Pakistan Entomologist

Journal homepage: www.pakentomol.com

ASSESSMENT OF WHITEFLY MORTALITY AND DECREASE IN YELLOW MOSAIC DISEASE SEVERITY BY USING INSECTICIDES WITH DIFFERENT MODES OF ACTION

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ARTICLE INFORMATION

Received: January 27, 2017
Received in revised form: June 10, 2017
Accepted: June 15, 2017

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ABSTRACT

Whitefly transmitted mungbean yellow mosaic virus disease (MYMVD) causes severe qualitative and quantitative losses to mungbean crop. Due to lack of genetic resistance in the available germplasm, insecticides from different groups were tested against whitefly and their effect was assessed on disease severity. All the insecticides significantly reduced whitefly infestation and consequently the disease severity as compared to untreated control. Acetamiprid was the most effective causing whitefly mortality (69.69%) and ultimately decreasing the disease severity followed by methomyl (62.69%), methamidophos (58.89%), fenpropathrin (54.76%), endosulfan (53.81%) and buprofezin (40.28%) respectively. As the new chemistry insecticide (acetamiprid) creates less environmental concerns that should be used against the whitefly.

Keywords: Assessment, Efficacy, Insecticides, Whitefly, Infestation

INTRODUCTION

Mungbean yellow mosaic virus (MYMV) affects legumes cultivation (Qazi *et al*., 2007) by causing the most important and widespread viral disease throughout Pakistan with alternate green and yellow patches on older leaves of mungbean. Reduced number of pods, flowers and seeds are the characteristic features of affected plants (Khan *et al*., 2012).

Mungbean yellow mosaic disease (MYMVD) is the most disastrous viral disease of pulses in Pakistan and other neighbouring countries of South East Asia (Bakar, 1981; Malik, 1991; Biswass *et al*., 2008; John *et al*., 2008) and firstly reported in India in 1955. MYMV disease causes heavy yield losses annually.

In Pakistan, disease incidence of MYMV range from 4 to 40% based upon crop variety (Malik, 1991; Bashir *et al*., 2006). Infection at seedling stage causes 85-100% yield losses (Nene, 1973). MYMV can also cause up to 85-100% yield losses in urdbean (Singh *et al*., 2011). The virus attacks many legume crops such as cowpea, mungbean, mothbean, soybean and urdbean and some other leguminous hosts (Dhingra and Chenululu, 1985; Qazi *et al.,* 2007).

A large number of insect pests i.e. aphids, cut worm, foliage caterpillar, jassids, leaf miner, pod borer and whitefly attack mungbean plants (Atwal, 1994). Among these, only whitefly (*Bemisia tabaci*) transmits MYMV. The virus is not transmitted by mechanical inoculation and seed (Shad *et al.*, 2005). MYMV disease severity depends upon the abundance and activities of whitefly population and the time of infection (Dhingra and Gosh, 1993).

Photosynthetic rate and crop yield decreases considerably due to MYVM disease infection (Malathi and John, 2008). MYMV disease causes huge losses when infection occurs in early growth stages in mungbean (Varma and Malathi 2003).

Keeping in view, the above mentioned facts and lack of commercial cultivars with MYMV resistance, the eradication of primary MYMV inoculums sources (perennial weeds and whitefly) at early stages would be helpful in disease management (Malathi and John, 2008; Ilyas *et al*., 2009;

Cite this article as: Zeeshan, M.A., S. Ali, M. Atiq, N. Ahmed, M.U. Ghani, R. Binyamin and M. Rizwan, 2017. Assessment of whitefly mortality and decrease in yellow mosaic disease severity by using insecticides with different modes of action. Pak. Entomol., 39(1):55-60.

