PLANT PATHOLOGICAL RESEARCHES FOR ENHANCING ORGANIC FARMING OF VEGETABLE CROPS

RD Timila and HK Manandhar
Plant Pathology Division, NARC

ABSTRACT

Pesticides use in vegetable farming is of great concerns as it has been using indiscriminately. Its use may have direct impact on human health as vegetables are consumed directly and uncooked as well. It is a general practice in our conditions that farmers do not wait for required period for harvest after the use of pesticides. Therefore, ecofriendly and safer disease management practices are today's demand. Plant Pathology Division has been conducting researches on different non-chemical aspects for plant disease management. They include varietal resistance against major diseases and management through biocontrol agents, cultural practices, organic amendments, botanicals and grafting technology using resistant root stock. Most of the researches are limited to screenhouse/glasshouse conditions and yet to be verified undere field conditions. Generally, success stories associated with biological control and use of botanicals are limited to controlled conditions or pot trials. Their efficacy is reduced or not effective under field conditions. There might be indigenous methods that farmers are practicing for disease management. Those need to be explored and verified. Non-chemical tools, especially biocontrol agents or botanicals alone are not effective enough to manage plant diseases but they can be effectively used as the components for integrated disease management.

INTRODUCTION

Various diseases are responsible for causing considerable losses in different crops. New diseases have been appeared in some vegetable crops as well as minor diseases are appearing as major ones e.g. rust in garlic, Rhizoctonia in Brassicas and Solanceous crops and bacterial stem rot in tomato. To combat with the disease problems farmers are using pesticides indiscriminately, which can add several problems such as pests' resistance, resurgence of pests, environmental pollution, toxic residue in agricultural products, disruption in ecosystem and animal and human health hazards.

Pesticides use in vegetable farming is of great concerns as they are used uncooked and raw as well. It is a general practice under our conditions that farmers do not wait for required period for harvest after the use of pesticides. So, emphasis on the production of most of the agricultural crops has shifted from inorganic to organic production by using natural resources and indigenous knowledge of the farming communities.

Considering the importance of organic agriculture for safer food and environment, Plant Pathology Division has been conducting researches on different aspects that could be used as components of organic agriculture for the management of plant diseases. Most of the researches are limited under screenhouse conditions or in pot trials. The effective treatments in pot trial or under controlled conditions should be verified in the filed conditions for their effectiveness. Some of the researches conducted by Plant Pathology Division with their outputs as well as some technologies revealed by growers' practices are given below.

VEGETABLE DISEASES OF ECONOMIC IMPORTANCE IN NEPAL

Important diseases of different groups of vegetables are given in Table 1.

Table 1. Major vegetable diseases of economic importance and their causal agents

Name of the disease	Causal agent/cause	Remarks
Brassica (Crucifers)		
Clubroot	*Plasmodiophora brassicae*	Fungal
Alternaria leaf spot	*Alternaria brassicae* and *A. brassicicola*	Fungal
Downy mildew	*Peronospora parasitica*	Fungal
Sclerotinia stalk rot	*Sclerotinia sclerotiorum*	Fungal
Black rot	*Xanthomonas campestris* pv. *Campestris*	Bacterial
Rhizoctonia wire stem/root rot/damping-off	*Rhizoctonia solani*	Fungal
Cucurbits		
Downy mildew	*Pseudoperonospora cubensis*	Fungal
Powdery mildew	*Sphaerotheca fuliginea* and *Erysiphe cichoracearum*	Fungal
Gummy stem blight	*Didymella theobromae/Phoma cucurbitarum*	Fungal, emerging problem
Virus complex	Cucumber mosaic virus (CMV), Squash mosaic virus (SqMV), Cucumber green mild mottle virus, Zucchini yellow mosaic virus	Viral
Solanaceous vegetables (Tomato, Pepper and Eggplant)		
Late blight of tomato	*Phytophthora infestans*	Fungal
Early blight	*Alternaria solani*	Fungal
Septoria blight of tomato	*Septoria lycopersici*	Fungal
Phytophthora blight of pepper	*Phytophthora capsici*	Fungal
Bacterial wilt	*Ralstonia solanacearum*	Bacterial
Bacterial stem rot of tomato	*Erwinia carotovora*	Bacterial
Rootknot	*Meloidogyne* spp.	Nematode
Viral disease complex	Tomato mosaic virus, Cucumber mosaic virus, Tomato yellow leaf curl virus	Viral
Blossom end rot of tomato	Calcium deficiency	
Bulb crops (Onion and Garlic)		
Downy mildew	*Peronospora destructor*	Fungal
Purple blotch	*Alternaria porrii/Stemphylium vesicarium*	Fungal
Garlic rust	*Puccinia allii*	Fungal, emerging problem
Bulb canker	*Embellisia allii*	Fungal, emerging problem

NON-CHEMICAL RESEARCH ACTIVITIES FOR DISEASE MANAGEMENT

There are various non-chemical researches in different aspects which are useful for organic farming. Generally those researches are limited to pot trials or under screenhouse conditions. The effective out puts either from pot trials or from screenhouse trials should be varified under field conditions before it is taken to farmers use.

