Integrated Pests Management of Arid Fruit and Vegetable crops

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Correct citation : Haldhar, S. M. and Maheshwari, S. K. 2019. Integrated Pests Management of Arid Fruit and Vegetable crops, comprised of manuscript of lectures to be delivered during Model Training Course at ICAR-Central Institute for Arid Horticulture, Bikaner- 334006, Rajasthan from September 02-09, 2019, p. 272. This compendium solely a study material and does not intended for wide publicity.

Published by : Director

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First edition : 2019

Word processing/ designing/setting : B . R . Khatri

Integrated disease management in arid cucurbitaceous crops

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Introduction

Hot and cold arid region in India is spread over 39.54 million ha encompassing about 12.02% of the total area of the country. Maximum precipitation in north-western arid region occurs during rainy season. The region has low and erratic rainfall with high temperature (1–48°C), high wind velocity and sandy soils having low fertility. Despite these limitations, arid regions have tremendous potential in production of arid vegetable crops. However, plant diseases caused by fungi, bacteria, viruses and phytoplasmas often reduce crop yields (Khoury and Makkouk, 2010). Arid cucurbitaceous crops like bottle gourd, bitter gourd, cucmber, kachri, muskmelon, snapmelon, sponge gourd, ridge gourd and watermelon/*mateera* are mostly grown in Central and Western India. These crops can be infected by several diseases such as *Alternaria* leaf blight, *Cercospora* leaf spot, powdery mildew, anthracnose, *Fusarium* wilt, mosaic disease, bud necrosis disease, *etc.* These diseases pose serious threat in production of cucurbits in arid region, which inflict significant losses to these crops every year.

Integrated disease management implies all the available disease management approaches including cultural, biological, chemical control and host resistance strategies with the main objective to keep the disease incidence below economic threshold level. Integrated Disease Management (IDM) involves the need based use of pesticide only when the disease incidence reaches economic threshold levels. This will promote the buildup of many beneficial organisms in the crop ecosystems. IDM promotes natural, economic and sociological farming methods through the most effective combination of farming techniques and judicious and limited use of fungicide. IDM combines cultural, physical, biological, host resistance and chemical control strategies in a holistic way rather than using a single component strategy proved to be more effective. The development of IDM systems depends on a thorough knowledge of the cropping systems as well as of the pathogen and can only be achieved by interdisciplinary research such as those involving horticulture, agronomy, plant physiology, biochemistry, agro-chemicals, plant pathology etc. Adoption and support for using IDM approaches enable farmers in practicing sustainable diseases management of cucurbitaceous crops, reducing costs and improving production efficiency. Therefore, a thorough knowledge of integrated disease management strategies in arid cucurbitaceous crops are inevitable. Such indispensable approaches are as followed:

Diseases and their management of bottle gourd (*Lagenaria siceraria)*

Bottle gourd {*Lagenaria siceraria* (Mol.) Standl.}is one of the most commonly grown cucurbitaceous vegetable crops in India. It is grown in warmer regions of the world. Nowadays, it is becoming popular for several health benefits. The fruits can be used as a vegetable or for making sweets. As a vegetable, it is easily digestible even by patients. It is gaining importance due to its high yield potential, steady market price throughout the season. The fruits contain 0.2% protein, 2.9% carbohydrates, 0.5% fat and 11 mg of vitamin C per 100 g fresh weight (Aykroyd 1963). It also has a wide medicinal property such as laxative, digestive and to prevent constipation. Bottle gourd is an important crop of Rajasthan and widely grown in open field conditions as well as in river beds to harvest early crop. Area and production of bottle gourd in India is 1,55,000 ha and 25,73,000 tonnes, respectively during 2016-17 (Anon. 2017).

(i) *Alternaria* leaf blight

This disease affects the leaves of cucurbits like bottle gourd, watermelon, muskmelon, and

pumpkin. It was observed in U.P., M.P. and Bihar. Disease severity varies depending on the prevailed weather conditions. Disease incidence was recorded up to 34% in bottle gourd genotypes/varieties under hot arid conditions.

Symptoms

Characteristic symptoms first appear on leaves as small, circular and light brown spots of different size which later enlarge in a concentric rings and margins appear. These spots mix together to form larger necrotic areas on leaves.

