https://doi.org/10.29321/MAJ.10.A04839

VIRUS DISEASES OF PLANTS

BY C. S. KRISHNASWAMI, B.A., B. Sc. Ag.,

Assistant in Mycology.

In the beginning of this century the plant pathologist was familiar with only two kinds of organisms which cause plant diseases viz., fungi and bacteria. But in recent times he has to be familiar with another entity which goes by the name of virus. Virus diseases are those caused by an infective principle which is ultra microscopic in character and is capable of multiplying within the tissue of its host. The presence of this principle is indicated by the manifestation of typical symptoms on the host. Virus diseases attack man, his domestic animals and plants. Small pox, measles, mumps, chicken pox, herpes, yellow fever, cattle plague, swine fever, rabies, foot and mouth diseases of cattle are but a few examples of virus diseases among animals and man. The number of virus diseases attacking crop plants is large and every day new diseases hitherto not observed or ascribed to other causes are brought to light by workers all over the world. Of these may be mentioned the diseases affecting sugarcane, tobacco, potato, the sugar beet and the sandal wood tree.

Economic importance. The losses caused by this class of diseases are enormous. It is has been estimated that the loss due to the use of mosaic infected sugarcane setts in Cuba is 62·9 per cent in the first crop, while the successive ratoon crops show an average 79·5 per cent loss in a five years period[4]. In our presidency, an experiment carried out on the variety Co. 213 for 3 years definitely showed that the net loss is 25 per cent.[1] In other varieties especially B 3412, the entire crop may be lost and in Poovan and Red Mauritius the yield is reduced by more than 50 per cent. In a series of tests in Rio Canto the average losses from mosaic over a five year and a three year period respectively were 11 and 8 tons per acre. The loss in yield in potatoes is estimated to range between 20 to 61 per cent in England, Ireland and Wales. Very high losses have also been reported from Germany Canada and the United States of America. In Nigeria a leaf curl disease of cotton, which is also present in North India, has been found to reduce the yield by 100 lb. of ginned cotton per acre. In the year 1924, the yield of sugar beet crop in the Yakima valley was reduced to one fourth by curly top of beets. In 1925, 10,000 acres of sugar beet were abandoned in California.[4] The spike disease of sandal, as is well known, reduces the value of the yield to as low as 50 per cent.

Nature of virus. In discussing the nature of virus a comparison of the different organisms causing plant diseases will not be out of place. Many fungi and bacteria can live apart from their hosts. i. e., they can be cultivated 'in vitro'. The effect of their attack on the plant is oftentimes direct and causes immediate and perceptible damage. Till recently the consensus of opinion among the scientists was that the virus is of a similiar nature, with this difference, namely (a) that it cannot be seen with the aid of the most powerful microscope now available and (b) that it is capable of passing through filters with pores of such dimensions through which the smallest known living organism could not pass, (c) it is not capable of being cultivated in vitro. But it was generally agreed that the agent was some kind of living entity. But recent discoveries have considerably upset the theory of a living organism and in this connection, Stanely's[6] work in 1935 is a historical landmark in the study of plant viruses. He succeeded in obtaining a crystalline substance from the sap of infected plants which he claimed to be the virus itself. Bawden and Pierie[1] have confirmed this observation in their work. The opinion is now veering round that the virus is an autocatalyse which is akin to Nucleo-protein and which is capable of permeating through plant tissues and converts other proteins to its own composition.[5] In general properties these proteins resemble enzymes. Very recent researches by Bernard have shown the possibility of some of the viruses being photographed with the aid of special apparatus. But whether the virus is a non-living substance or a living organism, it is certain that it is particulate and has a definite structure and shape as is proved by recent research on the filterability of many viruses by Elford. Evidence is also available to show that a virus may (either due to environmental conditions or by passing through another host,) change itself to another virus as was shown by Salaman[2]. Therefore in spite of considerable volume of work, it is still a difficult problem to correctly define a virus and it is still in the realm of the not fully solved mysteries of the world.

Properties of virus. The viruses resemble enzymes but vary widely in their physical properties. They react differently to heat, dilution, treatment with chemicals, and oxidation. Some viruses are capable of withstanding as high a temperature of 90° C, but many of them are destroyed at very much lower temperatures (42 to 43°C).

Toleration to dilution. The dilution end point of the most potent virus has been found to be 1 : 100,000, while some are inactivated by a dilution of 1 : 10.

Longevity in vitro. Many viruses are inactivated the moment they are extracted from the plant tissue, but there are some which are capable of remaining viable for years. In a dry state, the tobacco virus is said to have remained viable for 24 years.

Precipitation. Viruses are precipitated by lead acetate and safranin and certain other chemicals.

Pressure. Viruses are capable of withstanding very high pressures.

