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Evaluation of reflective silver plastic mulch on controlling whitefly and associated disease incidence on tomato crop

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Abstract
The present study was conducted to study the effect of reflective silver plastic mulch in reducing whitefly population and virus disease on tomato. The experiment was conducted at Vegetable Research Centre (VRC), G. B. Pant University of Agriculture during 2018-19. The result revealed that the reflective silver plastic mulch had significantly lowered the numbers of whitefly eggs (ranged 0.60-2.60/cm^2 leaf), nymphs (ranged 0.00-2.20/cm^2 leaf), and adults (ranged 0.40-3.20/ 3 leaves) as compared to the control 1.80- 8.20 egg/cm^2 leaf, 0.80-6.60 nymph/cm^2 leaf and 1.40-6.40 adults/ 3 leaves. The mulch can be successfully used in reducing the disease incidence in the crop. Results from the present investigation suggests that reflective silver mulch help in suppression of whitefly population which leads to reducing the associated disease incidence of tomato which ultimately increase the yield of tomato.

Keywords: Whitefly, *aphis gossypii* glover, *frankliniella schultzei* rybom

Introduction
Tomato (*Solanum lycopersicum* Mill.) belonging to the family Solanaceae, is the most widely consumed vegetable crop as it is the major source of vitamins and minerals. It is most popular and extensively grown vegetable throughout the world as well as in India, ranking as the second most important vegetable crop which is cultivated in almost all parts of the country [1]. Tomato growers regularly experience economic losses due to the damage caused by different insect pests such as whitefly (*Bemisia tabaci* Gennadius), aphid (*Aphis gossypii* Glover), fruit borer (*Helicoverpa armigera* Hubner) and thrips (*Frankliniella schultzei* Rybom). Among these insects species, whitefly is considered as the major threat to the tomato crop, as it causes direct damage by sucking the sap from plant which leads to the formation of distorted young leaves and inflicts indirect damage due to the release of honeydew, which induces the growth of sooty mold on leaves resulting in reduced photosynthesis rate [2, 3]. It also serves as a vector for the transmission of *Yellow Leaf Curl Virus* [4]. Tomato growers heavily rely on insecticides used for controlling whitefly population with high application frequency [5]. Such repeated and indiscriminate use of chemical pesticides can induce resistance development against the used insecticide which may further cause pest resurgence due to development of a new biotypes [6-9]. Excessive use of chemical pesticides also poses a threat to beneficial insects and human health due to residual effects which further pollutes the ecosystem. To limit the use of insecticides, integrated techniques should be considered by using the pesticides in rotation as well as in combination with cultural practices.
However, several studies have demonstrated the effective use of reflective plastic mulch and organic mulch in controlling aphids, thrips and whitefly populations. The reflection of UV light by the mulch deters the pests from landing on the plants during host searching [10]. Silver or gray reflective mulches have successfully reduced the incidence of whitefly and whiteflies have borne virus diseases in zucchini squash [11]. Several other advantages of mulches include weed control, soil moisture maintenance and yield improvement [12]. The objective of this study was to estimate the effectiveness of silver plastic mulch for the management of whitefly and whitefly borne virus in tomato under field conditions.

Materials and Methods

Experimental site and Experiment details

The present investigation was conducted to study the effect of reflective silver plastic mulch on whitefly population dynamics and disease incidence on tomato crop at Vegetable Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar (29.5°N latitude, 79.30°E longitude) during *kharif* crop season of 2018-19. Tomato seedlings (Heem Sonha) were transplanted in September with a plot size of 12 m^2 (4 m × 3 m). The entire standard agronomic practices were followed and the experiment was laid with two treatments and five replications, which were separated from each other by a distance of 2.0 m.

Estimation of whitefly population and disease incidence

The population of whitefly was recorded at 15, 30, 45 and 60 days after transplanting on 10 randomly selected plants of each treatment (three leaves/plant) during early morning hours. Eggs and nymphs were counted by gently turning the leaves with the help of a 10X hand lens [13]. The disease incidence was recorded after the first appearance of symptoms and percent incidence was calculated by dividing the number of infected plants by the total number of plants in each treatment.

