PLANT PROTECTION PROBLEMS IN CASSAVA IN INDIA

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ABSTRACT

Cassava is grown in India for both food and industrial purposes. Like all other crops, cassava is also prone to be infected by several pathogens. Among the various diseases of cassava that limit production, Indian Cassava Mosaic Disease (ICMD), root rot, *Phoma* and brown leaf spot are the most important.

ICMD is widespread in almost all cassava growing areas of India and causes yield losses of up to 88% in susceptible varieties and up to 50% in field tolerant varieties. The rate of spread and degeneration of cassava due to ICMD varies among varieties. Even in field tolerant varieties, entire plant populations may degenerate within three to four years. ICMD is caused by *Indian cassava mosaic begomovirus* which is serologically different from other cassava viruses, such as ACMV and EACMV. Time of infection, varietal susceptibility, climatic factors and vector population determine the disease incidence and yield loss.

Another important disease is root rot caused by *Phytophthora palmivora*, which is emerging as a serious threat to cassava in several industrial areas of Tamil Nadu, causing up to 50% loss in certain endemic areas. Characteristic symptoms as well as morphological features of the pathogen have been described. Excessive irrigation, poor drainage and the development of a hard pan favor the occurrence of this disease. Differential reaction of cassava varieties to infection by *Phytophthora* was observed. Brown leaf spot caused by *Cercospora henningsii* is also an important disease in certain areas, causing severe defoliation. Disease intensity/incidence varies depending upon climatic factors, nutrient management and varieties. *Phoma* dieback disease is an emerging problem in certain areas where cassava cultivation is intensive. Tip drying and stunted growth leads to reduction in quantity and quality of root production. Integrated disease management options to contain the above diseases, and strategies for production of healthy planting material, are discussed.

Among the several pests which attack cassava, scale insect, spider mite, termite and whitefly are the most important ones. Scale insects (*Aonidomytilus albus*) attack the stems in the field and during storage of planting material, leading to a loss of viability of the planting material and poor establishment. The insect perpetuates itself through planting material, which serves as a source of multiplication and spread. The severity of attack increases during prolonged dry weather. Red spidermites (*Tetranychus cinnabarinus* and *Eutetranychus orientalis*) are important foliage feeders, which cause chlorosis, withering and drying of leaves. Severe infestations are observed during dry periods and the incidence increases year after year depending upon the climate. Climatic factors and insect population determine the extent of the outbreak. Yield losses due to the spider mites range from 17 to 33%. Termites (*Odontotermus* spp) are often a serious pest, attacking stems and sets in the field during dry periods, especially in Tamil Nadu and Andhra Pradesh. Two kinds of whitefly i.e. common whitefly, *Bemisia tabaci*, and spiral whitefly, *Aleurodicus disperses*, may cause serious infestations; the latter one has emerged as a serious problem since 1993. *Bemisia tabaci* is important as a vector of ICMD and is present throughout the year. Spiral whitefly causes yellowing, crinkling and curling and and is the cause of sooty mould. In both cases severity of the damage increases during the summer. For all these pests effective management strategies have been developed.

INTRODUCTION

Tropical root and tuber crops form and important group of crops used as secondary or subsidiary food for one fifth of the world population in tropical and sub-tropical regions;

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they are also the third most important group of foods, after cereals and pulses. Cassava (*Manihot esculenta* Crantz), sweet potato (*Ipomoea batatas* (L.) Lam), aroids taro or arum (*Colocasia esculenta* (L.) Schott), tannia (*Xanthosoma sagittifolium* Schott) and elephant-foot yam (*Amorphophallus paeonifolius* (Dennst) Nicolson), (lesser yam (*Dioscorea esculenta* Burk), greater yam (*D. alata* L.), and African or white yam (*Dioscorea rotundata* Poir), country or Chinese potato (*Solenstemon rotundifolius* Poir) and yam bean (*Pachyrrihizus erosus* L.) are the important tropical root and tuber crops. These crops have a higher biological efficiency as producers of carbohydrates than the cereals. Besides, they can by used as raw materials for the production of alcohol, starch, sago flour, liquid glucose, vitamin C and many other industrial products, as well as animal feed. Hence, tropical root and tuber crops share a place with cereals as dietary staples, both in raw and processed forms. Their starches are invariably superior to the conventional sources of starch, and they are efficient biological producers of carbohydrates per unit area per unit time. In the 21st century nearly one fourth of the world population is estimated to live in severe poverty. With the burgeoning population in India we may have to import 40 million tonnes of food to meet the requirements by 2030. It is in this context that the tuber crops assume importance. Root and tuber crops, with due support of advanced technologies, will play a greater role in meeting the food requirements of the country in the coming years.