Chemicals. It has been found that viruses especially some tobacco viruses are capable of withstanding the effects of chemicals without deterioration to a high degree. Chloroform, carbon tetrachloride, toluene and acetone failed to destroy the tobacco virus and so also nitric, hydrochloric and phosphoric acids. The viruses can resist immerions in glycerol.

Effect on host. A group of viruses manifest themselves by producing mottling symptoms on the foliage. These are termed the mosaics. Others again cause a curling and rolling on the leaves. Others cause malformation, stunting and sterility, some reduction in the size of foliage and crowding of the auxiliary buds. Internally the virus affects the cells and its contents and profoundly alters the metabolism of the plant. In many cases cytoplasmic inclusions have been found. The net effect of the presence of the virus in many plants is the total suppression of the floral parts with the result that no seed is formed.

Means of spread of virus diseases. Virus diseases can be transmitted artificially by

(1) inoculation of sap extract,

(2) grafting,

and (3) insect vectors

but the means of their spread in the field is in some cases still an unsolved problem. In many cases, it has been definitely proved that insects, especially sucking insects are responsible for carrying infection from one plant to another. Undoubtedly, in sugarcane it is an insect that is responsible for the spread of the disease from diseased to healthy canes. The leaf curl of tobacco is spread by a white fly, but paradoxical as it may seem, the actual vector responsible for the spread of tobacco mosaic in the field is not determined, though under experimental conditions *Myzus pseudosolani* occasionally transmitted the disease. In the case of insect transmitted diseases, it is still a moot point if some of the viruses undergo a biological change in the body of the insect.

Human agency. In the case of tobacco mosaic, there is considerable observational and experimental evidence that the disease spreads mostly through human agency.

Seed. With very few exceptions, the virus is not carried through true seed, but in all cases where the plant is propagated vegetatively as in the case of sugarcane, potato, banana and cardamom, the disease spreads and multiplies by this means.

Mechanical contact. There is evidence that some diseases spread by contact of leaves of diseased plants with healthy plants.

Soil. The tobacco virus is capable of being retained in the soil along with the soil solution for nearly 8 months and infect new plantations.

Air. Whether the virus particles can be carried through air and infect new plants is a question yet to be solved. K. M. Smith has described a virus which would appear to be capable of aerial transmission.

Methods of combating the diseases. Owing to the nature of these diseases it will be evident that the usual method of plant protection such as spraying, improving the condition of the soil, etc. are of no avail in combating them.

Resistant varieties. By far the most practicable of methods hitherto found successful are the production of resistant and immune varieties by breeding. In sugarcane, this offers the most practicable solution in places where the disease is highly destructive.

Elimination of infective material. In places where the disease has not progressed considerably the methods of roguing out diseased plants seems to offer the best solution. But care must be exercised to see that the rogued plants are immediately destroyed to prevent the insect vectors transferring themselves to the healthy plants round about.

Destruction of insects which act as vectors. This may be practicable in limited areas and for such crops as are very valuable as for example, medicinal plants, vegetables and flowers grown in hot houses, but how far the methods could be utilised on a field scale remains to be investigated.

Growing plants from true seed. In the case of plants like cardamom the incidence of the disease could be minimised if new plantations are raised from true seed instead of from rhizomes.[7] In the case of tobacco, the disease can be eliminated from seed beds if the nursery is raised in a fresh area every year and the seed is thoroughly cleaned and winnowed to remove all debris of the previous year's crop adhering to the seed.

Other precautionary measures and field sanitation The removal of weeds which are likely to harbour the virus, the prompt destruction of all diseased material, the ploughing of the land and removal of stubbles immediately after harvest, the avoidance of growing the same crop in highly infected fields for a few years, are a few of the precautionary methods which have proved useful in controlling the disease.

Immunology. Yet another startling discovery of recent years in plant pathology is the possibility of immunising the crop plant by artificial inoculation similar to vaccination. The presence of one virus often inhibits the development of other viruses or a second dose of the same virus. Salaman[3] has shown that the presence of a weakly pathogenic virus in the potato variety "Up-to-date" protects it against more virulent forms.

At Coimbatore we have evidence that in some cases the virus becomes attenuated in course of time and further inoculations on such plants are not successful in transmitting the disease. Thung mentions a case where a ring spot virus confers immunity on the tobacco plant against further infection from the same virus and also other viruses.

Virus complexes. On the other hand, there is also the fact that while virus may be incapable of doing harm by itself, a combination of various viruses may prove very destructive to the host plant.

Work done in S. India. "The following is a resume of the work done in S. India in connection with virus diseases.

1. *Sugarcane mosaic.* (a) *Varietal resistance studies of 'cane mosiac'* The relative resistance of 150 varieties has been tested by field experiments[1].

(b) The loss due to mosaic in cane has been estimated on the basis of a well conducted experiment for three years.

