MANAGEMENT OF OKRA MOSAIC VIRUS AND IT VECTOR: OKRA LEAF HOPPERS (*Empoasca devastans*) THROUGH PLANT EXTRACTS

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INTRODUCTION

Okra (*Abelmoschus esculentus L*.) is the only vegetable crop of significance in the Malvaceae family. In India, it ranks number one in its consumption, but its original home is Ethiopia and Sudan, and North-eastern African countries. Medicinal plants are the nature's gift to human beings to have disease-free healthy life. It plays a vital role in preserving our health. In recent times, the use of herbal products has increased tremendously in the western world as well as in developed countries. Medicinal plants are believed to be safer and proved elixir in the treatment of various ailments. Okra is an important medicinal plant of tropical and subtropical countries. Its medicinal usage has been reported in the traditional systems of medicine such as Ayurveda and Siddha.

Okra (*Abelmoschus Esculantus*) is one of the most popular vegetables grown in Wet, Intermediate and Dry zones of Sri Lanka. Okra is cultivated in about 7066 ha producing average yield of 5.3 Mt/ha. Therefore, the total annual Okra production in Sri Lanka is 37,330 Mt with a per capita availability of 2.0 kg/ha. Young Okra pods are consumed fresh or cooked. Fiber of the Okra stem is used in the paper industry. Okra is a good source of vitamins A, B, C as well as protein, carbohydrates, fats, minerals, iron, and iodine. Consumption of 100 g of fresh okra pod provides 20%, 15%, and 50% of the daily requirement of calcium, iron and ascorbic acid, respectively (Fajinmi-2012).The crop is susceptible for various diseases caused by insects, fungi, nematodes, and viruses. But its cultivation is seriously threatened by the Okra Mosaic Virus (OkMV) by affecting different parts of the plant (Amit Kumar,2017). The virus is not seed transmitted, but it is mainly transmitted by hoppers. OkMV is a tymovirus infecting members of the family Malvaceae. Yield reductions of 20 to 50% have been reported in Okra due to OkMV. This loss may increase to 90% depending on the severity of the disease. Okra mosaic virus symptoms are characterized by a homogenous interwoven network of yellow mosaic pattern enclosing islands of green tissue in leaf blades. In extreme cases, infected leaves become yellowish or creamy colour (Deepal and Wasala, 2014). If plants are infected within 20 days after germination, growth is retarded and few leaves and pods are formed. Yield loss may be up to 95%. The extent of damage declines with delay in infection (Fajinmi,2012).

Okra mosaic disease is one of the most devastating disease causes in Sri Lanka. The weather condition in Sri Lanka is more congenial to the vector hopper survival throughout the region i.e., the warm and humid condition. Chemical pesticides usage for the control of insect vectors of plant viruses is very hazardous to the environment as well as to the humans directly associated with insecticides application or consumption of treated produce. The experiment management of viral disease is to prevent the crop losses and quality deterioration through different ways, which include use of chemical insecticide and plant extracts. The antiviral properties of the plant extracts in controlling viral diseases have been well discussed in several other earlier reports. Many plant extracts have several inhibitors and ribosome-inactivating proteins that directly interfere with virus multiplication and protein synthesis (Venkatesan, 2010). Therefore, this research project was designed to study the Management of okra mosaic virus and its vector: okra leaf hoppers (*Empoasca devastans*) through plant extracts.

MATERIALS AND METHODS

The study was conducted in an Okra (Variety Haritha) cultivation in a farmer's field in Mullaitivu from October, 2019 to May, 2020. The treatments used in the study were extracts of Neem (*Azadiracta indica*) seeds, Garlic (*Allium sativum*) bulbs, Ginger (*Zingiber officinale*) Rhizome, Chemical (Thiamethoxam) and no plant extract applied was considered as control. The field experiment was laid out in a randomized complete block design with three replications. Plant samples were ground in distilled water at 100 g L^{-1} (10% concentration) in blender and filtered through double layered cloths. Extracts were used immediately for spraying. First spray was done after 15 days of planting. The plant extracts were sprayed 5 times at 15 days interval. All exposed surface of the plants including leaves, buds, twigs, branches and fruits were sprayed.

Data were recorded on individual plant basis. Plant height was determined at two week intervals. Number of infected plants was counted in each plot. Before spraying plant extracts, vector population was observed and recorded, 24hours after spraying, number of vectors available in the field was recorded from randomly selected plants from each treatment. Numbers of pods, numbers of healthy pods, green pods weight and pods weight were taken from 5 randomly selected plants in each plot. Randomly selected five pods per plot were used to measure the length and diameter. Data were analyzed for ANOVA with the help of a computer package program of SAS.