Cassava is a staple food in Kerala state and is popular as an industrial crop in Tamil Nadu, Maharashtra and Andhra Pradesh. Cassava is grown on an area of about 200 thousand ha with a production of 5.87 million tonnes. Sweet potato is largely grown in Orissa , Uttar Pradesh, Bihar, Assam and Maharashtra and the area under sweet potato is about 130 thousand ha with a production of 1.06 million tonnes (FAO, 1998). The cultivation of edible aroids, yams and Chinese potato is restricted to parts of Bihar, Orissa, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra, West Bengal and Northeast India.

Pest Complexes of Root and Tuber Crops

Like other crops, tuber crops are subjected to the depredation of a number of insect and non-insect pests. A comprehensive global account of cassava pest management was given by Anon (1978), Bellotti and Schoonhoven (1978), and Bellotti *et al.* (1999). Lal and Pillai (1982), Pillai and Palaniswami (1984), and Pillai (1994) reviewed the pests of cassava in India. Anon (1978), Sutherland (1986), Palaniswami (1988) and Jansson and Raman (1999) reviewed world sweet potato pests. Rajamma *et al.* (1993) detailed the pests attacking sweet potato in India. Pests of edible aroids, yams and Chinese potato, were comprehensively reported by Anon (1978); Mitchell and Maddison (1983) and Palaniswami (1994a). In India, about 34 species infest cassava, 78 species attack sweet potato, 46 species on edible aroids, 21 on yams and 10 on Chinese potato (Palaniswami and Rajamma, 2000). Major pests of each crop are discussed in a comprehensive manner along with its management strategies.

Disease Complexes of Root and Tuber Crops

Tropical root and tuber crops are attacked by several diseases caused by fungi, bacteria, viruses and mycoplasma-like organisms, which may cause yield reductions in the crops. In India, more than 80 diseases have been reported on these crops while the global

figure is more than 200. However, many of these diseases are of minor importance or cause little damage and are limited in geographical distribution, while some are of considerable importance and cause significant damage. With the increase in the development of new varieties and with the international exchange of genetic material, the number of diseases are also on the increase, while in certain pathogens new virulent strains are also developing. As these crops are vegetatively propagated and many of the diseases are spread through the planting materials, great care should be taken during the import of planting materials from other countries so as to avoid introducing presently non-existing pathogens into the country. The most important viral disease of cassava reported in India is Cassava Mosaic, or more precisely Indian Cassava Mosaic Geminivirus (ICMV), which is transmitted by the whitefly, *Bemisia tabaci.*

Among all the diseases reported in India, only few diseases, like cassava mosaic disease, root rot of cassava, leaf blight of Colocasia and collar rot of elephant foot yam, are of major importance as they cause a considerable reduction in yield. Yield reduction of cassava mosaic disease (25-100%), leaf blight of Colocasia (25-50%), and collar rot of elephant foot yam (20-100%) may vary depending on the cultivars and influence of various weather factors.

MAJOR CASSAVA PESTS

Cassava Scale Insects

Scale insects attach to the stem in the field and during storage of planting material. The most important scale insect is the white mussel-shaped soft scale (*Aonidomytilus albus* CkII). It was first reported in Tamil Nadu. The insect sucks and desaps the stem. It multiplies rapidly covering the stem in large numbers, and it also attacks the side shoots and at times the petioles as well. In severe infestations the stem becomes weak and dry due to the prolonged infestation, resulting in the loss of viability of planting material and poor establishment of the crop. Weakening and breaking of the main stem causes profuse branching which gives a bushy appearance. The severity of attack increases during a prolonged dry season. The problem is perpetuated through planting materials which serve as the source of multiplication and spread. Eggs are laid beneath the scales. The young nymphs come out in 3-4 days after which they are active, spread out and settle. Once they start feeding they lose their legs and become sedentary. The adult produces a white waxy secretion over itself which develops into a scale. In 20-25 days the nymphs become full grown. The male is winged and the female is wingless and sedentary.

