REVIEW OF ALOMAE DISEASE OF TARO

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ABSTRACT

*The virus disease complex of taro (*Colocasia esculenta *(L.) Schott.) known as "alomae" is thought to be caused by a dual infection of taro large bacilliform virus (TLBV) and taro small bacilliform virus (TSBV). Alomae and a similar but less severe disease called "bobone" are restricted to Papua New Guinea and the Solomon Islands. Symptoms of alomae disease include a feathery mosaic on the leaves, young leaves are often crinkled and fail to open normally, and the plants become stunted and eventually die. Alomae disease can result in total yield loss and bobone can cause 25% yield loss. Control of alomae and bobone is by roguing, by control of insect vectors, breeding for disease tolerant cultivars and virus elimination through plant tissue culture and dissemination of virus tested planting stock.*

***Key words**: Alomae, taro large bacilliform virus, taro small bacilliform virus, tissue culture, virus detection*

INTRODUCTION

Taro (*Colocasia esculenta* (L.) Schott.) is a member of the monocot family Araceae, which has around 100 genera and approximately 1500 species (Purseglove 1988). There are two distinct types of taro: *Colocasia esculenta* (L.) Schott. var. *esculentum* which produces one central corm and is referred to in Papua New Guinea (PNG) as "Taro tru", and *Colocasia esculenta* (L.) Schott. var. *antiquorum* (Schott.), Hubbard and Rehder, which produces several cormels surrounding the one central corm and is sometimes referred to as the "eddoe" type.

Taro is an important staple food crop in PNG and other countries in the South Pacific. It is grown primarily for its edible corms and to a lesser extent for its foliage (Rangii 1977). The major growing areas in PNG include the Telefomin area of West Sepik Province, Manus, Gazelle Peninsula of East New Britain and parts of the Huon Peninsula and the North Solomons (Gurnah 1989).Over the last twenty years there has been a gradual decline in the growth of taro mainly due to inherent pest and disease problems. The virus disease complex of taro known as "alomae" is one of the most important factors contributing to the decline of taro in Papua New Guinea (Pearson 1981) and the Solomon Islands (Gollifer and Brown 1972). Despite its agronomic significance, the disease has not been thoroughly investigated. This paper collates the available information an alomae disease including its etiology, epidemiology and control.

GENERAL CHARACTERISTICS AND SYMPTOMS

Alomae is a lethal disease which is thought to be caused by dual infection with taro large bacilliform virus (TLBV) and taro small bacilliform virus (TSBV). A similar but milder disease, "bobone", is thought to be caused by infection with TLBV only. However, there is a considerable amount of confusion in the literature regarding the etiology and symptomatology of the two diseases.

Taro cultivars differ in their susceptibility to alomae and bobone diseases. In the Solomon Islands, growers group taro on size in to large ("male taro") and small ("female taro") cultivars (Jackson 1978), which have chromosome numbers of 2n = 42 and 2n = 28, respectively (Gollifer *et al.*1977). Jackson and Gollifer (1975) reported that male taro cultivars are susceptible

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to alomae disease whereas female taro have some resistance to alomae but are susceptible to bobone.

In male taro, one of the early symptoms of alomae disease is the development of a feathery mosaic on the leaves. Young leaves are often crinkled and fail to open normally, and the lamina and veins become thickened. Other symptoms include shortening of the petioles and the presence of irregularly shaped outgrowths on the petiole surface (Jackson 1978). As the disease progresses, the leaves fail to open and the plants become stunted. Finally, the tips of the unopened leaves die and a systematic necrosis progresses down the petioles resulting in the death of the plant (Gollifer and Brown 1972).

The early symptoms of bobone disease are generally similar to those of alomae, except that the leaves are more stunted and the lamina are more curled and twisted (Gollifer and Brown 1972). In contrast to alomae disease, however, necrosis of the leaves is rare and the plants usually recover.

Jackson (1978) reported that taro plants infected with TSBV alone become slightly stunted, show chlorosis of the marginal leaf veins and the leaf blades curl slightly downwards. The disappearance of symptoms from infected plants has also been observed (Golifer *et al.* 1977).

Taro Large Bacilliform virus

Taro large bacilliform virus (TLBV) is a possible member of the "Rhabdoviridae" as it has morphologically characteristic bullet-shaped or bacilliform particles measuring 300 - 335 nm x 50 - 55 nm (Brunt *et al.* 1990).