Akthar *et al*., 2011; Ara *et al*., 2012). Injudicious use of a single insecticide develops resistance in the insects (Cahill *et al*., 1996). Diversified management approaches would be helpful successful control of whitefly (Risch, 1983). Insect growth regulators could manage the resistance problems in the insects (Simmons *et al*., 1997). Use of new chemistry insecticides (Horowitz *et al*., 1998) and organophosphate (Afzal *et al*., 2002) gave best result in whitefly population reduction. Among organochlorines, endosulfan interepts with GABA receptors chloride channel complex (Anthony *et al*., 1995).

Thus, the present study was planned to find out the impact of insecticides with different modes of action under natural conditions on whitefly population and MYMV disease severity.

MATERIALS AND METHODS

Plan of experiment

The experiment was undertaken to evaluate the effect of insecticides with different modes of action against whitefly (*Bemisia tabaci*) population and consequently on MYMV disease severity in mungbean germplasm. The trial was conducted at research area Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan.

Experimental layout

All the varieties/lines were sown in randomized complete block design (RCBD) with three replications. The mungbean seed was sown with 30 cm row to row and 10 cm plant to plant distance on a 2 m long row in each replication. Thus, 20 plants were maintained in each row. Seven treatments including control were randomly used with three replications on all the entries.

Germplasm collection

The mugbean germplasm for the experiment was obtained from Pulses Section, Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan that comprised of M-6, NM-2006, 08010, 08007, 08008 and 08009).

Cultural practices

Recommended agronomic operations were practiced during the experiment. The field was applied with light irrigation one day after sowing. Hand weeding was done after 10, 20 and 30 days after sowing. Recommended doses of fertilizers were applied.

Transmission of MYMV by whitefly inoculation

Whiteflies were collected from infected plants by using an aspirator and were 5 whiteflies were released on young healthy plants of mungbean grown in a glass box and covered with net. Viruliferous whiteflies were given 48 hours inoculation feeding period on healthy plants. Inoculated plants were maintained in insect free environment for 30 days following Naimuddin and Aditya (2011).

Treatments application

All the insecticides were sprayed at recommended doses when the population of insect reached the economic threshold level which was considered as five adults/nymphs per leaf. There were 7 treatments including control in each replicate. The recommended doses of the insecticides are given in Table 1. Unsprayed rows were considered as control.

Data recording

Whitefly population dynamics

Three plants in each row of all the replications were randomly selected and tagged for whitefly population data recording. The number of whiteflies was counted from three points (upper, middle and lower) of each selected plant. The average whitefly population was calculated after recording data from three leaves (one from each upper, middle and lower portion) of a plant separately and then total average of three plants was taken. The data was recorded early in the morning because of the reduced activity of whitefly. The data was recorded 24 hours before and 24 after each spray application.

% population mortality = Population before spray-Population after spray/population before spray*100.

Disease severity = No. infected leaves/total no. of leaves*100.

Percent decrease over control = treated-control/treated*100 (Singh *et al*., 2011).

Statistical data analysis

The data regarding whitefly population and disease severity were subjected to statistical analysis using statistix 8.1 software. ANOVA was used to determine the effect of insecticides on the whitefly population and MYMV disease severity while treatment means were compared by LSD test (Steel *et al.,* 1997). The comparative efficacy of the control methods was considered to be an indirect reflection of the sucking insect pests population, per leaf/flower.

RESULTS AND DISCUSSIONS

Effect of insecticides with different modes of action on whitefly population

In all replicates, maximum whitefly population was recorded in control where no insecticide applied. acetamiprid from neonicotenoid group resulted in lowest whitefly population causing highest mortality (Table 2; Fig. 1). Whitefly population was significantly ($P<0.05$) lower in acetamiprid treated plots as compared to control. Methomyl was the second most effective insecticide after acetamiprid in reducing whitefly population and causing mortality. Also fenpropathrin that belongs to pyrethroid group significantly increased the mortality of *B. tabaci* after weekly applications as compared to control. However, pyrethroid group was less effective as compared to carbamate. Endosulfan was the fourth most significant insecticide at field recommended dose against whitefly in different mungbean germplasm in all replicates. Endosulfan was followed by methamidophos and buprofezin which caused significant mortality of the insect as compared to control. In buprofezin treated plots whitefly population was significantly higher (7.62/leaf) than all other insecticides.