For the effective management, scale-free stems should be collected for storing and planting. Storing the stems in a horizontal position encourages multiplication of scales due to the development of higher temperature and humidity. Therefore, healthy stems are to be kept in a vertical position under shade to facilitate easy aeration and diffused day light. As a prophylactic measure the stems may be sprayed with Dimethoate (0.05%) at the time of storing. If further infestation is observed, one more spraying may be carried out. The infested stems are to be rejected and burned at time of planting. In case of acute shortage of planting material and when the scale attack is mild, then the stakes can be dipped into the above insecticidal solution for 10-15 minutes before planting.

Cassava Spidermites

Among the foliage feeding pests, the most serious ones are the spidermites. There are two distinct groups of spidermites. One group feeds on the lower surface of the leaves (*Tetranychus cinnabarinus* (Boisd.) and *T. neocaledonicus* Andre) causing elongated streaks, chlorosis, withering and drying of leaves. The other group which prefer to infest on the upper leaf surface includes *Eutetranychus orientalis* (Klien) and *Oligonychus biharensis* (Hirst); these cause depletion of chlorophyl, resulting in the characteristic bronzing and typical rusted & leathery appearance, and such leaves begin to curl from margins and later fold into one twisted roll. The teranychid mites usually infest the lower leaf surface but during epidemics may cover both sides of the leaf. The predominant species are *T. cinnabarinus* and *E. orientalis.* They appear together and multiply rapidly during dry periods. Both groups infest from the bottom leaves upwards. In periods of heavy infestation the population density ranges from 200-1000/leaf in almost all leaves. The lower surface feeding mites cause more severe leaf fall than other groups. The biology and binomics of *T. cinnabarinus* and *E. orientalis* reveal that the total life cycle from egg to adult ranges from 11-20 and 10-14 days, respectively. The spidermites' incidence may increase year after year depending on climatic conditions. Rainfall is the most limiting factor. Heavy rainfall accompanied by wind is harmful to mites, while a fall in relative humidity and an increase in temperature are highly conducive for their rapid multiplication. An outbreak can be expected during dry summers when the temperature is above 32°C and the relative humidity below 75%. The yield loss due to spidermites alone ranged from 17.8 to 33.1% in different varieties under natural infestation in Kerala. The economic threshold levels for spidermites was found to be 25% leaf infestation for Sree Vishakam and 10% for Sree Sahya and M4 varieties. Seasonal incidence of biotic agents of spidermites of cassava indicated that predators of mites had a preference for eggs and nymphs to adults. Several cassava accessions at CTCRI, *i.e.* CE-4, CE-14, CE-38 and CE-139, were found to be highly resistant to spidermites. The host plant resistance is the most satisfactory and long-term solution to control mites on cassava. Spraying Demethoate or Methyldemeton (0.05%) during severe infestation (Jan to April) is highly effective against the mites; spraying water at run-off level is also effective in reducing mite infestation. This has an added advantage of preserving the biotic agents of mites. Foliar application of urea followed by spraying Dimethoate at 0.05% in severe situations was recommended as an IPM approach against spidermite outbreaks.

Cassava Whiteflies

Bemisia tabaci (Genn.) is the common whitefly on cassava. It is more important as a vector of CMD than as a pest and is abundant throughout the year. An aphelinid nymphal-pupal parasitoid *Encarsia flava* (6.8 to 30%) was found to be an effective biological control agent for white flies in the field.

Spiral whitefly, *Aleurodicus disperses* Russel, was found to seriously infest cassava since 1993. It is highly polyphagous in nature and causes yellowish specks of leaves, resulting in crinkling and curling and sooty mould development. Adults are much larger than the normal whitefly, i.e. *B. tabaci* (2 mm in size). Eggs are deposited spirally on leaves and take 18-23 days to become adult. Severity of damage increases during summer.

MAJOR CASSAVA DISEASES

Cassava Mosaic Disease

Cassava mosaic disease is caused by the Indian Cassava Mosaic Geminivirus. The symptoms are chlorotic areas intermixing with normal green tissue, which gives the mosaic pattern. In severe cases leaves are reduced in size, twisted and distorted. It affects the growth of the plant, resulting in a significant reduction in plant height, stem girth, petiole length and leaf size. It causes 25-80% yield reduction depending upon the varieties.

The primary spread of the disease is through the indiscriminate use of infected planting material; the secondary spread is through the vector, the whitefly *Bemisia tabaci* G. Studies on modes of transmission indicate that the disease is not transmitted through true seeds. Sap transmission of the disease from cassava to cassava could not be achieved. However, the disease could be transmitted through sap from cassava to *Nicotiana benthamiana* and *N. glutinosa*. CMD can also be easily transmitted through grafting.

