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EVALUATION OF ORGANIC AMENDMENTS AND INSECTICIDES AGAINST OKRA YELLOW VEIN MOSAIC VIRUS AND ITS VECTOR

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ABSTRACT

Okra (*Abelmoschus esculentus* L.) is susceptible to number of diseases like Yellow Vein Mosaic Virus disease, Damping Off, Fusarium wilt, Powdery Mildew and Enation Leaf Curl. The Okra is favorite host of whitefly which transmits the okra Yellow Vein Mosaic Virus (OYVMV). OYVMV disease causes considerable yield losses in Okra. Experiment was conducted to check the efficacy of organic matter (poultry manure, leaves) and insecticides (Acetamiprid, Diafenthiuron, Pyridine Carboxamide) against OYVMV and its whitefly vector. In this experiment, ten okra varieties were sown in randomized complete block design (RCBD). Organic matter and insecticides were applied at recommended doses (@5ml/L) on weekly intervals. Among insecticides, Acetamiprid showed the best result to manage whitefly infestation with 60.01% mortality and OYVMV disease severity with 53.98% efficiency. Polo (Diafenthiuron) also showed good results to manage whitefly (56.36%) and OYVMVD (46.34%), but Ulala (Pyridine Carboxamide) insecticide was least effective to control whitefly population (47.27%) and to manage the infection of OYVMV disease (43.91%). Leaf manure was more effective with 61.16% efficiency as compared to poultry manure (56.01%) against OYVMV disease severity. New chemistry insecticide (acetamiprid) gave the most effective control of whitefly and transmission of OYVMV and could be used in place of conventional insecticides. Leaf manure proved significant defense activator in okra plants with effective control of disease and could be used as eco-friendly management approach.

Keywords: insecticides, nutrients, OYVMV, plant defense, vector

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is the most important summer vegetable crop (Rahim and Dawar, 2015) which is cultivated in many countries of the world (Khan *et al*., 2013). It belongs to family Malvaceae. Pakistan ranked at 6th number in okra production which is 113270 tons per year (FAO, 2018). Okra is best antioxidant and its mucilage can be used for medicinal purpose (Roy *et al*., 2015). It can also be used for industrial applications (Akinyele and Temikotan, 2007). Okra is susceptible to various diseases like Damping Off, Enation Leaf Curl, Fusarium wilt, Okra Yellow Vein Mosaic disease (OYVMD) and Powdery mildew (Amadi *et al*., 2014). Okra leaf curl virus (OLCV), and okra enation leaf curl virus (OELCV) are the most prevalent pathogens from begomovirus genus other than OYVMV (Mishra *et al.,* 2017). Among viral diseases, OYVMD is responsible for more than 50% yield losses in okra (Mubeen *et al*., 2017). The OYVMD was first time reported in 1924 in India (Kulkarni, 1924). The causal agent of this disease is Okra Yellow Vein Mosaic Virus (Chaudhary *et al*., 2017). The OYVMV is transmitted by an insect vector whitefly (*Bemisia tabaci*) (Nagaraju *et al*., 2015). The early symptoms appear as diffused mottling on leaves with vein clearing near leaf margin. The vein clearing turns into vein chlorosis as the disease progresses (Chaudhary *et al*., 2017). Small leaves, stunted growth and malformed fruits are also characteristic symptoms of the disease (Venkataravanappa *et al*., 2012). Whitefly population and OYVMV disease incidence is less in cooler months than hot and dry weather (Sanwal *et al*., 2016).

Whitefly transmits OYVMV in healthy plants that are cause of the disease. To get rid from the causes of disease, vector control is mostly relied upon that is accomplished by insecticides

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application (Pagire *et al*., 2017). Synthetic chemicals are quick source to manage the OYVMV but it is not eco-friendly due to its residual long term bad effects (Chaitanya and Kumar, 2018). Suitable and timely application of Cyfluthrin and methamidophos resulted in significant whitefly mortality (Afzal *et al*., 2002). Significant whitefly mortality was recorded from carbofuran and malathion treated crops (Sharma *et al*., 2017). The yellow mosaic disease incidence was minimized where oxydimehon methy and carbofuron were sprayed against whitefly infestation (Saurabh *et al*., 2016). Whitefly has developed resistance against organophosphates and carbamates due to their repeated application (Thumar *et al*., 2018). New chemistry insecticides (neonicotenoids) are environmentally safe and no insect resistance is developed due to their unique mode of action (Acharya *et al*., 2002).