Reduction in whitefly infestation by different insecticides consequently reduced the disease severity in all replicates. Untreated plots showed maximum disease severity because there was no insecticidal application and increased insect activities caused highest damage (Table 3, Fig. 2). All other insecticides affected the disease severity indirectly in the same order as they caused mortality of vector (whitefly population) in different mungbean germplasm. Minimum disease severity was found in acetamiprid treated plots followed by methomyl, fenoproathrin, endosulfan, buprofezin and methamidophos in that order. The results revealed significant (P<0.05) difference among all treatments at all post treatment intervals. There was clear cut difference in disease severity pre and post sprays in all varieties/lines due to reduction in vector.

MYMV disease is causing huge yield losses of mungbean crop. Being the insect transmitted disease, its management is accomplished by successful control of whitefly population. Whiteflies inhabit the younger plants and increase disease severity with the passage of time. Application of neonicotenoid insecticide (acetamiprid) appears an effective method to reduce the whitefly population infestation and MYMV disease severity. Due to efficient movement and development of whitefly, early protection of crops against the insect decreases transmission of the virus from infected sources.

In the present study, acetamiprid caused maximum whitefly mortality and ultimately severity of MYMV disease. These results are in conformity with those of Parrish (2001) and Aslam *et al*. (2003) who observed significant mortality of whitefly with the application of acetamiprid. As the acetamiprid belongs to neonicotenoids group, its efficacy can also be strengthened by the findings of Mustafa (2000) who found that confidor (acetamiprid) resulted almost 72.76% mortality of whitefly. Neonicotenoids moves through plant tissues and make them toxic to feeding insects. The toxic tissues protect the plant from sucking insects and indirectly from damage by insect transmitted plant viruses (Tomizawa and Casida, 2011).

Methomyl proved the second most effective insecticide in reducing whitefly infestation and MYMV disease severity. Efficacy of methomyl was determined against various sucking insect pests like whitefly, *Bamacia tabaci* (Reddy and Kumar, 2004). The results of insecticidal efficacy of methamidophos are similar to those of Ahmad and Khan (1995) who described that methamidophos was the most effective insecticide against whitefly. Afzal *et al*. (2002) found that methamidophos proved the best against whitefly. The results of fenpropathrin are agreed with that of Akbar and Hasan (1999) and Ahmad and Khan (1995).

Endosulfan also significantly reduced the whitefly population and MYMV disease severity. Similar findings were reported that endosulfan is being used against whitefly on cotton and other crops in Pakistan. Since last two decades and develops very low level of resistance in the insect. These findings are in conformity with those of Kranthi *et al.* (2001), who reported very low level of resistance (up to 5-folds) in field populations of whitefly against endosulfan. Similar results were described by Prabhaker *et al.* (1996). Bouharroud *et al.* (2007) also reported very low level of resistance in all the test populations of whitefly against endosulfan (not more than 2).

There was (40.28%) mortality in buprofezin treated plants because it reduces the rate of adult emergence from young ones of whitefly (Ellsworth and Martinez-Carrillo, 2001). These results strengthen the findings of Lublinkhof and Odom (1994), Perez *et al.* (1994) and Wolfenbarger and Riley (1994). Buprofezin being an insect growth regulator inhibits chitin synthesis in insects (Ishaaya *et al*., 1988). It hinders the growth and development of the immature insects (Bi *et al.*, 2002). De Cock *et al*. (1990) reported that buprofezin caused mortality of whitefly nymphs by producing vapors. It acted upon the inhalation of nymphs, direct contact and adsorption by the integument of insects. Although buprofezin has no direct effect on longevity and oviposition of whitefly adult, it may reduce the fecundity and egg hatching ability of female whiteflies (Ishaaya *et al*., 1988). Moreover, the application of buprofezin could reduce the pesticide residue problems in freshly harvested fields (Rasdi *et al*., 2012). Early spray of buprofezin can cause significant mortality of whitefly (Palumbo, 2009).