The virus is persistently transmitted in nature by the plant hopper *Tarophagus proserpina* (Dabek and Plumb 1975). Attempts to transmit the virus using the aphid *Aphis gossypi* and by mechanical inoculation, seed or pollen, were unsuccessful (Brunt *et al.* 1990, Kenton and Woods 1973). The natural host range of TLBV is restricted to *C. esculenta* although the virus can be experimentally transmitted to *Philodendron selloum* (Brunt *et al.* 1990). Gollifer *et al.* (1977) reported the distribution of TLBV to be restricted to PNG and the Solomon Islands.

Particles of TLBV are found in both mesophyll and phloem cells, causing an increase in the number of polyribosomes and a build-up of starch in the chloroplasts (Strauss 1983). Infected cells are found to contain inclusion bodies (viroplasms) which may be of some diagnostic value.

Taro Small Bacilliform virus (TSBV)

Taro small bacilliform virus (TSBV) has been classified as a possible member of the Badnavirus group based on the presence of 125 nm x 28 nm virions and the transmission of the virus is by the mealybug, *Planococcus citri* (Brunt *et al.* 1990).

The virus is not transmitted by mechanical inoculation, grafting or by the aphid, *Aphis gossypii*, and has a natural host range restricted to *C. esculenta*. Under glasshouse conditions, TSBV has been transmitted to several members of the Araceae, including *Alocasia macroryhiza* and *Xanthosoma spp.* (Brunt *et al.* 1990). The virus appears to be distributed throughout many taro growing areas in the South Pacific, including PNG, Solomon Islands, Fiji, Vanuatu, Western Somoa and the Cook Islands (Gollifer *et al.* 1977).

YIELD LOSSES

Little information is available on the yield losses of taro due to infection with TLBV and/or TSBV. The lethal alomae disease (TLBV and TSBV), however, is clearly the most devastating virus disease of taro. Gollifer *et al.* (1978) reported that (i) the percentage of plants showing symptoms in any given taro field is directly proportional to yield loss, and (ii) if alomae disease does not kill the plant then the corms harvested from infected plants are not of a useful size.

Yield losses as a result of bobone disease average approximately 25% (Gollifer *et al.* 1978).

CONTROL

1. Cultural Methods

There have been few attempts to control alomae and bobone disease of taro under experimental conditions (Gollifer *et al.* 1978). In the field the traditional practice for controlling these diseases is roguing, and this has resulted in a reduction of the incidence of bobone disease from 30% to 1% in the Solomon Islands (Jackson and Gollifer 1975). This method of control is not entirely successful, however, since only plants showing severe symptoms are removed, leaving the symptomless plants or those showing mild symptoms to act as virus reservoirs.

The establishment of gardens in new areas reduces the build-up of vectors within a garden and probably reduces the incidence of the disease (Shaw *et al.* 1979). For a successful control, however, all vectors must be eradicated from new planting material and the distance between new and existing plots should be as great as possible. Unfortunately, the land available for growing taro is limited and as a result, the distance between new and existing plots is decreasing, thus increasing the chances of viliferous vectors moving into new plots.

2. Vector

A possible method to control these diseases may be through the biological control of the vectors (Shaw *et al.* 1979). Species of ladybird beetle (*Cryptolaemus* spp.) have been found in Hawaii, for example, which are predacious on mealybugs. Further, large populations of *T. proserpina* have been controlled in Hawaii by the introduction of the egg suckling bug of *Cytrohinus fulvis* from the Philippines. Related species of *Cytrohinus* have been reported in PNG.

There has been no comprehensive study on the control of the vectors of TLBV and TSBV in PNG and the Solomon Islands using insecticides. However, Shaw *et al.* (1979) proposed that the best way to control alomae and bobone disease was through an integrated approach consisting of (i) regular inspections for symptoms and subsequent roguing of diseased plants, (ii) chemical control of insect vectors and (iii) selection of apparently healthy plants for propagation stock.

3. Tissue Culture

Taro is a vegetatively propagated crop, with the petiole base attached to 1-2 cm of apical corm tissue from the previous seasons harvest being used as new planting stock. A key factor to controlling alomae and bobone disease, therefore, is the propagation and dissemination of virus tested planting stock. The most successful method for eradicating viruses from plants is through heat treatment (thermotherapy), meristem tip culture or a combination of both (Walkey 1985).