RESULT AND DISCUSSION

Plant height in 2 weeks interval

There was a significant influence of plant extracts against okra mosaic virus on plant height at different growth stages. It was revealed that virus infestation reduced plant height irrespective of growth stages. But at the later stages 4week, 6week, 8week and 10week after sowing there was a significant difference among the plants of different treatments. The tallest plants were observed in Chemical –Thiamethoxam (T5) treatment followed by Neem seeds extract (T2) treatment. Garlic bulbs extract (T3) and Ginger Rhizome extract (T4) treatments showed similar plant height. Control (T1) treatment resulted in shortest plants and it was significantly different from all the other treatments. Further the plants under control treatment were found to be stunted due to the influence of virus. While in other cases, okra plants treated with plant extracts have shown better growth. It is thus clear that there was a significant role of plant virus on growth habit of okra and simultaneously plant extracts played a greater role against the OkMV for the continuation of the growth of the plants. It may be due to the fact that the application of plant extracts reduced the virus incidence because of the presence of antiviral activity in the plant extracts (Bhyan et al, 2007).

Number of infected plants/ plot

The numbers of infected plants/plot were significantly different from each treatment. Chemical (Thiamethoxam) treatment (T5) has shown the lowest infected plants/plot followed by Neem seeds extract (T2) treatment but these two treatments are not significantly different from each other. Control (T1) treatment has shown the highest number of infected plants and this treatment is significantly different from all the other treatments. Garlic bulbs extract (T3) and Ginger Rhizome extract (T4) treatments have shown lower number of infected plants significantly different from each other (Figure 1). It can also be concluded that plant extracts can be used as a good pesticide to keep the rate of infestation under control. Lower rate of plant infestation may be due to the effect of phytopesticides on the vectors of the virus or directly on OkMV. It was recorded that some plant extract like neem extract have a number of properties useful for insect management (Schmutterer, 1990).

Number of healthy pods/ plant

Chemical-Thiamethoxam (T5) and Neem seeds extract (T2) treatments have shown the highest number of pod/ plant and the lowest number of pods/plant was observed in Control (T1) treatment. Number of pods/plant in Garlic bulbs extract (T3) () and Ginger Rhizome extract (T4) treatments were not significantly different from each other. According to Ibrahim Khaskheli (2017) the maximum number of pods per plant was observed in healthy plants. In this study healthy plants were high in T5 and T2 treatments and therefore the number of pods per plant also high in T2 and T5 treatments.

Healthy pod length and diameter

Chemical –Thiamethoxam (T5) and Neem seeds extract (T2) treatments have shown highest pod length and diameter (Figure 2 and 3). Garlic bulbs extract (T3) and Ginger Rhizome extract (T4) treatments have shown medium pod length and diameter by these treatments are not significantly different from each other. Control (T1) treatment has shown the lowest pod length and diameter. Pods of OkMV infested plants of the control plot appeared to be smaller (5.13 cm), and lighter (7.475 g) than that of plant extract treated plant's pods. This finding agrees with Bhyan *et al* (2007) that the application of plant extracts reduced the virus incidence because of the presence of antiviral activity in the plant extracts.

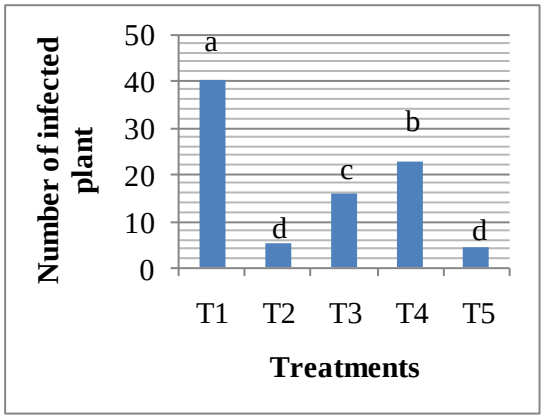


Figure 1. Number of infected plants/ plot

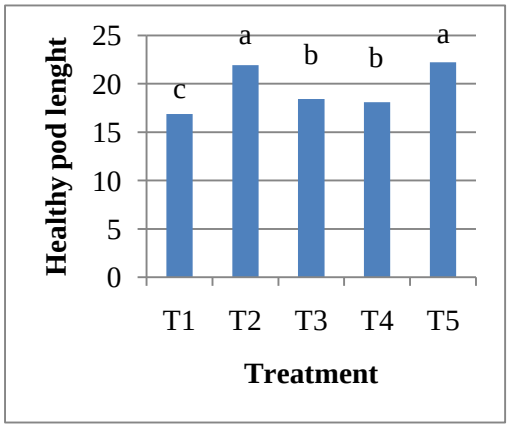
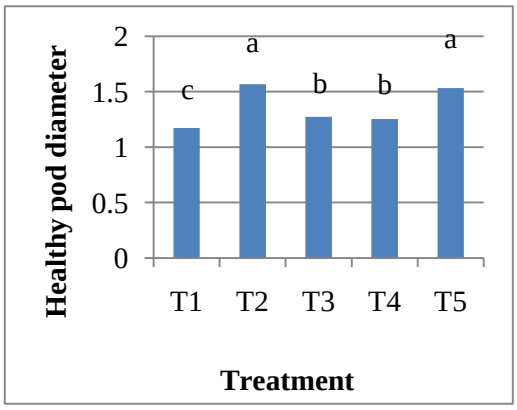


