000	26800	5
Untreated control	12.90	12900	0	12900	7
	Second season 2014				
Covering with Agryl	37.50	37500	3500	34000	2
Covering with White net	43.20	43200	7500	35700	1
Covering with Green net	37.58	37580	7500	30080	4
Dusting with sulfur	28.14	28140	1000	27140	6
Foliar spraying with Actara	32.13	32130	2000	30130	3
Soil drench with Actara	30.40	30400	2000	28400	5
Untreated control	15.20	15200	0	15200	7

*****Price of sell one ton of tomato fruits during the season = 1000 L.E.

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