Journal of Phytopathology and Pest Management

eISSN: 2356-6507

Volume (1), Issue (1)

2014

Impact of the Pirimicarb resistance on the ability of the cotton aphids, *Aphis gossypii* Glover (Homoptera: Aphididae) in transmitting plant viruses

M. M. A. Rizk, Y. A. Darwish*, S. A. Eraky and A. H. A. Atta

Plant Protection Dept., Faculty of Agriculture, Assiut University, 71526 Assiut, Egypt

Abstract

The present investigation was conducted to identify the relationship between pirimicarb resistance in Aphis gossypii Glover and its transmitting cucumber mosaic virus (CMV) potency to squash plants. Data showed that the percent of plants infested by mosaic virus transmitted by the dark colored form of cotton aphids, commonly, were higher than that inoculated by the light colored form. In the baseline of the Assiut aphid colony, virus infestation % caused by light and dark colored forms were 46.3 and 55.5 %, respectively, whereas, the infestation percentages of light and dark colored forms after one year of pirimicarb selection were 65.1 and 94.3 %, respectively. Data of light and dark colored forms of the New Valley aphid colony, gave the same trend of the Assiut aphid colony. The percent of plants infested by mosaic virus transmitted by the dark colored form of cotton aphid were higher than that inoculated by the light colored form. In the baseline of the Assiut aphid colony, virus inoculation periods in case of light and dark colored forms were 23.0 and 11.0 days, respectively, and after a one year of Pirimicarb selection were 15.0 and 7.5 days, respectively. In the baseline of the New Valley aphid colony, virus inoculation periods in case of light and dark colored forms were 25.00 and 13.00 days, respectively, and after one year of Pirimicarb selection were 16.40 and 12.00 days, respectively. The inoculation period of mosaic virus transmitted by the dark colored form of cotton aphids, commonly, was shorter than that of the light colored form. In the present study, it was found that 64% of the differences in plant virus infestation were due to the level of pirimicarb resistant value. This finding may be attributed to the inoculation period, which has a negative correlation with the pirimicarb resistance level. The coefficient of determination indicates that 70% of the variability in the inoculation period is due to pirimicarb resistance level. Our studies lead to the fact that the presence of the dark colored form of cotton aphid in the normal conditions is an alarm telling us that the aphid colony is going toward insecticide resistance subsequently, spread out plant virus diseases. Therefore, farmers must pay attention to the integrated pest management programs, and ration out the use of pesticides to avoid the appearance of resistant strains (dark colored forms).

Key words: carbamates, colored morphs, insecticide selection, IPM program

Introduction

Cotton aphid, *Aphis gossypii* Glover is a polyphagous pest causing severe damage to cucurbitaceous crops. Both nymphs and adults suck sap from the lower surface of the leaves and from the shoots resulting in reducing fruit yield. Although, aphid is a secondary pest of cotton, it is now causing a major problem for growers in many countries. Problems associated with aphid with Egyptian cotton include yield reductions due to the large early season infestations and the effects of honeydew on fiber quality at late season infestations, as well as transmission of virus diseases to cotton and other economic plants. Resistance to insecticides was found in at least 20 species of aphids, including *A. gossypii* (Georghiou, 1981).

* **Corresponding author:** yousefdarwish11@yahoo.com

Resistance of *A. gossypii* to carbamates was first reported by Kung et al. (1964) and found to be associated with some morphological and physiological characteristics. With the extensive use of Pirimicarb for aphid control, the reproductive capacity increased up to 30% as compared with that of the control (Rongai et al., 1998). The body of the apterous parthenogenetic is quite variable in color, light green mottled with dark green in most common, but also occurring a whitish red, yellow, pale green, and dark green colored forms (Capinera, 2001). In North America, red morphs existed on tobacco plants were more resistant to organophosphorus insecticides than the green morphs (Harlow & Lampert, 1990). The red form of the tobacco aphid was also observed as far back as 1985 in North Carolina, USA (Harlow & Lampert, 1990) and appeared to be a more serious pest than the green form. The sudden shift from the green morph to the red morph is common as reported in insecticide resistance data (Masukwedza et al., 2013). The present investigations were carried out to determine the relationship between insecticide resistance in *A. gossypii* and its efficiency in transmitting cucumber mosaic virus (CMV) to squash plants.

Materials and methods

Maintenance of aphids: Two populations of *A. gossypii* were collected from cucurbitaceous plants grown in Assiut and the New Valley Governorates. These two groups were brought into the laboratory at the Plant Protection Department, Faculty of Agriculture, Assiut University and used as a base line of Pirimicarb resistance.

Insecticide Selection: Pirimicarb LC_{50} baseline was determined by the dipping technique in successive concentrations of the trade form of Pirimicarb in water; (150, 200, 300, 500, 750, and 1000 ppm). The LC_{25} was monthly used for the selection throughout a year. The insecticide selection was stopped whenever the aphid population seemed to be in stress. This procedure resulted in four groups of aphids for each Governorate; light and dark of both the baseline and Pirimicarb selected aphids (Plate 1).

