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Reducing sap-sucking pests infesting Eggplant using biological control agent and colored plastic soil mulches under green house

Inas M. Y. Mostafa[1], Mona I. Ammar[1], Hayam M. Saad[1] and S.M. Abolmaaty[2]

[1]*Plant Protection Research Institute, Agricultural Research Center (ARC), Dokki, Giza, Egypt.*
[2]*The Central Laboratory for Agriculture Climate, Agricultural Research Center (ARC), Dokki, Giza, Egypt.*

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ABSTRACT

Field trial was conducted during two successive seasons on 2017- 2018 and 2018 - 2019 at greenhouse experimental area, Dokki, Giza Governorate. This study aims to evaluating the efficiency of different colored mulches and biological control *Chrysoperla carnea*) (Stephens), agents well as the effect of some environmental factors on the reduction of population density of the main sap-sucking pests infesting eggplant (*Solanum melanogena* L.) and yield. The trials were used two treatments; White cover + *C. carnea* agent, Black cover + *C. carnea* agent, only colored mulches and without colored mulches or biological agent The results revealed that there are significant differences between using colored mulches with BC on population densities of some pests the whitefly, *Bemisia tabaci* (Genn.) and the spider mite, *Tetranychus urticae* (Koch). Data showed that the relationship between different treatments of management on population density of *B. tabaci* and *T. urticae* with decrease of crop yield for eggplant were highly significant effect of different treatments. These results revealed significant negative effects of maximum temperature and minimum temperature on the seasonal fluctuations of *B. tabaci* and *T. urticae* throughout in both season. While in the mean percentages of relative humidity found insignificant positive effects.

Recommendation: the paper recommendation by cover soil surface with black or white mulch and use BC to reduce population of whitefly and red mite and increase yield.

***Keywords*:** eggplant, *Solanum melanogena* L., BCG, *Chrysoperla carnea* covering soil, ecosystems, population densities, *Bemisia tabaci*, *Tetranychus urticae*, Maximum temperature, Minimum temperature, relative humidity, soil temperature and yield.

Introduction

Integrated pest management (IPM) is a systemic approach in which interacting components (mainly control measures) act together to maximize the advantages (mainly producing a profitable crop yield) and minimize the disadvantages (mainly causing risk to human and environment) of pest control programs (Fathipour and Sedaratian 2013). IPM has also been defined as a pest population management system that uses all suitable techniques in a compatible manner to reduce pest populations and maintain them at levels below those causing economic injury (Kogan 1998). A fundamental component of an IPM program for any crop is an understanding of the compatibility of control tactics that we will integrate to control a target pest. Eggplant, *Solanum melongena* L. (Solanaceae), is grown in both fields and greenhouses worldwide and is one of the main vegetables in Egypt (Khanamani *et al*. 2012). This crop is attacked by various pests including Whitefly، *Bemisia tabaci* (Genn.), and spider mites, *Tetranychus urticae* Koch the most important pest of eggplant (Yadav & Kumawat, 2013 and Mona & Rahouma 2018). *Bemisia tabaci* (Genn.), make direct and indirect damage (Berlinger, 1986). Direct damage startups by sucking plant sap from the plant foliage, while Indirect damage due to the accumulation of honeydew that is considered as a good media for sooty mold growth, vectoring of plant viruses, so a few population of these pest is sufficient to cause considerable damage to the importance crop (Francki, 1979; Cohen and Berlinger, 1986; Berlinger, 1986 ; Conte, 1998; Devasahyam, 1998; Stansly *et al*., 2004; Baiomy, 2008; Hanafy *et al*. 2014 and Mona & Rahouma 2018). Two- spotted spider mite, *Tetranychus urticae* Koch attacking a wide spectrum of economic plants, causing greet losses in their yield (Azouz, *et al*., 2014 and Mona & Rahouma 2018). Different types of mulch effect on the vegetative growth and yield of plants through