Figure 2.Healthy pod length (cm)

Yield/plant

The healthy pods weight is important in yield components of Okra to achieve highest yield. Average healthy pods weight/ plant among the treatments ranged from 295.1g -1302.2g. Variety Haritha produced pods less than 30 g of average weight (Gunawardana et al., 2011). According to figure 4 control (T1) treatment has shown lowest healthy pod weight and it is significantly different from other treatments. This is because all the okra plants in control treatment were infected with OkMV. Chemical –Thiamethoxam (T5) treatment has shown significantly highest healthy pods weight/plant but it was not significantly different from that of Neem seeds extract (T2) treatment. Garlic bulbs extract (T3) and Ginger Rhizome extract (T4) treatments have shown medium healthy pods weight/plant but they were not significantly different from each other. The difference between the yield of healthy and infested plants indicated that there was a negative influence of OkMV on yield. In healthy plants, pod yield ranged from 1302.2g /plant and in OkMV infested plant it was 295.1g /plant. It was thus clear that virus caused a severe effect on fruit formation, which was minimized by the application of phytopecticides as reported by Bhyan et al, (2007). Vanlommel et al. (1996) revealed that OkMV infestation causes a yield loss of 26%. However, in cowpea a complete loss of yield has also been observed (Kareem and Taiwo, 2007).



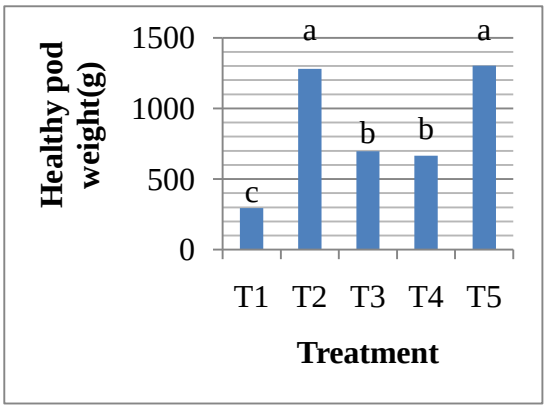


Figure 3 Healthy fruit Diameter (cm) **Figure 4 Healthy pods weight/plant**

Vector population/plant

Figure 5 indicates the neem seeds extract (T2) treatment and Chemical –Thiamethoxam (T5) treatment affect the vector population and the result showing outcomes are significantly different with each other.

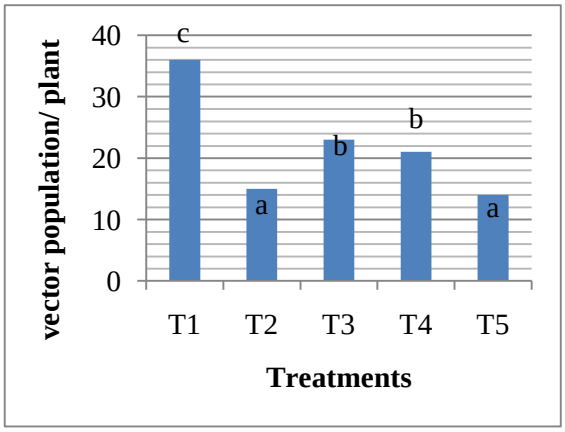


Figure 5 Vector population/plant

CONCLUSION

According to the study, spray of Chemical (Thiamethoxam) and Neem seeds extracts have shown success in controlling Okra mosaic virus. However, due to the maximum waiting period of this chemical as well as its negative impact on human and plant health, Neem seeds extracts can be suggested to farmers to have eco-friendly management of Okra mosaic virus. This is because plant extracts are the sources possessing antiviral compounds. Among all plant extracts Neem seeds extracts showed the best response for controlling OkMV disease incidence and suppressing hopper population when applied after 15 days interval stating from two weeks after germination. The easiest and cheapest method of reducing Okra mosaic disease of okra cultivation is neem seeds extract at 15 days interval starting two weeks after germination. It also reduced the spread of OkMV by checking its vector hopper.

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