The disease causing agent (virus) was purified and found to belong to the group "Gemini" viruses. The particles measure 18-24 nm in diameter. The antisera with adequate titre strength, which can detect successfully even latent infection of the disease, have also been developed.

Symptoms of the disease are masked during dry and hot months and make it impossible to identify the diseased plants. Therefore, disease-free planting materials should be selected before the beginning of the dry/hot season.

Resistance to CMD has been studied since 1968 in the country. No cassava variety is immune to CMD. Even the related species, i.e. *M. glaziovii* is susceptible on artificial inoculation. However, a great variation in the degree of susceptibility was observed; a few field resistant/tolerant lines such as M4, H97, H165, H 2304, H1687, S1315, S1310, S2381 and S2380 were identified and recommended for cultivation.

Integrated management of CMD

This includes the following measures:

- Selection of disease-free planting material.
- Use of field tolerant varieties like H-97, H-165 and Sree Visakham.
- Selection of disease-free meristem-derived planting material, followed by clonal multiplication with periodical screening and rouging of freshly infected plants, will be useful to raise a good disease-free crop.
- Disease-free planting material can be multiplied on a large scale at higher altitude where the whitefly population is low or nil.
- Raising the plants in the nursery at closer spacing prior to transplantation into the main field is an useful step to prevent the primary spread of the disease in the main field.
- Adherence to strict sanitary practices such as timely harvest and prompt disposal of crop residues, and eradication of self-sown plants and weeds which may harbor both the disease and vectors.

Cassava Root Rot

Cassava root rot is caused by *Phytophthora drechsleri*. There are no external symptoms. Infected roots show brown discoloration of internal tissues, or are rotten and exhibit foul smell. Infected roots rot and become unfit for consumption or marketing and hence cause heavy economic losses.

The disease can be managed by providing proper drainage in the field. The infected roots should be removed from the field and burned. *Trichoderma viride* is a good biological control agent and can be released in the problem areas.

Plant Quarantine

African mealy bugs, American green mites, grasshopper, hornworm and thrips, which are serious pests in south America and Africa, have so far not gained entry into India. Mealy bugs of cassava are actually a devastating pest which has greatly affected cassava cultivation in Africa. However, it is now being contained by a massive Africa-wide biological control program.

Similarly, many serious cassava diseases, such as witches broom, super-elongation, frog skin, vein mosaic and brown streak etc. have so far not been reported in India. This warrants for strict surveillance and quarantine measures to prevent their introduction. The diseases given below, need special attention.

Name of the disease		***Causative agent***
African Cassava Mosaic	-	African cassava mosaic virus - Uganda strain
East African Cassava Mosaic	-	East African cassava mosaic virus
Cassava Common Mosaic	-	Cassava common mosaic virus
Cassava Brown Streak	-	Cassava brown streak virus
Cassava Vein Mosaic	-	Cassava vein mosaic virus
Witches Broom	-	Mycoplasma-like organisms

FUTURE OUTLOOK

In the developing countries, tropical root and tuber crops have received far less attention with respect to research and development than other crops. Most of the basic and applied research in the area of crop protection of root and tuber crops have been conducted in the developed countries. Considerably more attention has to be given to IPM/IDM of tropical tuber crops in developing countries.

Effective plant quarantine is the first line of defence against the introduction of pests and diseases. It is obviously an important component of IPM/IDM. It requires coordination at national and international levels. With efficient and vigilant quarantine, the introduction and spread of exotic pests which are of serious nature can be avoided or greatly curtailed.

In addition to the tactical approaches (biological control, host plant resistance, chemical control and systems entomology) associated with IPM for cassava, the following areas of research are also needed.

- Use of flow cytometry in determining the DNA content of insect cells in order to differentiate biotypes, sub species and the genetic make-up of populations
- Use of NMR and mass spectrometry for identification of chemicals in insects and plants affecting behaviour or survival
- Genetic engineering of microbes and its applications
- Application of artificial intelligence and expert systems.

Use of fungicides to control the fungal diseases or insecticides to keep off the vectors, are generally not practical due to economic considerations; however, fungicides can be economically used for the treatment of planting materials such as stem cuttings before planting. It is therefore necessary to use new technologies integrating flexible combinations with minimum use of pesticides. Such technologies may include use of host plant resistance, selection of disease-free planting material, field sanitation, improved cultural practices that reduce disease vulnerability, biological control, and developing disease diagnostic kits for major viruses. Many of the virus diseases need to be studied systematically for better understanding and formulation of an effective integrated disease management.