Corresponding Author: Mona I. Ammar, Plant Protection Research Institute, Agricultural Research Center (ARC), Dokki, Giza, Egypt. Email: nm.shahde@yahoo.com

effect on soil temperatures which cause positive effect on the growth and yield of plants. The influence of polyethylene mulch type on soil temperature and crop response was dependent upon film color (Lippert & Witing, 1964 and Wein & Minotti 1988, Amna *et al*., 2012 and Mona & Abolmaaty 2016), reported that plastic mulching increased total yield and shoot, compared with un-mulched plants. Concentrations of N, P, K, Ca, Mg, Cu and B an increase the soil temperature may interfere in the nutrient levels in plants. As the temperature rises, calcium and phosphorus tend to diminish while nitrogen and potassium tend to increase, as well as the growth or the aerial part of the plant (Teasdale and Abdul-bakla, 1995). In vegetable agro-ecosystems, there are several native parasitoids and predators that can be effective in the control of crop pests (Nicoli and Burgio, 1997). The multi-use of natural enemies has showed an increase in their efficacies for controlling specific pests and for reducing the risk of virus infection (Perdikis *et al*., 2008). To produce healthy vegetables and fruits must be free from insecticide to avoid human being health problems and also produce a save product. The present work was carried out as an attempt to suggest certain integrated pest management (IPM)' tools to control insect' pests on eggplant plant. The present study aims to evaluating the efficiency of two different colors of mulches, multi-use of natural enemies and some environmental factors on reduction of population density to the main sap-sucking pests infesting eggplant crop in greenhouse conditions in Egypt.

Material and Methods

Green houses

The experiments were carried out at the greenhouse experimental area in Dokki, Giza, Egypt, using two commercial plastic greenhouses 640 m2 (16 m × 40 m each). Eggplant seedlings were transplanted at October 15, 2017 and October 15, 2018 in the greenhouse as winter plantation, by 1000 eggplant (*Solanum melanogena* L.) plants. Eggplant crop was weighted during harvesting period. In the first greenhouse covered 5 rows with black mulch cover and 5 rows covered with white mulch cover for preventing the growing of weeds and releasing biological control agents (BC *Chrysoperla carnea* (Stephens). In the second greenhouse 3 rows were covered with black mulch cover and 3 rows covered with white mulch cover as a control treatment also, 4 rows was left free from any application. Daily data of minimum, maximum temperatures and relative humidity (R.H %) and soil temp were obtained from the Central Laboratory for Agriculture Climate (CLAC), Dokki, Giza, Egypt.

Sampling technique:

Population densities of the targeted pests; *B. tabaci* and *T. urticae* were estimated weekly throughout the plant growing season (14 weeks). After three weeks for cultivation, chosen 25 random leaves at each treatments, was counted at three levels of the plant (top, middle and lower), using one square inch lens. In BCG, timing, number and rate of releases of biocontrol agent /release were determined according to the weekly average numbers of pests / plant. Five releases were done. Data were statistically analyzed using two ways ANOVA. data were statistically analyzed by correlation analysis between weather parameters and pests population. Reduction percentage in yield was calculated according to Henderson and Tilton equation (1955).

The total numbers were registered and the mean were calculated number of different pests on eggplant to study the effect of Maximum temperature, Minimum temp. ,Mean relative humidity (R.H %) and soil temp population dynamics of these pests, the correlation (r) and the partial regression (b) were calculated between each of the above mentioned factors (Xs) and the weekly mean numbers of these pests.

Analysis of variance (ANOVA) was performed on infesting pests and yield variables (SAS, 1999) and appropriate error terms for the F tests of interactions were calculated separately. Comparisons of means were performed using the Duncan's multiple range test (= 0.05).

Results and Discussion

Effect of different treatments: White cover with *C. carnea*, Black cover with *C. carnea*, colored mulches covers and without mulches covers on targeted pests; *Bemisia tabaci* (Genn.) and

spider mite, *Tetranychus urticae* (Koch) infesting eggplant are presented in Tables (1 and 2) and Figs. (1 and 2) during two successive seasons 2017-2018 and 2018- 2019, respectively. Results of statistical analysis revealed that there are significant differences between using (colored mulches with *C. carnea* agent vs the population densities of whitefly, *B. tabaci* and *T. urticae* during the two tested seasons, whereas F value = 19.2*** and L.S.D. = 12.5 individuals/300 leaves in first season and in the second season F value = 28.44*** and L.S.D. = 17.15 individuals/300 leaves, Whitefly, *Bemisia tabaci*.