Table 1

Details of insecticides used in the experiment.

Serial No.	Common Name	Group	Trade Name	Formulation	Dose
T_1	methamidophos	Organophophate	Tamaron	SL	500 ml/ha
T_2	buprofezin	Thiadizine	Pride	25 WP	1500 gm/ha
T_3	endosulfan	Organochlorine	Thiodan	35EC	500 ml/ha
T_4	fenpropathrin	Pyrthroid	Danital	10EC	1500 ml/ha
T_5	acetamiprid	Neonicotenoid	Mospilan	20SP	625 g/ha
T_6	methomyl	Carbamate	Lannate	40SP	750 g/ha
T_7	Control				

Table 2

Evaluation of insecticides against whitefly population.

Serial No.	Common Name	Whitefly population/leaf Before spray	Whitefly population/leaf after spray	% mortality
T_1	methamidophos	7.25	2.98	58.89 e
T_2	buprofezin	12.76	7.62	40.28 b
T_3	endosulfan	9.98	4.61	53.81 c
T_4	fenpropathrin	11.23	5.08	54.76 d
T_5	acetamiprid	7.16	2.17	69.69 g
T_6	methomyl	8.71	3.25	62.69 f
T_7	Control	14.65	14.13	3.55 a

Table 3

Evaluation of different insecticides against MYMV disease severity.

Serial No.	Common Name	Disease severity/leaf before spray	Disease severity/leaf after spray	% decrease over control
T_1	methamidophos	49.27	20.78	57.82 e
T_2	buprofezin	56.55	37.44	33.79 b
T_3	endosulfan	53.89	31.82	40.95 c
T_4	fenpropathrin	51.12	26.22	48.71 d
T_5	acetamiprid	46.17	14.00	69.68 g
T_6	methomyl	48.26	18.02	62.66 f
T_7	Control	60.00	59.63	3.55 a

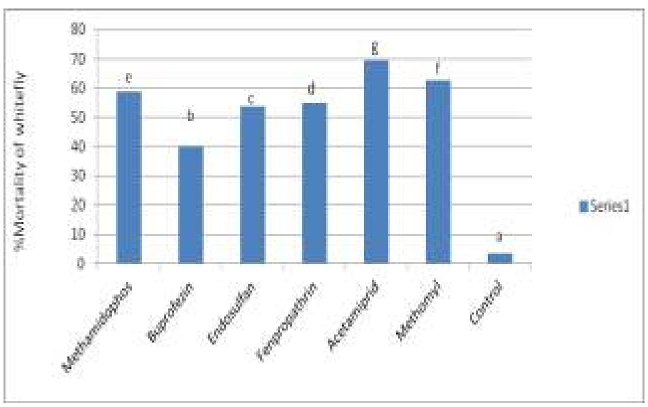

Fig. 1

Effect of insecticides on % mortality of whitefly population.

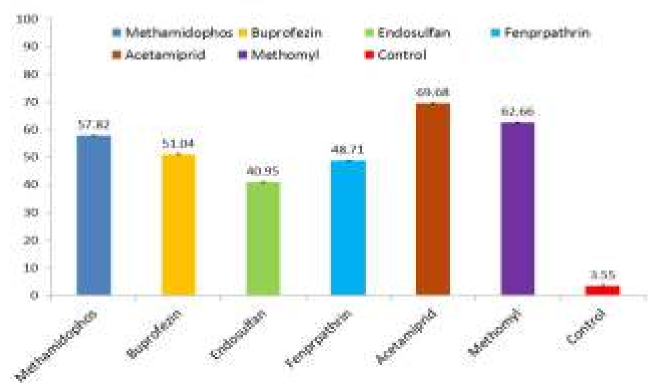

Fig. 2

Percent decrease in MYMV disease severity due to mortality of whitefly by insecticides.

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