Screening for Disease Resistance

Searching for resistance against major diseases of vegetable crops have been conducted under screenhouse and field conditions. The genotypes/cultivars found moderately resistant to resistant to different diseases are given below.

Peppers against Phytophthora blight: Pepper hybrids: Tara, NS 1701, Karma 757, Chandani, and Angarika were found moderately resistant to resistant against Phytophthora blight under screenhouse and field conditions (PPD, 2009-2010).

Tomatoes against late blight and bacterial wilt: Tomato hybrids Arka Alok and KWR were resistant to late blight (Shrestha, 2003) under field conditions. Similarly, the genotypes, CLN 2026 C and CLN 2026 D were found resistant to bacterial wilt under field conditions (Timila and Joshi, 2008). Likewise, eggplant genotypes, such as TS 64, EG 203 and EG 190 were resistant to bacterial wilt under field conditions (Timila and Shrestha, 2001). Those genotypes could be used to minimize crop losses caused by respective diseases.

Cauliflowers and cabbages against clubroot: Cauliflower hybrids such as Clapton A, Clapton B, Clarify A and Clarify B, and cabbage hybrids such as Tekila, Kilaherb, Kilaton, Kilaxy and Kilazol were found resistant to clubroot disease under screenhouse and field conditions (PPD, 2010 and Timila, 2011). Since the seeds are not available in the market, it should be made available through proper channel.

Cultural Practices

Modifications in common cultural practices in the cultivation of vegetables contributed in reducing disease severity or incidence.

Seedling age effect: Age-related resistance plays an important role in reducing certain soil borne diseases. Older seedlings of cauliflower of seven weeks or more had reduced clubroot severity compared to younger seedlings of four weeks (PPD, 2001). This may be applied for long period varieties of cauliflower such as Kathmandu local and Kibo Giant.

Mulching effect: Mulching in soil surface is useful in reducing infection with certain soil borne pathogens thereby reducing disease incidence and severity. Mulching with rice straw reduced stalk rot incidence by 71 percent in cauliflower under field conditions (Timila and Shrestha, 1999).

Planting date manipulation: Some diseases can be managed by manipulating planting dates that skips the most favorable conditions for disease development. Early planting (3rd week of February to 1st week of March) reduced rust in bean (Timila and Shrestha, 1998). Similarly, late planting by three weeks (July planting) reduced late blight of tomato under mid hill conditions (Shrestha and Ashley, 2007)..

Biological Control

It is one of the potential tool for the management of diseases specially of soil borne nature. However, their effectivity is higher under controlled conditions or in pot trials. Researches have been conducted using *Trichoderma* spp. against various diseases.

Trichoderma spp. against clubroot of crucifers: An isolate of *T. harzianum* (T22) and two native isolates of *Trichoderma* (T69 and TS) reduced clubroot severity by 35 – 40 percent under field conditions at Makwanpur (Timila, 2010). Since the efficacy of biocontrol agents may be vary from one location to another, testing of those isolates should be done in other locations also.

Damping-off of radish: *Trichoderma harzianum*, *T. auroviride*, and one native isolate of Trichoderma reduced damping off (*Rhizoctonia solani)* of radish by 50-80% in pot trial (PPD, 2001). Their efficacy in the field conditions needs to be verified

Phytophthora blight of pepper: *Gliocladium virens* and *Trichoderma harzianum* (T22) significantly reduced Phytophthora blight of pepper by 27 and 38 percent, respectively under screenhouse conditions (Timila, 2004). Verification of their effectivity in the field conditions is required.

Botanicals (Aqueous Extraction)

A large number of plant species have been reported having pesticidal properties. Of them, only a few are known for fungicidal or antibacterial activity.

Garlic clove extract: Drenching of 12 percent garlic clove extract reduced clubroot incidence by 52 percent and Phytophthora blight of pepper by 71 percent under screenhouse conditions (PPD, 2009).