Data in Tables (1 and 2) revealed that White cover with *C. carnea* agent and Black cover with *C. carnea* agent , were the most superior treatment in low infestation with immature stages of whitefly (nymphs) during two successive seasons followed by mulches only without biological agent , the last one was the free treatment without covers or biological agent that recorded the highest mean number in both seasons. These treatments white and black colors mulch and use *C. carnea* showing highly mortality 72%, 68% and 77%, 70% and Followed by third treatment using mulch only showing moderate effect 51 % and 49%, in two seasons, respectively. (Compared with control without any application found 1504 and 2100 individuals/300 leaves).

Red mite, *Tetranychus urticae*

Also, Tables (1 and 2) show that white and black colors mulch with using *C. carnea* agent were the most superior treatment in low infestation with immature stages of red mite during two successive seasons followed by mulch only and control without mulch which recorded the highest mean number in both seasons. These treatments the black and the white colors mulches covers and using *C. carnea* agent showing highly mortality 61%, 64% and 60%, 58% and followed by third treatment using mulch only showing moderate effect 49% and 45% in two seasons, respectively. (Compared with control without any application found 2320 and 1970 individuals/300 leaves).

Table 1: Effect of different treatments on reduction of some pests infesting eggplant and total yield in greenhouse - during 2017-2018 season - Giza Governorate.

Mulch color	Reduction % of White fly Nymph.	Reduction % of Red spider Immature stage	Mean	Total yield (Kg)
White cover + *C. carnea* agent	72	61	66 a	4687
Black cover + *C. carnea* agent	68	64	66 a	4790
Control only color mulch	51	49	50 b	3982
Control without color mulch	1504	2320	1912	1842

F value between treatments = 19.2*** sig. at 0.0001 L.S.D. = 12.5 individuals/300 leaves.