Heat therapy involves growing infected plants or plant parts in a controlled environment cabinet at 30 to 40°C for a periods of six to twelve weeks. Although this procedure does not usually eradicate the virus from the whole plant, the meristems usually become virus free. These virus free shoots are removed and regenerated into healthy plants using either meristem tips or bud grafts.

Healthy plants from a wide range of crops have been regenerated from meristem tips, including taro (Walkey 1985). The two main advantages of this technique are (i) there is minimal variability produced in the regenerated plants and (ii) mature plants are generally produced much quicker from meristem tips than from other plant tissue. The combined use of meristem tip culture and thermotherapy has also been widely used in the eradication of viruses from plants.

All three viruses that infect taro, namely TLBV, TSBV and dasheen mosaic potyvirus (DMV), have been eliminated from taro plants using tissue culture (Hartman 1974, Zettler *et al.* 1989), without additional heat treatment. Taro plants can be readily freed from TLBV and TSBV by meristem tip culture when small (0.5 mm or less) meristem tips are used (Zettler *et al.* 1989). Hartman (1974) successfully eradicated DMV from taro and *Xanthosoma spp.* by excising shoot tips trimmed down to the apical dome (with one or two leaf primordia), and culturing these tips on a slightly revised Murashige and Skoog medium (M&S). Tissue cultured plantlets were screened for DMV by electron microscopy and mechanical inoculation to *Philodendron selloum* seedlings and were found to be free of DMV at the levels of sensitivity for these two techniques.

A variety of media have been used to culture and regenerate taro plants from excised meristem tips. Jackson *et al.* (1977) used the medium of Linsmaier and Skoog supplemented with varying concentrations of indolea-3-cetic acid and kinetin but reported that growth of taro plantlets was best on unsupplemented media. Kesevan *et al.* (1991) used a basal Murashige and Skoog medium supplemented with varying levels of indole-3-acetic acid and kinetin, whereas Ghani (pers comm. 1989) supplemented their basal medium of Murashige and Skoog with indole -3-butyric acid and N-Benzyl-9-(2tetra hydropyranyl)-adenine.The IRETA Tissue Culture Unit in Western Somoa maintains its taro collection on Murashige and Skoog minimal organic medium supplemented with 0.3 mg/l Naphthalene acetic acid and 1.0 mg/l of 6-Benzylaminopurine (Dr.M.B.Taylor, pers. comm.). Yam *et al.* (1990) used half-strength Murashige and Skoog medium containing 25ml/l of "Taro extract" to regenerate plantlets of *Colocasia esculenta* var. *esculenta*. The addition of the taro extract, obtained from boiled and filtered taro corm tissue, was necessary for regeneration of plantlets. Regardless of the medium used, considerable variation in growth rate and amount of suckering has been observed between cultivars. Our experience here at Unitech is that some cultivars of variety *'esculenta'* grow very easily in tissue culture, sucker readily while other varieties are extremely slow.

4. Breeding

Failure to discover alomae disease resistant cultivars which are also high yielding from within the South Pacific region prompted attempts to breed for resistance (Jackson and Pelomo 1980). Shaw *et al.* (1979) suggested that if cultivars showing resistance to the bacilliform virus diseases were crossed with cultivars showing favourable agronomic qualities then it may be possible to develop disease resistant progeny with acceptable taste and yield. Thirteen varieties of female taro have been found which show resistance to alomae disease (Gollifer *et al* .1978). Jackson and Pelomo (1980) successfully crossed these taro cultivars (female) that showed resistance to alomae with taro cultivars that are high yielding but susceptible (male) and reported that the progeny showed considerable differences in plant height, leaf size and petiole colour.

CONCLUSIONS

Alomae is one of the most important diseases affecting taro in Papua New Guinea and Solomon Islands. Despite its agronomic significance, however, a great deal of confusion still exists in the literature regarding the exact nature of the disease. Apart from the initial reports of the association of two bacilliform viruses with the disease, little has been done to further confirm this association or to characterise the viruses involved. Further, there are conflicting reports in the literature regarding the disease symptoms. These problems cannot be fully resolved until techniques to detect the viruses are found.

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