2. *Cholam 'Freckled yellow and Stripe'*. That the insect (Pundalaya) *Peregrinus maidi*, is the vector of one of the diseases is established by Cherian and Kylasam. The disease is not sap transmissible.[7]

3. *Tobacco Mosaics and Leaf Curl.* A survey of the tobacco area in Coimbatore and Salem districts has been made, and the existence of a number of strains of tobacco mosaic has been noticed. A highly destructive leaf curl is also prevalent This was not sap transmissible but grafting induced infection on healthy plants. A destructive ring spot disease has been noticed, and further work is in progress.

4. *Brinjal little leaf disease.* Recently a disease of the brinjal * plant came under the purview of the Government Mycologist Mr. K. M. Thomas[8]. It was observed at the Central Farm, Coimbatore and has been reported from Rajahmundry, Madura and some villages in the Coimbatore district. The disease manifests itself by the great reduction in the size of leaves, alteration in its shape and structure, the crowding of buds in the axils, malformation and the complete absence of floral parts. The plant is completely changed in appearance. The affected plants do not bear fruit. Careful examination of all the parts of affected plants did not reveal the presence of any organism and the disease was suspected to be of virus origin. Sap inoculation did not prove successful but grafting gave positive results. The disease was found to be reciprocally transmissible to *Datura fastuosa*.

5. *Red gram.* A disease resembling spike has been noticed on red gram (*Cajanus indicus*) plants[8]. Preliminary trials have given indication that it is transmissible by a jassid. The disease is not sap transmissible.

6. *Potato diseases.* Fortunately, the variety usually grown by ryots in the Nilgiris. 'Great Scott', is fairly resistant but a number of virus diseases have been noticed in other varieties grown in the Nanjanad Farm on a small scale. Of these, a mild mosaic affecting "Arran banner" and a kind of 'calico mosaic' affecting the varieties "Golden Wonder" and 'Up to date' may be mentioned.

The writer is greatly indebted to Mr. K. M Thomas, Government Mycologist for guidance, help and encouragement given in the preparation of this paper. The paper was primarily intended to acquaint the officers in the districts with some of the recent developments in plant pathology, and to impress on them the need for further virus research in S. India.

References.

1. Bawdon and Pierie (1938). A plant virus preparation in a fully crystaline state. *Nature* 141 : (3568) p 593.

2. Salaman Redcliffe. N. (1936). Immunity to virus diseases in plants *Proceedings of the third International Congress of Plant Pathology*, Athens.

3. ....(1937). Acquired immunity against the potato virus *Nature* 139 p 924.

* *Solanum melongena.*

4. Smith K. M. (1933). Recent advances in the study of plant viruses.

5. Smith Henderson (1938). Some recent developments in virus research. *Annals of applied biology.* XXV Nos. 227—43.

6. Stanley W. M. 1935. Isolation of a crystalline protein possessing the properties of Tobacco Mosaic Virus. *Science* N. S. LXXXI (2113). pp. 644—645.

7. Sundararaman. Administration report of Government Mycologist Madras 1926 to 1935.

8. Thomas K. M. 1937. Administration report of Government Mycologist Madras 1936—37.

STUDIES IN SUGARCANE JAGGERY

V. Macro-Structure of Jaggery.

BY T. VARAHALU, B.A., M. Sc.,

Agricultural Research Institute, Coimbatore.

In previous communications (1, 2) the probability was suggested that the good and bad jaggeries might show marked differences in their gross structure as well as in their micro-texture. In verification of this suggestion, a large number of samples of Jaggery, collected from several parts of the presidency, were examined for their macro-structure and micro-texture. In addition to these, several other jaggeries, the conditions attending the preparation of which were known, were similarly examined. This examination revealed that both structurally and texturally, the two types of jaggery distinguish themselves strikingly from each other. The present paper deals with macro-structure.

The jaggeries collected were classified into good and bad ones on the basis of the physical tests indicated previously (2). Cross sections of the samples were cut, and their photographs taken after smoothening the cut faces. An examination of the sections reveals the mode of distribution of crystalline sucrose and the ground mass of the matrix within the bulk of the jaggery (plate I) and the tendencies in the two types seem to be characteristic of them.

GOOD JAGGERY (Plate 1.)

1. Sucrose occurs as an extensive internal core, and the matrix, as a thin compact envelope or shell over the core (Nos. 1—5, 7—10, 12, 16—18, 21 and 22).

2. Sucrose sometimes disposes itself in wide concentric bands which tend to rapidly coalesce into what approaches an extensive core, and the matrix ranges itself as narrow veins or as envelope on the outside (Nos. 2, 6, 10, 13 and 14).

3. Occasionally sucrose occurs also as wide or extensive patches inter-spersed by thin compact veins or patches of matrix (Nos. 6,7,11, 13, 14 & 19.)

4. Cellular and vesiculer conditions within the sucrose core or its patches seems to be general.