Statistical analysis

Paired t-test was used to analyze and compare the mean number of whitefly and disease incidence on reflective plastic mulch and control. All statistical evaluations were performed by SPSS (Version 20, SPSS, Inc. Chicago, II, USA).

Results

At all the sampling dates there were significant differences between the numbers of eggs, nymphs and adults in the reflective plastic mulch plot as compared to the control (Table 1). The results of *t*-test revealed that there were significant differences between the number of eggs in controls and reflective plastic mulch plot after 15 DAT (t = 3.20; p = 0.03), 30 DAT (t = 4.47; p = 0.01), 45 DAT (t = 3.53; p = 0.02) and 60 DAT (t = 5.18; p = 0.00), respectively (Table 1 and fig. 1). At 15 days after transplanting, in the case of reflective plastic mulch, the number of mean eggs per cm^2 leaf was found to be 0.60±0.24 while in control it was found to be 1.80±0.37. However at 30 days after transplanting mean numbers of egg found in reflective plastic mulch was 1.20±0.38 which was lower than control i.e. 3.20±0.38 eggs. At 45 days after transplanting, mean number of eggs was found to be 2.20±0.37 in the plot covered with plastic mulch and 4.60±0.51, without mulch (control). At 60 days after transplanting, maximum number of eggs per cm^2 of leaf was found in control (8.20±0.86 eggs) while mulched plot had 2.60±0.40 eggs per cm^2.

Data on nymphs per cm^2 of leaf in controls and reflective plastic mulch plot revealed that at 15 days after transplanting the readings were found non-significantly different (t = 2.13; p = 0.99) from others on the basis of t-test while significantly differ on 30 DAT (t = 3.13; p = 0.03), 45 DAT (t = 3.16; p = 0.03) and 60 DAT (t = 4.74; p = 0.00), respectively. The average number of nymphs per cm^2 of leaf in reflective silver plastic mulch ranged from 0.00±0.00 to 2.20±0.37 while in control population ranged from 0.80±0.37 to 6.60±0.87 in 15 and 60 days, respectively. The results of t-test on adult whitefly population showed that there was significant difference between controls and reflective plastic mulch plot after 15 days (t = 3.16; p = 0.03; 30 DAT (t = 3.50; p = 0.02); 45 DAT (t = 2.99; p = 0.04) and 60 DAT (t = 4.35; p = 0.01). The counted number of nymph per 3 leaves was 0.40±0.24 in reflective plastic mulch at 15 days after transplanting while in control mean population it was 1.40±0.25. The mean adult population of whitefly per 3 leaves on mulched plot 30 days after transplanting was 1.20±0.25 while higher population was found in control (2.60±0.68). The average population at 45 days after transplanting on reflective silver plastic mulch was 2.20±0.37 while in control average whitefly per 3 leaves was 5.40±0.93. At 60 days after transplanting average population found were 3.20±0.49 and 6.40±1.08 on reflective silver plastic mulch and control respectively.