As the virus affects plant growth by disturbing plant physiology, the resulting damages can be repaired by using growth enhancers. Organic matter (leaves manure and poultry manure) improves soil health that strengthens plant anchorage and its ability to absorb nutrients for increased plant growth (Calvo *et al*., 2014). Dry leaves increase the plant defense against biotic stresses by enhancing enzyme activities (Sana *et al*., 2015). OYVMV disturbs the plant physiology in the form of chlorosis and mosaic; use of poultry manures provides with nutrients which boost the photosynthesis process (Riyana *et al*., 2018). Organic amendments (leaves and poultry manure) may enhance the okra plants immunity against OYVMV and the insecticides with varied mode of action would be beneficial for whitefly control and spread of OYVMV. The OYVMV was selected because it causes more losses than other begomoviruses in okra. The present study was focused to evaluate organic matter and non-conventional insecticides and against OYVMV disease and whitefly.

MATERIALS AND METHODS

Experimental plan

The trial was performed in the field of Plant Pathology Department, University of Agriculture, Faisalabad (UAF). Ten varieties (Suraksha F1, Raksha-14, G-Ho-2, OH-841, K-HO-2, Lakshmee, OK-409, Rupa-14, OK-Marvi, OK-Nayab) were sown in randomized complete block design (RCBD). Seeds of these varieties were collected from the Vegetable Research Institute, Ayub Agricultural Research Institute, Faisalabad. Each variety was planted in six rows sub-plots with row-row 60 cm and plant-plant 20 cm spacing.

Confirmation of virus through whitefly inoculation

Two plants of each variety were also sown under diseased free area (net house) and other plants of each variety were grown in open field. After 25 days of sowing whiteflies were collected from the infected plants in the field with the help of aspirator and allowed to feed on healthy plants in net-house. These infected plants served source of virus inoculation through whitefly. The whiteflies were collected early in the morning. Symptoms were observed after 3-4 days.

Data recording

OYVMV confirmation in net-house was followed by data recording from diseased field. The disease severity data was recorded on the basis of symptomology (mosaic, chlorosis, and reduced leaf size). The data was recorded by using following formula:.

$$\text{Diease severity} = \frac{Number\ of\ infected\ leaves}{Total\ number\ of\ leaves}\ X\ 100$$

For whitefly data recording, three plants were selected randomly. After counting number of whiteflies from lower, middle and upper leaves, average was calculated.

Collection of organic matter

Organic material such as fallen leaves of the different trees was taken from the campus of UAF. The fallen leaves were collected from Shisham (*Dalbergia sisso*), Eucalyptus (*Eucalyptus globules*), and Neem (*Azadirachta indica*). Poultry manure (PM) was also collected from poultry farm of UAF. The fallen leaves were properly decomposed by placing them in polythene bags. After 15 days of decomposition, these were used for organic amendments. The decomposed leaves and poultry manure were applied in okra field before sowing separately @ 1 kg row^{-1}.

Evaluation of different chemicals against OYVMV and its vector

Different insecticides were sprayed against whitefly and for reduction of disease severity. The crop was sprayed at 7 days intervals. The three treatments were used at random in each block on okra varieties. The dosages given in the table are based upon per acre treatments which were adjusted according to the plot size. Usually 100 liters of water was sprayed in 1 acre @ 20 liters/tank. The total package of one acre divided and dissolved in each tank to cover the whole area.