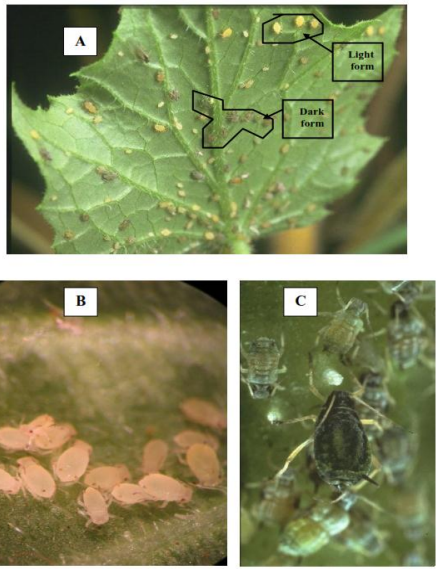

Plate 1: Cotton aphid *Aphis gossypii* Glover: A, mixed colored form; B, light colored form C; dark colored form.

Maintenance of virus: Squash leave samples, naturally infected with cucumber mosaic virus (CMV) were collected and maintained at the same laboratory. For transmitting and identifying CMV, mechanical inoculations were carried out by extracting squash tissues infected with CMV in 0.1 M phosphate buffer, pH 7.0 containing 1.0% sodium sulphite (1:2W/V).

The contaminated sap was applied to the healthy *Cucurbita pepo (*zucchini squash) cv. eskandarani, *Gamphorina globosa* and *Phaseolus vulgais*. The procedures used in the present investigation are essentially similar to those described by Fattooh, (2003); Dheepa and Paranjothi, (2010) with slight modifications. The leaves of the inoculated plants were previously dusted with carborandum granules (400 meshes). For control treatment carborandum dusted leaves were inoculated with only phosphate buffer. Inoculated plants were kept in the greenhouse at 25-30ºC for 30 days and were inspected daily for symptom development.

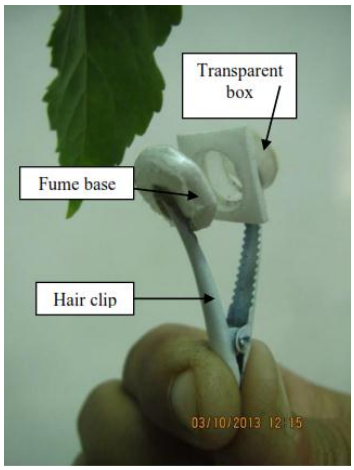

Plate 2: Small cage for maintaining aphids on its natural host.

Aphid transmission: After a year of Pirimicarb selection, individuals of the four groups of *A. gossypii*, light and dark colored forms of baseline and Pirimicarb selected aphids of both Assiut and New Valley Governorates were reared on healthy Squash seedlings. The above mentioned aphids were starved for two hours, then allowed to feed for 20 min. (acquisition period) on infested plants. After that the aphids were transferred separately in cages (plate 2) to healthy *Cucurbita pepo* (zucchini squash) cv. eskandarani, and allowed to feed for 10-15 min. (inoculation period), then removed. The plants were left in insect proof cage (Plate 3), and inspected daily for symptom development.

Plate 3: Insect proof cages and detached virus infected leaves.

Statistical analysis: Obtained data were subjected to Probit analysis, F-test, LSD and correlation by means of Advanced Statistical Analysis Package (ASAP)®.

Results

Incidence of mosaic virus transmitted by Pirimicarb selected *A. gossypii*: Data presented in Table (1)) show that the percent of plants infested by mosaic virus transmitted by the dark form of cotton aphids, commonly, were higher than that inoculated by the light form. In the baseline of the Assiut aphid colony, virus infestation (%) caused by light and dark forms were 46.30 and 55.50 respectively, whereas the infestation percentages of light and dark colored forms after one year of pirimicarb selection were 65.10 and 94.30, respectively. Data of light and dark colored forms of the New Valley aphid colony showed the same

trend of Assiut aphids. These data indicate that the percent of plants infested with mosaic virus transmitted by the dark form of cotton aphid were higher than that inoculated by the light form. In the baseline aphid colony, virus infestation (%) caused by light and dark forms were 40.00 and 47.60, respectively, whereas the infestation percentages of light and dark colored forms after one year of pirimicarb selection were 57.50 and 83.75, respectively .

The statistical analysis indicated that the differences between these four different colored forms of Assiut and New Valley were highly significant.