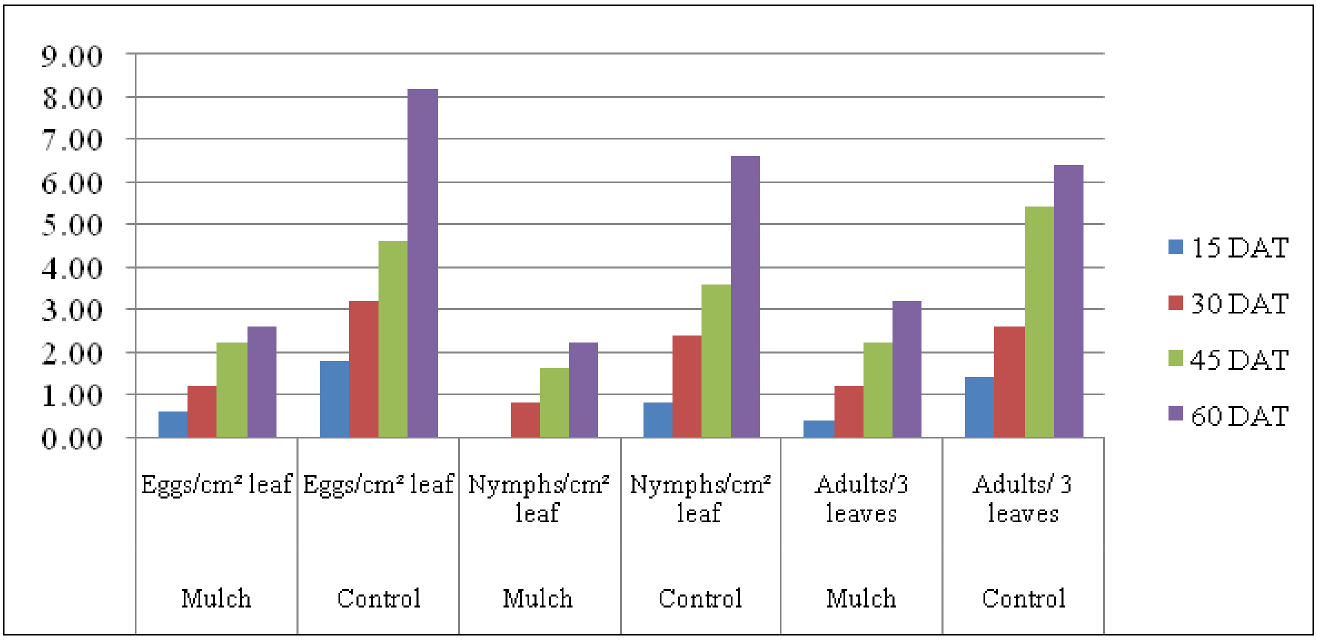

Fig 1: Mean numbers of whitefly eggs, nymphs, and adults (±SEM) in reflective silver mulch and control during 2018-19

Table 1: Mean numbers of whitefly eggs, nymphs, and adults (±SEM) in reflective silver mulch and control during 2018-19

Observation day after transplanting	Eggs per 1 cm^2 leaf		t value	p value	Nymphs per 1 cm^2 leaf		t value	p value	Adults / 3 leaves		t value	p value
	Reflective silver plastic	Control			Reflective silver plastic	control			Reflective silver plastic	control		
15 (DAT)	0.60±0.24	1.80±0.37	3.20	0.03	0.00±0.00	0.80±0.37	2.13	0.99	0.40±0.24	1.40±0.25	3.16	0.03
30 (DAT)	1.20±0.38	3.20±0.58	4.47	0.01	0.80±0.20	2.40±0.51	3.13	0.03	1.20±0.25	2.60±0.68	3.50	0.02
45 (DAT)	2.20±0.37	4.60±0.51	3.53	0.02	1.60±0.40	3.60±0.40	3.16	0.03	2.20±0.37	5.40±0.93	2.99	0.04
60 (DAT)	2.60±0.40	8.20±0.86	5.19	0.00	2.20±0.37	6.60±0.87	4.74	0.00	3.20±0.49	6.40±1.08	4.35	0.01

The data presented in Table 2, fig. 2 showed that per cent incidence of viral disease between the reflective silver mulch and control as per paired t- test study was found significantly different at 30 (*t* = 4.48; *p*= 0.01), 45 (*t* = 4.20; *p* = 0.01) and 60 (*t* = 5.24; *p* = 0.00) days while no difference was found at 15 days after transplanting. At 15 days after transplanting there was no incidence found in control as well in the mulched plot but at 30 days after transplanting incidence in reflective plastic mulch were 7.72 while in control incidence was 18.63 per cent. The mean per cent incidence at 45 days after transplanting in mulched plot and control was 17.28 and 30.00, respectively. T he highest incidence was found at 60 days after transplanting in which it was observed that 27.27 per cent incidence was in the mulched plot while 39.55 per cent was in control.