Serial No.	Treatments	Dose
T_1	Acetamiprid (Neonicotinoid)	@80 gm/acre
T_2	Polo (Diafenthiuron)	@200ml/acre
T_3	Ulala (Pyridine carboxamide)	@60gm/acre

Statistical analysis

The crop was sprayed at 7 days intervals. All data of YVMV and whitefly population as influenced by chemical application was statistically analyzed. All possible interactions were determined through ANOVA and the treatment means were compared by LSD test at 5% level of probability (Steel *et al*., 1997).

RESULTS

The data was collected for evaluation of organic matter and different insecticides to control whitefly and yellow mosaic virus disease on 10 okra varieties. Organic amendments (leaves manure, poultry manure), showed significant reduction in managing OYVMD in all varieties (Figure 1). Among organic amendments, leaf manure indicated the best results as compared to poultry manure and untreated control in all varieties. Minimum disease severity (16.32%) was recorded in Lakshmee variety, followed by OK-Nayab (19.54%) in leaf manure treated plants. There was significant difference between Lakshmee and OK-Nayab in response to disease severity against leaf manure. Maximum disease severity due to leaf manure application was recorded in Rupa-14, followed by K-Ho-2 where 27.38% and 25.83% disease severity was found, respectively. The difference of disease severity in Rupa-14, and K-Ho-2 was significant. Leaf manure was more effective as compared poultry manure and untreated control. The overall disease severity in leaf manure treated plants was 20.61% (Table 1). Leaf manure was 61.16% more efficient in managing the OYVMVD as compared to control.

Poultry manure also showed good results as compared to untreated control in all varieties. The most efficient disease control due to poultry manure was recorded in variety Lakshmee which exhibited (18.29%) disease severity followed by OK-Nayab that gave 21.23% disease severity. Maximum disease severity and minimum efficiency of poultry manure was recorded in Rupa-14 (28.73%), followed by OK-409 (27.09%). All the varieties showed significant difference in response to both treatments. The disease severity recorded in poultry manure treated plants was 23.35% (Table 1). Poultry manure gave 56.01% efficient management of OYVMVD.

Results revealed that Acetamiprid showed the best result in reducing the severity of OYVMV due to maximum control of whitefly in all the varieties with 23.01% disease severity (Table 2). Polo (Diafenthiuron) also showed good results in reducing OYVMV disease severity (26.82%) but Ulala (Pyridine Carboxamide) was least effective with (28.05%) as compared to control (50.00%). Acetamiprid depicted 53.98% efficiency in managing OYVMV disease, followed by Polo (46.34%), and Ulala (43.91%).

In acetamiprid treated plants, OK-Nayab gave maximum OYVMV disease reduction with 8.32% disease severity, followed by K-Ho-2 that showed 10.38% disease severity (Figure 2). Minimum disease reduction due to acetamiprid was recorded in variety Lakshmee which showed 17.23% disease severity, followed by OK-Marvi (15.72%). Polo (Diafenthiuron) depicted maximum reduction in severity of OYVMV disease in all varieties after acetamiprid. Minimum disease severity due to Polo (Diafenthiuron) was showed by OK-Nayab (11.55%) maximum by Lakshmee (19.56%). There was significant difference of disease severity between all the varieties in response to each treatment.

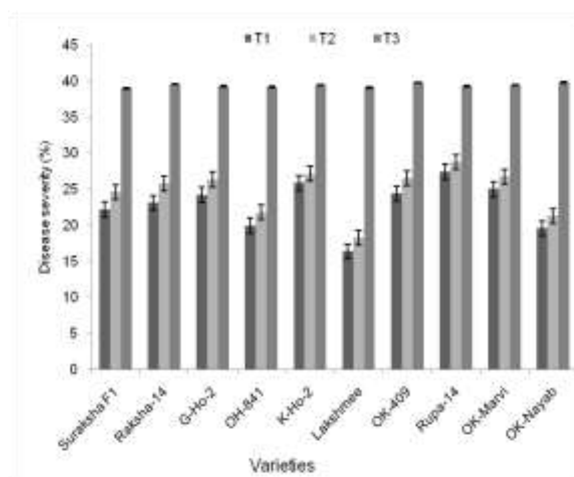

Figure 1. Evaluation of organic amendments against OYVMV disease severity recorded on different varieties T_1 (Leaves manure), T_2 (Poultry manure), T_3 (Control)