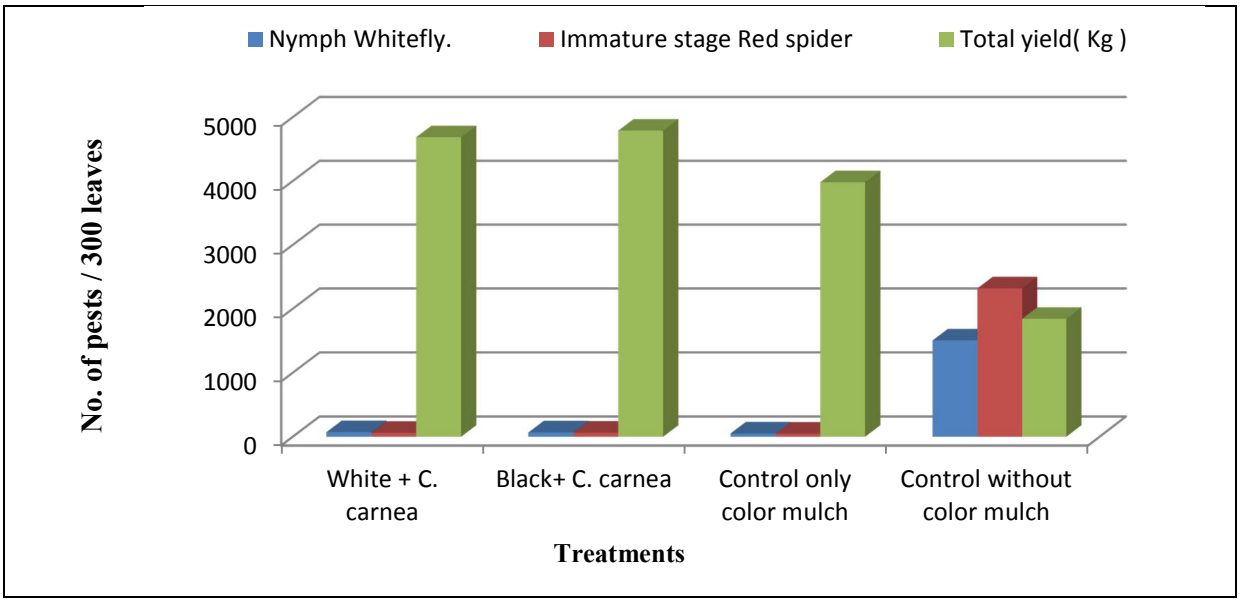

Fig. 1: Mean impact of treatments on weekly mean number of some pests infesting eggplant and weight yield during 2017 -2018 in greenhouse el - Giza Governorate.

Table 2: Effect of different treatments on reduction of some pests infesting eggplant and total yield in greenhouse during 2018-2019 season - Giza Governorate.

Mulch color	Reduction % of Whitefly	Reduction % Of Red spider	Mean	Total yield (Kg)
	Nymph.	Immature stage		
White cover+ *C. carnea* agent	77	60	68 a	4888
Black cover + *C. carnea* agent	70	58	64 a	4711
Control only color mulch	49	45	47 b	3512
Control without color mulch	2100	1970	2035	1780

F value between treatments = 28.44*** sig. at 0.0001 L.S.D. = 17.15 individuals/300 leaves.

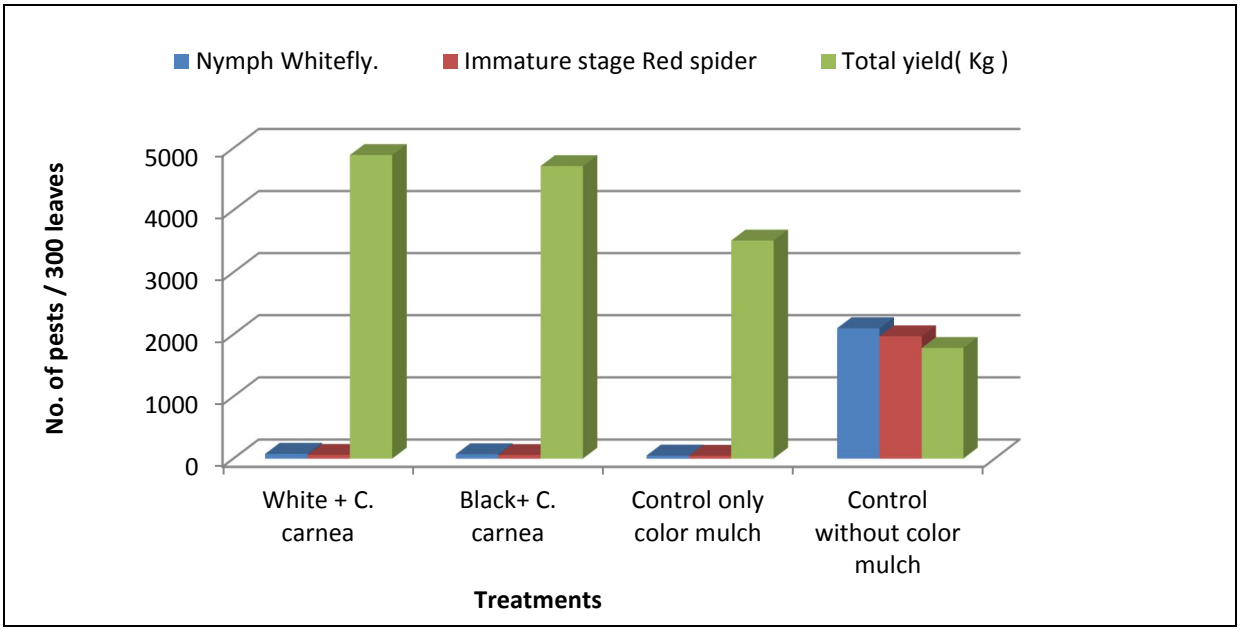

Fig. 2: Mean impact of treatments on weekly mean number of pests infesting eggplant and weight yield during 2018&2019 at Giza Governorate.

