Mini Review

Management of Plant Virus Diseases; Farmer's Knowledge and our Suggestions

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Abstract | Incidence of virus diseases and their damage caused to economically important crops are reportedly increasing every day particularly in the countries embedding tropical and subtropical conditions. Integrated management approaches involving utilization of virus resistant crops and efficient management of insect vectors can reduce this disastrous problem. However, in developing countries such strategies are rarely applied due to lack of farmer's knowledge about plant virus diseases. Therefore, here we reviewed about this issue by highlighting that what farmers know about plant viruses, what is their perception about yield losses by virus diseases and what management strategies they choose to apply against viruses. We further added our suggestions that how plant viruses can be managed effectively through simple and credible efforts.

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Introduction

Huge economic lossess are being reported continuously every years due to plant virus diseases especially in tropics and subtropics (Varma and Malathi, 2003; Islam et al., 2017a,c). Intensifying spread and prevalence of virus disease epidemics have been reported in many previous studies (Ghini et al., 2011; Jones, 2014; Islam et al., 2017a). It is difficult for farmers to identify virus diseases because viral disease symptoms such as leaf streaking, distortion, stunting, vein clearing, mosaic and mottle can be similar in appearance to those caused by abiotic stresses, herbicidal injuries or variation in nutritional levels (van den Bosch et al., 2007; Jones, 2014). Plant infecting viruses show greater variation in their genetic make-up, transmission mode and disease symptoms (Islam et al., 2017). Many virus species from closely relating families show a high mutation rate and there can be recombination or genetic components exchange between these related species thus enhancing the chances of genetic diversity and aggressiveness in their strains (García-Arenal et al., 2001). Similarly at the same time two or more viruses can infect a single plant thus exhibiting synergistic or antagonistic effects between viruses (Mendez-Lozano et al., 2003; Syller, 2012). The disease identification or the causal agent for virus diseases from their symptoms is may be impossible for non expert persons. So how can we close our eyes from the facts that farmers are always confused when we talk about plant virus diseases? Knowledge about how viruses are transmitted and their infec-

tion cycle is also important for proper management of virus diseases and their spread as no approved or reliable antiviral products are available commercially (Schreinemachers et al., 2015). Recently several farmer surveys from various countries evaluated farmer's knowledge about plant virus diseases at farm level regarding economically important crops(van den Bosch et al., 2007; Colvin et al., 2012; Oo et al., 2012; Adam et al., 2015; Schreinemachers et al., 2015). All these studies explained the confusion of farmers about plant virus diseases and there management strategies against these diseases. This confusion not only leads farmer towards economical losses via application of unsuitable pesticides (Rehman et al., 2013) but also is a leading cause to environmental pollutions as these chemicals are very hazardous for their surroundings (Islam et al., 2016a,b; Islam and Ahmad, 2016; Islam et al., 2017b). So here we have reviewed that what farmer's percept about plant virus diseases and what knowledge they embed to manage them via incorporation of recent studies and examples. We also have included our suggestions to manage plant virus disease through simple and efficient manner.

Farmer's perception about plant virus diseases

Small scale farmers in developing countries often lack such believe and knowledge that diseases can be controlled by pesticides. Managed incorrectly or left unmanaged, viruses can cause all harvestable yield loss. It is therefore important to understand what farmers know about plant viruses, their perceptions about damage of crop yield, their choice of methods for control of viruses and their perceived effectiveness. Even it has been recognized that these facts are alarming that farmers are confused about plant virus diseases (Figure 1), only a few research publications have address this topic, particularly in regard to smallholder farmers in developing countries. For example, in 2002 a survey was conducted in southern India to understand the farmers perception and knowledge about tomato yellow leaf curl virus and its insect vector (Whitefly) which involved 174 tomato growing farmers from five Karnataka districts (Nagaraju et al., 2002). They found that majority of farmers were generally aware about the leaf curl symptom i.e curly leaves with reduced size and stunted plants but alarmingly only 2% of the growers knew that the disease was transmitted by whiteflies. Interestingly, 86% farmers thought that high temperature in the leading cause of the curly leaves. When it comes to the management of tomoto yellow leaf curl virus, almost 90% of the farmers were relying on pesticides to control the disease. Following up, Colvin et al. (2012) interviewed 75 tomato growers in Karnataka (India) involving from seven districts in 2003 and reported that the disease had huge economic impacts upon these farmers as they loss one third of their income due to this every year. It was further determined that disease resistant varieties were very beneficial in improving the condition as it given five times more profit the farmers and also reduced their utilization of pesticides. Oo et al. (2012) conducted a broader study regarding tomato growers for their knowledge about tomoto virus diseases, pesticide usage and integrated pest management (IPM) in Inle Lake region (Myanmar). He reported that the farmers had even never heard about the IPM and they only manage the tomato diseases through application of pesticides. The practice of farmers about usage of pesticides was commendable because they had received proper training regarding their use through various extension services. But all this was only resulting in economic loss as virus diseases cannot be minimized by this mal practice.