Table 1. Efficiency of organic amendments against OYVMV disease severity

Serial No.	Treatments	Disease severity (%)	Efficiency (%)
T_1	Leaves manure	20.61c	61.16
T_2	Poultry manure	23.35b	56.01
T_3	Control	53.07a	--

LSD=1.23 Different letters in column indicate significantly different values

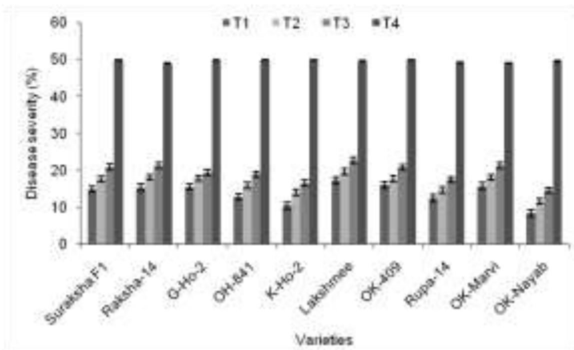

Figure 2. Evaluation of insecticides against OYVMV disease severity recorded on different varieties T_1 (Acetamiprid), T_2 (Polo), T_3 (Ulala), T_4 (Control)

Table 2. Efficiency of insecticides against OYVMV disease severity

Serial No.	Treatments	Disease severity (%)	Efficiency (%)
T_1	Acetamiprid	23.01d	53.98
T_2	Polo (Diafenthiuron)	26.82c	46.34
T_3	Ulala (Pyridine Carboxamide)	28.05b	43.91
T_4	Control	50.00a	

LSD=1.47 Different letters in column indicate significantly different values

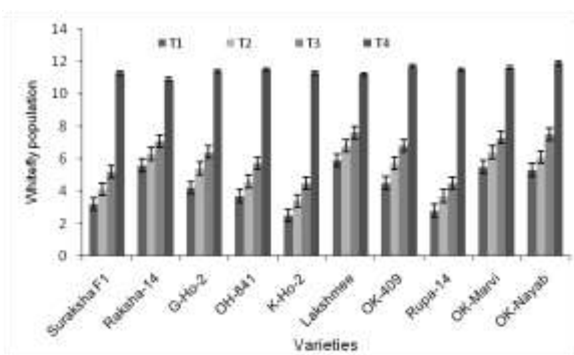

Figure 3. Evaluation of insecticides against whitefly recorded on different varieties T_1 (Acetamiprid), T_2 (Polo), T_3 (Ulala), T_4 (Control)

In the control of whitefly, all the insecticides significantly reduced whitefly infestation (Table 3). Acetamiprid was appeared to be most effective with mean whitefly population (3.4) as compared to Polo (4.8) and Ulala (5.8) in all the varieties as compared with control (11.00). Acetamiprid showed 62.01% efficiency in controlling whitefly population, followed by Polo (56.36%) and Ulala (47.27%). Minimum whitefly population was recorded in acetamiprid treated plants (2.5) and highest in Lakshmee (5.9). Polo (Diafenthiuron) gave maximum control of whiteflies in variety (K-Ho-2) 3.4 and Ulala (Pyridine Carboxamide) in 4.5. The response of all varieties against whitefly was significant in all treatments.

Table 3. Efficiency of insecticides against whitefly infestation

Serial No.	Treatment	Whitefly population	Efficiency (%)
T_1	Acetamiprid	3.4	62.01
T_2	Polo (Diafenthiuron)	4.8	56.36
T_3	Ulala	5.8	47.27
T_4	Control	11.00	