Causal organism: *Alternaria cucumerina*
Integrated disease management

Cultural control
(a) Removal of infected crop debris, collateral hosts and weeds.
(b) Use of certified seed.
(c) Deep ploughing of the soil

Biological control

Application of *Trichoderma viride* and *T. harzianum* (5%) was effective against this disease.

hemical control
(a) Sprays of indofil M-45 (0.2%) at regular interval was very effective against this disease.
(b) Integrated management of *Alternaria* leaf blight were developed under field conditions. Combined treatment of carbendazim @ 0.1% (Seed treatment) + mancozeb @ 0.25% (Foliar spray) + *Pseudomonas fluorescens* @ 5% (Foliar spray) + neem leaf extract @ 5% (Foliar spray) was the most effective with minimum disease incidence of 9.25%, minimum disease severity of 7.07% and maximum disease control of 78.23% (Maheshwari et al. 2017).

(ii) Powdery mildew

Powdery mildew affects cucurbits like bottle gourd, cucumber, muskmelon, squash and pumpkin under field and greenhouse conditions. The disease is widely distributed and destructive among cucurbits in most areas of the world and can be a major production problem causing yield losses of 30%–50% (El-Naggar et al. 2012). In India, the disease is prevalent in almost all the states and causes yield losses **(Gupta et al. 2001).**

Symptoms

The symptoms appear as small floury patches on leaves first on the lower surface followed by upper surface. Fungal growth on these spots results in production of powdery growth. Severely affected leaves lose their dark green colour and become pale yellow green to brown and are shrivelled, reduction in plant growth and premature defoliation, drying and collapse. Fruits remain undersized and consequently reduction in yield.

Causal organism: *Sphaerotheca fuliginea*
Epidemiology

The most favorable conditions for disease development are 35°C temperature and high relative humidity of more than 70% (Ali et al. 2013). Temperature and humidity must be examined together since it is the water vapor pressure deficit that has the greatest effect on host–parasite interactions. During periods of intensive dew on leaf surfaces, the severity of this disease is enhanced. However, excessive water on the leaf surface is often detrimental to the development of powdery mildew disease.

Integrated disease management

Cultural control

(a) Removal of infected crop debris.

(b) Deep ploughing may burry the pathogen where it may be killed by soil microflora of the pathogen present in below soil layers, after ploughing, may be brought to the soil surface and inactivated by solar radiation.

(c) Destruction of weeds and collateral hosts.

(d) Crop sequence with appropriate crops may be the most effective management practices in eliminating soil borne pathogens.

(e) Introduction of resistance or non-host crops in rotation helps in disease reduction.

Host resistance

Use of moderately resistant bottle gourd varieties (Pusa Naveen, Pusa Santushti, Pusa Sandesh and Arka Bahar) against this disease (Maheshwari et al. 2012)

Biological control- Biological control involves *Ampelomyces quisqualis* , which parasitize and destroy the powdery mildew.

Chemical control

(a) Three sprays of hexaconazole (0.05%) were found effective (Gupta and Gupta, 2001).

(b) Foliar sprays of non-target chemicals and neem kernel extract (5%) were effective.

(c) Foliar sprays of benomyl (0.1%) and carbendazim (0.1%) are very effective.

(iii) *Cercospora* leaf spot

This disease caused by *Cercospora citrulina* was observed on cucurbits (Sarbhoy 2006). Disease incidence was noted from 6.70 to 39.25% in different bottle gourd genotypes under arid conditions. First record of *Cercospora* leaf spot on bottle gourd in Pakistan was reported by Mukhtar et al. (2013).

Symptoms

Small, circular to irregular circular spots with tan to light brown lesions with dark margins appear on older leaves. The number and size of lesions increases. These lesions coalesce with each other and causing entire leaves to become diseased. Infected leaves turn yellow under severe conditions and finally fall off. If the disease is severe, then defoliation occurs and the yield is affected. It can reduce fruit size and quality (Schwartz and Gent 2007).

Causal organism: *Cercospora citrulina*

Integrated disease management

Cultural control

(a) Removal of infected crop debris, weeds and collateral hosts.

(b) Avoid overhead irrigation and irrigation in the morning hours.