Other than tomato, there are many other economically important crops which are under plant virus attack particularly begomoviruses in Asia which are increasing frustration in the small holding farmers. Once the virus disease has spread on the small farm and farmer missed the trick to manage it properly, it can ruin the farmer's life completely via wiping out his commodity (Islam et al., 2017a). For example, chili peppers (*Capsicum spp.*) are important crops across the tropics and subtropics grown for home consumption and also as a cash income source. As the pepper cultivation area is increasing, particularly in southern and eastern Asia so too is the pests and diseases incidence such as chili leaf curl virus. In India, the epidemic break down of the particular virus resulted in huge economic losses thus completely prohibiting the farmers to grow chilies in future (Kumar et al., 2006; SarathBabu et al., 2011). Similarly, Mungbean (*Vigna radiata*) is one of the favorite crop of the farmers in south Asia and south east Asia but the crop is under threat of begomoviruses continuously which can lead to a sudden disaster (Akhtar et al., 2011; Tsai et al., 2013). Farmers also have no sort of knowledge about begomoviruses that attack upon this cash and highly nutritive crop and they always tend towards the control of diseases through pesticides (Rehman et al., 2013).

Recently, Adam et al. (2015) conducted a survey of

Figure 1: *Farmer is confused when he first see the plant virus infected plants as thousands of questions revolve in his mind that why the plant has died.*

sweet potato growers in lake Victoria region Tanzania to understand the farmer's knowledge perception and management strategies about sweet potato virus disease (SPDV). SPDV is caused by the synergetic combination of two viruses i.e. Sweet potato feathery mottle potyvirus (SPFMV) and the whitefly borne Sweet potato chlorotic stunt virus (SPCSV) (Gibson et al., 2000). He compiled a data set of 621 small holder farmers from three different districts though interviews about their knowledge about SPDV. He reported that even the farmers had various training by pathologists about SPDV but still they were somewhat literate in finding that the sweet potato are un healthy (53.6% farmers). They further could not find that what the basic problems with unhealthy sweet potato are. Only 2.1% could actually diagnose, its SPDV. 31.5% said its insect problem or planting material problem. He further reported that majority of

farmer's use multiple approaches against SPDV i.e. stop sowing sweet potato, uprooting of plants, chemical usage. Similarly, Schreinemachers *et al.*, 2015 interview 800 growers of chilies, tomato and mongbean from Vietnam, Thailand and India and reported alarming facts that averagely more than 50% of farmers in these countries had no idea about plant virus diseases of above mentioned crops and damages caused by these disease. He further added that 31% of the farmers were interested in applying pesticides to manage these virus diseases.

Suggestions to manage plant viruses

The above mentioned facts are representing only few countries and small sample size, however the facts clarify that the farmers knowledge about plant virus diseases of economically important crops and their transmitting vectors is not only limited but they are even distracted to manage these disease un fairly though non judicial and un effective use of chemicals. This not only is increasing the economic losses but also enhancing environmental pollution. So here we have added some simple suggestions to manage the plant viruses at farmer level.

1. The best way is to avoid the disease. If the plant viruses are prevailing in an area continuously; farmers just need to apply crop rotation to avoid the availability of same host.
2. Selection of seed should be done from credible sources ensuring virus free tags. This may include Cuttings, bulls, rhizomes, tubers and seeds.
3. Eradicate the diseased plant from the field which will eliminate the inoculum from the field.
4. Insect vectors are the active transmitters of the viruses from weeds and other plant sources. These must be efficiently managed though eradication of weeds which harbor them and via sowing of trap crops. e.g. Cotton reddening for white flies in bhendi. Similarly soil fumigation can be applied against **n**ematode transmitted viruses to control nematodes. Furthermore insecticides can also be applied for reducing their population.
5. Understanding the non crop plants which are active hosts and harbors of plant viruses is also important as they are the virus factories which must be terminated through cleaning of farm sides.
6. Selection of virus tolerant verities can be very effective. e.g. Parbhani Kranti against yellow vein mosaic of the bhendi.
7. Hot water treatment can be effective against some viruses. e.g. Sugarcane mosaic can be reduced by such treatment at 52^0 C for 30 minutes.
8. Lastly and most importantly; the education. All the above mentioned suggestions can only be applied if farmer is able to identify the virus diseases. So farmers should take trainings and contact the active extension service departments for learning.

Conclusion and Future Prospects

Conclusive evidences of various studies about farmer's knowledge and perception criticize the farmer's literacy about the plant virus diseases, their symptoms recognition and proper management practices. Virus diseases are critical in cash crops for farmers and they can even quickly roll back the economy of any region if they hit to their epidemics. So their timely management acquires huge importance. The farmers are not only confused about the virus disease but they further pile up to their loss via wrong usage of pesticides. Due to lack of knowledge in the farmer community about virus diseases, the long lasting solution against these diseases can only be through incorporation of host plant resistance. Hundreds of research institutes, laboratories and universities utilized billions of funds every year to do research upon plant virus diseases but they are failed in generating the virus resistant crop verities against most of the plant viruses. There are only few success stories regarding virus resistant cultivars but they are 0.1% of the total which is un-justifying. The other solution and the better solution for the farmers is to rely on themselves and help themselves via improving their knowledge about plant viruses, their symptomology, their management strategies. This can be done via increasing the connections between extension services and farmers community through arranging various activities and trainings. The problem that former lacks knowledge about the viruses is alarming not only for farmers but also for the food security worldwide but no one is ready to pay the attention to this matter seriously which can lead to a sudden disaster in near future.

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