LSD=0.71 Different letters in column indicate significantly different values

DISCUSSION

Ten okra varieties were sown to check the efficacy of organic matter and different insecticides against OYVMV and its vector (whitefly) population with the comparison to the untreated control. Organic matter (leaves and poultry manure) was effective against OYVMV. The leaf manure provide ease in the provision of soil nutrients that otherwise trigger the plant defense mechanism resulting in enhanced resistance against biotic stresses (Sana *et al*., 2015). In yellow mosaic disease, virus destroys the chlorophyll formation leading to yellowing of leaves. Leaf manure increase the activity of chlorophyll by producing enzymes (Kasai, 2008). The incorporation of leaf manure into the soil results in enhanced availability of nitrogen (N) (Singh *et al*., 2014). The nutrient balance of the plants is disturbed by the pathogenic attack; in such conditions plants require nutrients for smoothing functioning of defense mechanisms. The provision of N to the stressed plants from any source increases the constitutive and induced defense (Mur *et al*., 2017). Mosaic and chlorosis are the salient symptoms of OYMVD; which indicate destruction of chloroplast cells and chlorophyll. Leaf manure provide N that is the main component of the chlorophyll and helps in managing the losses (Bassi *et al*., 2018). The application of poultry manure also increases N content in soil which helps the plant to manage the losses incurred by the virus infection (Agyarko *et al*., 2006). Fajinmi and Odebode (2005) applied organic manures against plant viruses in horticultural crops. Hassan *et al*. (2013) recorded significant disease reduction caused by whitefly transmitted begmoviruses in soils amended with poultry litter. Poultry manure contains many nutrients and growth regulators which affect plant growth and accelerate its immunity against several biotic and abiotic stresses (Yadav *et al*., 2017). Poultry manure provides the soil with NPK that are helpful in the production different phytoalexins to combat with pathogens (Chun *et al*., 2017).

Among three insecticides, Acetamiprid was more effective against OYVMD with comparison to the other two insecticides and untreated control. These results are further strengthened by the findings of Gowdar *et al*. (2007) who observed significant whitefly mortality and YMVD in okra due to acetamiprid sprays. Acetamiprid @ 5 ml/L proved more effective than other insecticides for controlling whitefly resulting in reduced OYMV disease severity (Yadav *et al*., 2007). Minimum whitefly infestation was observed in okra fields where new chemistry insecticides were applied (Sarkar *et al*., 2016). Pawar *et al*. (2016) stated that after application of neonicotenoids the infestation of sucking insects considerably minimized. Neonicotenoids disturbs the synaptic nerves of the sucking insects resulting in death thus reducing the infestation (Begum and Patil, 2016). The disturbance in synaptic nerves creates stimulation in sucking insect pests which ultimately retarded (Bacci *et al*., 2007). The insecticides with this mode of action have effective translaminar movement which is absorbed by the insects while sucking from lower sides of the leaves (Natwick *et al*., 2001). Chandio *et al*. (2017) concluded that synthetic insecticides like Polo (Diafenthiuron) applied weekly on okra plants, showed the best result to manage whitefly (*Bemisia tabaci*) population on okra. Kalyan *et al*. (2017) described significant reduction in whitefly population in Diafenthiuron okra plants. Diafenthiuron disrupts the process of oxidative phosphorylation and interrupts the formation of ATP (Kumar *et al*., 2019). Sathyan *et al*. (2016) concluded that Diafenthiuron reduced the whitefly population upto 65%. It reduces the function of mitochondria causing immobility in the insects (Haq *et al*., 2018). Mortita *et al*. (2007) described that Pyridine Carboxamide caused significant whitefly mortality due to starvation and convulsions. It alters the feeding behavior of whitefly when it sucks the treated plants (Morita *et al.,* 2014). It blocks the potassium. A type channel which causes failure of nervous system and insect pierce the leaf surface (Jansen *et al*., 2011). Colomer *et al*. (2011) declared the flonicamid from Pyridine Carboxamide group as the efficient control of whitefly after repeated experiments.

CONCLUSION

It is concluded that leaf manure and acetamiprid are more effective in reducing okra yellow vein mosaic virus disease severity and whitefly population.

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AUTHOR'S CONTRIBUTION

A. Munir: Conducted research
S. Ali: Supervised
M. A. Zeshan: Paper writeup
M. U. Ghani: Supervised
A. A. Khan: Statistical analysis of data

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