Inoculation period of the mosaic virus infestation transmitted by Pirimicarb selected *A. gossypii*: The data shown in Table (1) demonstrated that the inoculation period of mosaic virus transmitted by the dark form of cotton aphid generally was shorter than that inoculated by the light form. In the baseline of the Assiut aphid colony, virus inoculation periods in case of light and dark forms were 23.00 and 11.00 days, respectively, whereas in case of light and dark colored forms after one year of pirimicarb selection were 15.00 and 7.50 days, respectively. The statistical analyses indicated that the differences between them were highly significant. Data of light and dark colored forms of the New Valley aphid colony shows that the inoculation periods of the mosaic virus transmitted by the dark form of cotton aphid was shorter than that inoculated by the light form. In the baseline aphid colony, the inoculation periods caused by light and dark forms were 25.00 and 13.50, respectively, whereas, the infestation percentages of light and dark colored forms after one year of pirimicarb selection were 16.40 and 12.00, respectively. The statistical analysis indicated that the differences between them were highly significant.

Table 1: Relationship between pirimicarb resistance in *Aphis gossypii* Glover and its efficiency in transmitting cucumber mosaic virus (CMV) to squash plants.

Location	Aphid group	Color Form	LC_{50} ppm	Infection %	Inoculation period (days)
Assiut	Base line	light	379.94	46.30	23.00
		Dark	437.50	55.50	11.00
	1 year selection	light	473.85	65.10	15.00
		Dark	482.22	94.30	7.50
New Valley	Base line	light	328.47	40.00	25.00
		Dark	398.09	47.60	13.50
	1 year selection	light	379.94	57.50	16.40
		Dark	437.50	83.75	12.00
Correlation co-efficient between LC_{50} and virus parameters (r)				0.797	-0.838
Co-efficient of determinations (r^2)				0.635	0.702
F- value				24.9**	24.97**
LSD				4.88	3.04

** means that probability of chance (p. value) is less than 0.01

Discussion

Many investigators studied the effects of insecticide resistance on the biological and physiological characteristics of aphids and other insects, (Georghiou, 1981; Rongai et al., 1998; Harlow & Lampert, 1990; Capinera, 2001; Masukwedza et al., 2013). Available review hasn't any research concerning insecticide resistant insects in relation to their ability in transmitting plant viruses. Table (1) shows that the positive correlation between LC_{50}'s and the percent of infested plants was significant (r=0.8). This indicates that the more cotton aphid pirimicarb resistant, the more ability to transmit plant virus. The statistical analysis exhibited that the coefficient of determination was found to be 0.64. This means that 64% of the differences in plant virus infestation are due to the level of pirimicarb resistant value. This may be attributed to the inoculation period, which has a negative correlation (r=-0.838**) with the pirimicarb resistance level, thus the more resistance level, the less inoculated period. The coefficient of determination was represented by 0.70 indicating that 70% of the variability in the inoculation period is due to pirimicarb resistance level. Our studies lead to the fact that the presence of the dark form of cotton aphid in the normal conditions is an alarm telling us that the aphid colony is going toward insecticide resistance subsequently; it will be more able to spread plant virus diseases. Therefore, farmers should pay attention to the integrated pest management programs; including chemical control in rationing methods to avoid the appearance of resistant strains (dark forms). Moreover, the frequency of dark colored form in cotton aphid population indicates how much this population is resistant to pirimicarb subsequently, its ability to transmit the plant viruses. Additional studies must be carried out on different aphid species selected by different insecticide groups in relation to the morphological and physiological aspects of aphids. These studies will be fruitful in following up insect resistant to insecticides by simple and quick procedure.

References

Capinera JH, 2001. Hand book of vegetable pest. Academic Press, San Diago. 729 pp.

Dheepa R, Paranjothi S, 2010. Transmission of cucumber mosaic virus (CMV) infecting banana by aphid and mechanical methods. Emirates Journal of Food and Agriculture **22**, 117-129.

Ezzeldin HA, 1997. Insecticide resistance in the green peach aphid, *Myzus persicae* (Sluzer),[Ph.D Thesis] Fac. Agric., Assiut Univ., Assiut, Egypt. 169 pp.

Fattouh Faiza A, 2003. Double infection of a Cucurbit Host by Zucchini Yellow Mosaic Virus and Cucumber Mosaic Virus. Plant Pathology Journal **2**, 85-90.

Georghiou GP, 1981, The occurrence of resistance to pesticide in arthuropods: an index of cases reported through 1980. FAO Plant Production and Protection Series. Rome, 192 pp.

Harlow CD, Lampert EP. 1990. Resistance mechanisms in two color forms of the tobacco aphid (*Homoptera: Aphididae*). Journal of Economic Entomology **83**, 2130-2135.

Kung KY, Chang KL, Chai KY, 1964, Detecting and measuring the resistance

of cotton aphids to systox. Acta Entomologica Sinica **13**, 1-9.

Masukwedza R, Mazarura U, Chinwada P, Dimbi S, 2013. The Response of red morph of the tobacco aphid, *Myzus persicae Nicotianae* ,to insecticide applied under laboratory and field conditions". Asian Journal of Agriculture and Rural Development **3**, 141-147.

Rongai D, Cerato C, Martelli R, Ghedini R, 1998. Aspects of insecticide resistance and reproductive biology of *Aphis gossypii* Glover on seed potatoes. Potato Research **41**, 29-37.