Table 2: Percent incidence of viral disease in reflective silver mulch and control during 2018-19

Observation (Days after transplanting)	Reflective silver plastic	control	T value	P value
15 (DAT)	0.00 (0.00)	0.00 (0.00)	-	-
30 (DAT)	7.72 (16. 14)	18.63(25.58)	4.48	0.01
45 (DAT)	17.28 (24.56)	30.00 (33.21)	4.20	0.01
60 (DAT)	27.27 (31.48)	39.55 (38.97)	5.24	0.06

Parentheses are Arcsine transformed values

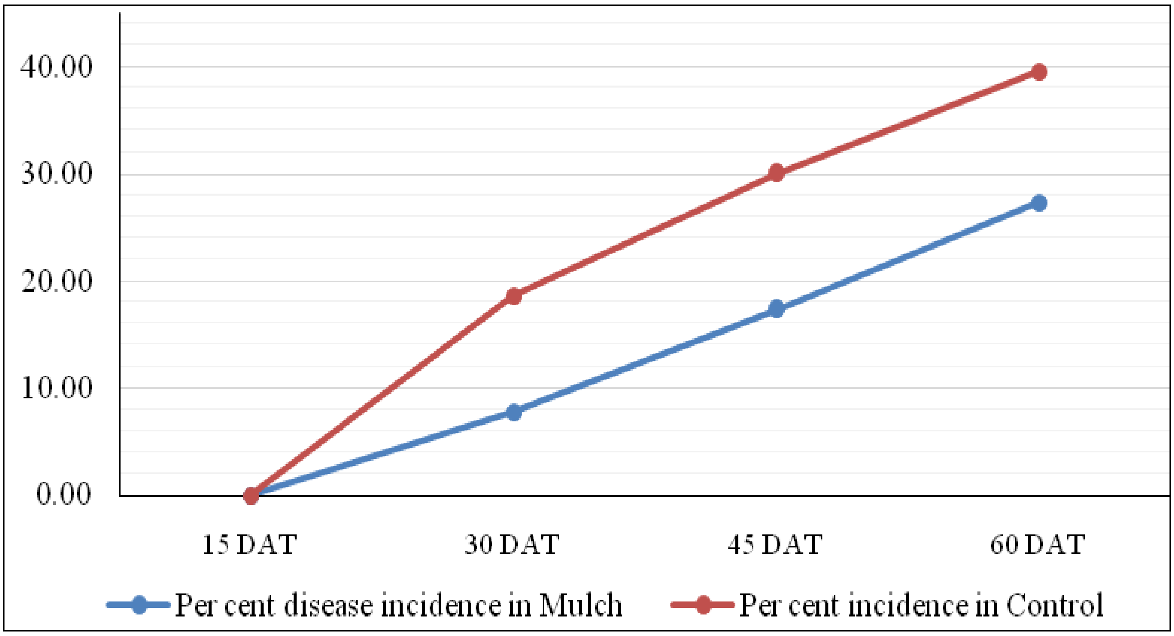

Fig 2: Percent incidence of viral disease in reflective silver mulch and control during 2018-19

Discussion

The present investigation clearly showed the effectiveness of silver reflective mulches in limiting whitefly eggs, nymphs and adults. This finding is supported by [14-17]. This is probably due to the insect-repellent characteristic of silver reflective metalized mulch. Similarly the lower incidence of viral diseases was observed in silver reflective mulch plot as compared to the control which is under the findings of [18, 19]. The significantly lower incidence of viral diseases on mulch plots was due to the minimum density of vectors. Silver reflective mulches also manipulated the microclimate (soil temperature and humidity) and reduce the weeds population which ultimately affects the whitefly population buildup in tomato crop. Besides causing direct economic loss by feeding, whiteflies also transmit virus and accelerates the economic loss further. Yet another biotic competition for the tomato crop production is by the weeds. Mulching is proved to be an effective integrative and alternative tool for the management of two important menace *viz*., whiteflies and weeds.

Conclusion

The present investigation revealed that the use of silver reflective mulch reduces the whitefly and whitefly borne diseases because mulch act as insect-repellant, soil-microclimate modifier, and have photo biologically effects so, we can use the reflective mulches in the glasshouse as well as field condition. In times of concerns for environmental protection, global warming, a definite replacement of insecticides is need of the hour. Mulch can be effectively used in Integrated Pest Management, as it reduces or eliminate the need for insecticide applications. Hence, these cultural methods when combined with other management practices help in containing the disease through vector control.

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