The treatments-yield relationship:

The effect of different treatments of management of pests were recorded in both seasons 2017-2018 and 2018-2019 reflection on eggplant total yield was presented in Tables (1 and 2) and Figs. (1 and 2) for the two successive seasons. Referring the effect using different treatments of management was high significantly between pests population and weight yield.

Data in Table (3) showed that the relationship between different treatments of management on population density of *B. tabaci* and *T. urticae* with decrease of crop yield for eggplant were highly significant effect of different treatments (white colors mulch, use *C. carnea*, black colors mulch and use *C. carnea,* colors mulch use only and control without any applications in two seasons.

Table 3: Correlation and partial regression values of the yield and some pests and corresponding percentages of explained variance on eggplant plants at Giza Governorate during two seasons, 2017-2018 and 2018-2019 in greenhouse.

Year	2017-2018				2018-2019			
Treatments	**White + *C. arnea***	**Black + *C. carnea***	**only color mulch**	**without color mulch**	**White + *C. arnea***	**Black + *C. arnea***	**only color mulch**	**without color mulch**
Correlation (r)	-0.835*	-0.779*	-0.677*	-0.354 insig.	-0.828*	-0.811*	-0.512*	-0.301 insig.
Partial regression (b)	-0.033	-0.043	-1.09	-3.14	-0.030	-0.032	-2.87	-7.00
F value	3.53*	7.18*	2.55 insig.	0.41 insig.	5.22*	6.65*	1.90 insig.	0.33 insig.
E.V	87	80	56	10	88	82	50	8

r= Correspondent correlations, b = Partial regression, E.V = Explained Variance

In the first season, whereas "r" values were -0.835, -0.779, -0.677 and -0.354 , while "b" values were -0.03 Kg, -0.04 Kg , -1.09 kg, and -3.14 Kg with mean of both seasons, respectively. These values of (E.V%) indicated that the different treatments were responsible percentage for 87%,80%,56% and 10% in the average weight. In the second season, whereas "r" values were -0.828, -0.811, -0.512 and -0.301 , while "b" values were -0.03 Kg, -0.03 Kg , -2.78 kg, and -7.00 Kg with mean of both seasons, respectively. These values of (E.V%) indicated that the different treatments were responsible percentage for 88%,82%,50% and 8% in the average weight.

The combined effect of some weather factors:

In both greenhouses, weekly accumulated means of maximum, minimum temperatures and relative humidity ranged (27.37–29.22˚C) for maximum, (15.29–16.44˚C) for minimum temperatures showed significant negative effects (r = -0.863, 0.004 and -0.715, 0.016) in first season and in second season found (r = -0.714, 0.01 and -0.611, 0.05) with whitefly and red mite populations in different treatments(white colors mulch, use *C. carnea*, black colors mulch and use *C. carnea,* colors mulch use only and control without any applications), respectively. Correspondent correlations with the minimum temperature were (r = -0.765, 0.02 and -0.701, 0.04) in first season and in second season found (r = -0.717, 0.04, and -0.848, -0.01) mean relative humidity (52.6-60.7%) showed insignificant positive effects (r = 0.513, 0.07 and 0.315, 0. 17) in first season and in second season found (r = 0.256, 0.91 and 0.211, 0.85) with whitefly and red mite populations in different treatments.

These results were in line with those obtained by (Lippert & Witing, 1964; Wein & Minotti. 1987; Teasdale & Abdul-bakla, 1995; Lamont 1993; Tagliavini *et al* . 1991; McMichael & Burke 1998 , Abdrabbo *et al* 2009 , Moses Mutetwa & Tuarira Mtaita.2014, Mona & Abolmaaty 2016 and Mona & Rahouma 2018).

Conclusion

The colored mulches and biological control agent using to grown eggplant in winter season has a significant effect on the growth and yield. The mulch colors and (BC) have effect on pests population whereas decreased mean number of pests.

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