(c) Growing the crop with non-host crop.

(d) Deep ploughing may also be practiced immediately after final harvest.

Host resistance

Use of moderately resistant varieties such as Pusa Naveen, Pusa Santushti, Pusa Samridhi and Pusa Sandesh against *Cercospora* leaf spot (Maheshwari et al. 2015).

Chemical control

Fungicide sprays are necessary for disease control in wet and humid weather. Two sprays of

chlorothalonil/ chlorothalonil mixtures or ridomil (0.15%)/ indofil M-45 at 0.2% are effective.

Muskmelon (*Cucumis melo* L.)

Muskmelon (*Cucumis melo* L.) popularly known as 'kharbuja' in India is one of the most important cucurbits grown as a 'Dessert crop' throughout the world. In India, its production is concentrated in the tropical and sub-tropical regions. It is grown under both riverbed and irrigated conditions for local and interstate sales. Area of muskmelon crop was 45,000 ha with production of 9,35,ooo MT in India during 2015-16 (Anon. 2016).

(i) Wilt

It is a threat to bottle gourd, cucumber, muskmelon and watermelon) of all over the world (Radhakrishnan and Sen 1985). The disease is the most destructive at places wherever soil temperatures are high enough for the pathogen to grow but unsuitable for the plants. Yield losses up to 80% have been reported in the worst affected areas (Gupta et al. 2001).

Symptoms

Disease appears at flowering stage of the crop. The leaves are accompanied by yellowing and marginal necrosis. The infection results in lesion formation on the collar region and infected areas appear brown and water soaked. Wilting starts sudden after fungal infection. As a result of softening of the tissue, the plants shriveled, followed by rapid mortality of whole plant. The older plants wither and die during the growing season.

Causal organism: *Fusarium oxysporum and Fusarium acuminatum*

Integrated disease management

Cultural control

(a) Crop rotation with garlic, radish, onion has been found to reduce the disease in melons and cucumber.

(b) The exclusion of the pathogen is the best means to manage disease and, accordingly, pro-cure disease-free seeds from reliable sources.

c) Field sanitation and uprooting of the infected plants.

d) Growing the crop with non-host crop.

(e) Wilt suppressiveness can be induced in soil by repeated croppings of resistant varieties of melons.

(f) Soil solarization can be used to lower infection in soil sufficiently to delay the onset of wilt symptoms as well as to reduce the disease incidence.

Host resistance

(a) In muskmelon, The Indian cultivars (Durgapura Madhu and Punjab Sunehri) are resistant to *Fusarium oxysporum* and *F. solani* (Radhakrishnan and Sen, 1985).

(b) Mark *et al.* (2005) found Hannahs Choice F1 as resistance source against *Fusarium* race 2 as well as powdery mildew in muskmelon.

Biological control

Use of antibiotic-producing soil fungi and bacteria, that is, *Gliocladium* spp., *Trichoderma* spp., and *Pseudomonas* spp. were found effective (Srinon *et al.* 2006).

Chemical control

Drenching of carbendazim (0.1%) is very effective against this disease.

Watermelon/*mateera* (*Citrullus lanatus*)

Area and production of watermelon in India is 91,000 ha and 21,69,000 tonnes respectively

during 2016-17 (Anon. 2017). The fruits are rich source of B-carotene, vitamin B, C and E, minerals (K, Mg, Ca and Fe), citrulline amino acid and phenolics. Watermelon is also known as *Tarbooj* in some parts of India and *Mateera,* particularly in Rajasthan. *Mateera* is drought hardy landraces crop. It is an indigenous type of watermelon and is extensively grown with mixed cropping on sand-dunes landscape in Thar desert.

(i) Mosaic disease

It is a viral disease and causes severe losses in Rajasthan. During 1999 crop season an epidemic of mosaic disease was prevalent on muskmelon, cucumber and squash in Punjab and in adjoining states causing huge fruit losses to the crops. Disease incidence was appeared from 14.29 to 50.0% and 5.0-33.33% in different genotypes of watermelon/ *mateera* and ridge gourd, respectively at experimental field of the institute.

Symptoms

Plants showed characteristic symptoms of wilting and dry, necrotic lesions on leaves and internode shortening, mottling of leaves and development of vein clearing. Plants are stunted.
Causal organism: This disease is caused by virus and transmitted by aphid.