Zanthoxylum extract: Ten percent *Zanthoxylum armatum* (Timur) fruit extract reduced bacterial wilt incidence by 53 and 18 percent under screenhouse and field conditions, respectively (Timila and Shrestha, 2001).

Nettle extract: Spraying with nettle (*Urtica diodica*) extract in cattle urine (1 kg in 5 liter) and diluted with water at the ratio of 1:4 reduced powdery and downy mildew of cucumber (Gautam and Gauli, 2063).

Artemisia leaf extract: Ten percent leaf extract of Mugwort (*Artemisia vulgaris*) reduced late blight severity significantly under field conditions compared to control (Shrestha and Ashley, 2007).

Organic Amendments

Mustard meal: Mustard meal amendment in soil reduced Phytophthora blight incidence by 77 percent and 35-63 percent under screenhouse and field conditions, respectively (Timila, 2004). It also reduced root knot nematode galling index by 57 percent under field conditions at Hemja, Kaski (PPD, 2009).

Biogas slurry: Biogas slurry amendment reduced root knot nematode galling index by 4 percent when used 250 g per plant in tomato under plastic tunnel at Hemja, Kaski (PPD, 2009).

Grafting in Resistant Root Stock

Tomato plants grafted in wild eggplant (*Solanum sysimbriifolium*) resistant to root knot nematodes controlled the disease by 100 percent in tomato at Hemja in Kaski under plastic tunnel (PPD, 2009) and the fruit yield was increased by 50 percent compared to non-grafted plants.

DISCUSSION

Vegetable growers are practicing to manage diseases through a number of traditional methods as their usual cultivation practices such as intercropping, raised beds, deep ploughing, good drainage system, crop rotation and so on. Due to introduction of short period hybrids and good return from the crop, mono as well as intensive cropping became dominant in vegetable cultivation. As a result, new diseases have appeared as well as increased disease severity and incidence. To combat with disease problems, growers are using huge amount of chemical pesticides neglecting their adverse effect on environment and animal/human health. In recent years, environmental pollution and food safety due to chemical contamination have become a great concern worldwide. As a result, non-chemical tools for disease management have been emphasized.

There are some technologies for disease management documented on the use of biological agents, botanicals and indigenous materials (Table 2 and 3). However those tools may not have consistent effects. Usually, their efficacies are higher under controlled conditions or in pot trials and less or not effective under field conditions. Their effects could also be affected by the application methods and their storage conditions.

CONCLUSIONS

Most of the researches are limited to screen house/glasshouse conditions and yet to be verified under field conditions. Generally, biological control measures are effective under controlled conditions (plastic house/ greenhouse) than under field conditions. There might be a lot of indigenous methods that are practicing by farmers for vegetable disease management. Those need to be explored and verified. Biological control or botanicals alone may not be effective enough to manage plant diseases but they can be effectively used as the components for integrated disease management.

Table 2. Some botanicals reported for management of vegetable diseases

Name of botanicals	Preparations	Disease	Source
Ginger *(Zingiber officinale)*	Pure powder 20 g in 1 liter water	Collar rot of Potato	Budhathoki (2006)
Turmeric (*Curcuma longa*	Turmeric powder: ash @ 1: 4	Powdery mildew	,,
Onion (*Allium cepa*)	50 g in 1 liter water	Leaf spot and collar rot of different vegetables	,,
Pire Jhar (*Polygonum hydropiper)*	50 g. in 2 liter water	Blight diseases of tomato and carrot	,,
Neem (*Azadirachta indica*)	One ml Neem oil in one liter water	Stem blight and root rot	,,
Chilli powder	100 g in 1 liter water/soap water soaked over night and diluted to 1:5	Viral diseases	Anon, 2006, Kathmandu
Tobacco leaves and stem	Tobacco leaves and stem in water (1:15), boiled for half an hour and diluted to 1:4	Rust of bean	,,
Symbucus nigra	Flower and leaves 400-550 g in 3 liter water, boiled, cool and spray	Powdery and downy mildew of cucurbits and beans.	,,
Lemon grass	250 g paste and dilute in 4 liter water.	Blight disease of potato and tomato	Sapkota, 2005).

Table 3. Some other materials reported for management of vegetable diseases

Name of the materials	Preparations	Disease	Source
Milk	250 ml and 250g sugar spray in the morning.	Viral diseases	Anon., 2006.
Cattle urine	Cattle urine stored for 10-15 days and diluted to1:5 and spray.	Root and stem rot of beans, mosaic virus and powdery mildew of pepper	,,
Cowdung	2-3 handful in 10 liter of water and spray each day for 14 days	Mosaic of tomato and pepper	,,

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