Integrated disease management
Cultural control

(a) Field sanitation
(b) Use of disease free seed.
(c) In the early stages of crop growth, monitor the crop carefully and remove the plants with symptoms of virus.
(d) Remove all weeds and volunteer cucurbit crop plants within and around cucurbit crops as these can harbor aphids and viruses.

Chemical control
a) Application of insecticides like dimethote (0.05%) are recommended for the control of vectors (aphid).
(b) Spraying of imidacloprid (3-5 ml/ 10 lit. of water) is also very effective for vector control.

(ii) Bud necrosis disease

It is also a serious problem and causes yield losses in Bikaner district and also in western Rajasthan of watermelon/*mateera* growing areas. It is also a viral disease.

Symptoms

Symptoms are leaf crinkling, mottling, yellowing, necrotic streaks on vines, shortened internodes, upright branches and necrosis and dieback of the buds.
Causal organism: This disease is caused by virus and transmitted by thrips

Disease cycle

Diseases occur throughout the entire year but the disease incidence is generally higher during dry and hot periods when thrips populations increase rapidly. The virus is transmitted by thrips species, in a persistent manner (vector can acquire and transmit the virus after feeding for several minutes to hours: virus replicates inside the vector) young thrips (larval stage) acquire the virus and adult thrips spread the virus from plant to plant during feeding. The virus is not seed transmitted.

Integrated disease management

Cultural control

(a) Use virus free seedlings

(b) Remove infected plants as early as virus symptoms are observed to prevent/minimize spread of the virus by thrips.

(c) Remove crop debris, weeds and other sources of thrips after the cropping season.

(d) Ploughing and harrowing may help reduce vector population in the soil.

(e) Control thrips population by using plastic mulch, blue sticky traps.

Chemical control

(a) Spray monocrotophos/acephate (0.15%) at fortnight intervals after transplanting till flowering stage.

(b) Chemical spray followed by neem seed kernel extract (2%) is also effective in rotation with insecticides.

(c). Spraying imidacloprid at the rate of 0.5 ml/litre of water to control of sucking insects.

Ridge gourd (*Luffa acutangula)*

Ridge gourd [*Luffa acutangula* (Roxb.) L.] is one of the important warm season vegetable crop which belong to cucurbitaceae family and grown in different parts of India. The immature fruits are consumed as vegetable and used in the preparation of chutneys and curries. The fruits contain good amount of calcium, phosphorus, ascorbic acid, iron and fibre content (Aykroyd 1963). Being a warm season vegetable crop, it has the ability to tolerate high temperature which ensures its adaptability for widespred cultivation throughout the tropics. Due to monoecious condition, it is a highly cross pollinated and had wide variability in qualitative characters.

(i) Mosaic disease

It is a viral disease and causes severe losses in Northern India. Disease incidence was appeared from 7.14 to 50.0% in different genotypes of ridge gourd and ridge gourd at experimental field of the institute.

Symptoms

Plants showed characteristic symptoms of wilting and dry, necrotic lesions on leaves and internode shortening, mottling of leaves and development of vein clearing. Plants are stunted.

Causal organism: This disease is caused by virus and transmitted by aphid.

Disease management

Cultural control

(a) Removal of infected plant.

(b) Use of disease free seed.

Chemical control

(a) Spraying of imidacloprid (3-5 ml/ 10 lit. of water) is very effective for vector control.

Some other arid vegetables like kachri, kakdi and snapmelon are not affected by fungal, bacterial and viral diseases due to hardy nature of crops, their drought tolerance ability and unfavourable climatic conditions for initiation of disease development.

Future scope and research need

(i) Standardization of cultural practices integrated with reduced doses of fungicides.

(ii) Assessment of the efficacy of botanicals and bio-agents against major diseases of arid cucurbitaceous crops. Besides, the rearing feasibilities of the promising bio-agents should be further investigated under natural field conditions.

(iii) Development of fungicides/pesticides with less toxicity.
(iv) Study the residual effect of fungicides/chemicals on human beings and environment and to advise residue tolerance limit.
(v) Collaboration between research organization and pesticides industries for developing new molecules with minimum persistence and their commercialization.

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