PHYTOPHTHORA LEAF BLIGHT OF *COLOCASIA ESCULENTA**

IN THE BRITISH SOLOMON ISLANDS

D. E. GOLLIFER† AND J. F. BROWN‡

ABSTRACT

Leaf blight of Colocasia esculenta *(L.) Schott, caused by* Phytophthora colocasiae *Rac. is the most widespread disease of dryland taro on the larger volcanic islands of the British Solomon Islands. None of the* 181 *local cultivars tested proved to be immune or highly resistant to the disease. A small proportion of cultivars however, failed to develop high levels of disease. The application of copper fungicides as foliar sprays, although giving poor control of the disease, resulted in yield increases of up to* 25 *per cent compared with unsprayed controls.*

INTRODUCTION

COLOCASIA esculenta, commonly known as taro, dasheen or cocoyam, is an edible aroid which is one of the staple subsistence foods in the British Solomon Islands Protectorate. Taro is of great importance to many inland dwellers and to the inhabitants of outlying Polynesian islands. In some coastal districts however, taro is being replaced in the diet by sweet potato and rice.

Phytophthora leaf blight was first recorded in the Solomon Islands by Parham (1947). Johnston (1960) and Trujillo (1967) suggested that the fungus was introduced into the Protectorate from Indonesia via Papua New Guinea. This appears likely because local farmers say that the disease first appeared towards the end of the second world war and spread through the Protectorate in a south-easterly direction. The disease is now widespread on all the larger volcanic Melanesian islands but is less prevalent and is of minor importance on wetland and dryland taro grown on the smaller Polynesian islands of low elevation. This difference in disease incidence is probably related to differences in environment between the larger and smaller islands.

*Published with the approval of the Director of Agriculture, British Solomon Islands Protectorate.

†General Crops Agronomist, Dala Experiment Station, Malaita, British Solomon Islands.

‡Plant Pathologist seconded to the British Solomon Islands under the Australian South Pacific Aid Programme. Present address: Department of Botany, University of New England, Armidale, New South Wales. 2351, Australia.

Leaf blight or "Abasao" as it is called in the Kwara'ae language is now considered to be the most widespread disease of taro on the larger volcanic islands in the Protectorate. The word "Abasao" literally means drying-up or blight of leaves and is used to describe leaf diseases of a number of hosts.

Plucknett, de la Pena and Obrero (1970) suggested that it might be possible to control leaf blight by incorporating factors for resistance into taro cultivars by means of a breeding programme. There have been several reports of resistance to leaf blight in some cultivars of taro. These include those by Barrau (1958), Deshmukh and Chhibber (1960), Hicks (1967) and Paharia and Mathur (1964).

However, most workers have failed to observe immunity or high levels of resistance in taro cultivars. Some cultivars however appear to be less susceptible than others to the disease under field conditions. The success of any plant breeding programme will depend upon suitable resistant breeding material becoming available.

In some regions, adequate control of leaf blight has been achieved through the application of foliar fungicides. This has been reported by Berquist (1972), Gomez (1925) and Trujillo and Aragaki (1964). However, it is uncertain whether fungicides would be effective in controlling the disease in the Solomon Islands. The climatic conditions in the British Solomons favour disease development and are not conducive to long term residual activity of protective fungicides. At Dala Experiment Station for example, the mean minimum temperature is 22.7° C, the mean maximum temperature is 30.1° C, the mean relative humidity at 0900 hrs is 79.1 per cent and the mean annual rainfall is 3900 mm. This environment approaches that which Trujillo (1965) considered to be optimal for development of leaf blight. Experiments by Brown and Friend (1974) with Phytophthora pod rot of cocoa indicated that the residual activity of copper fungicides is poor under the environmental conditions which exist in the Solomon Islands. However, no information is available on the effectiveness of protective fungicides in the control of leaf blight of taro.

This paper reports the results of investigations, conducted at Dala Experiment Station, on differences in susceptibility to *P. colocasiae* among Solomon Island cultivars of taro, on the effect of leaf blight on taro yields and on the effectiveness of fungicides in controlling leaf blight of taro.

EXPERIMENTAL

Description of the disease

Leaf blight causes large, more-or-less circular brown to purple lesions on the leaves of taro (*Plate* I). Young lesions are characteristically water-soaked and zonate in appearance and often exude a clear, yellow to red liquid. The lesions are normally surrounded by a chlorotic margin. One or more whitish rings of sporangia can often be seen on the lesions, particularly in the morning before they have been dried out by the sun. As the disease progresses, individual lesions coalesce and severe defoliation occurs (*Plate* I).

Cultivar susceptibility

Field trials involving 181 cultivars, some of which were reputed to be resistant to leaf blight, were planted to compare their relative resistance to *P. colocasiae.* Discrimination among cultivars was made by local growers. The taro cultivars used in this trial had been collected from various districts within the Solomon Islands. Taro tops consisting of about 43 cm of petiole and 0.5 cm of the upper part of the corm were planted in 76 cm squares. The amount of disease resulting from natural infection was assessed on each fully expanded leaf arising from the central corm of each cultivar and was determined at 3, 4 and 5 months after planting. Disease assessments were made using the key shown in *Figure* 1 which is based on the percentage of leaf area affected by the disease. Nine plants of each cultivar were examined and the mean disease rating for each plant was calculated by dividing the sum of the assessment for each leaf by the total number of leaves examined. The assessment for each cultivar was obtained by dividing the sum of the assessments for each plant by

Plate I.—Typical lesions of Phytophthora leaf blight of *Colocasia esculenta.* (*a*) young lesions, (*b*) advanced lesions the total number (nine) of plants examined. Plants were harvested at 175 days after planting and the yield for each cultivar recorded.

None of the 181 cultivars examined showed an immune or highly resistant reaction to *P. colocasiae*. However, the disease ratings varied among cultivars. Most cultivars showed blight assessments of between 20 and 50 per cent at all recording times (*Table* 1). The proportion of cultivars showing less than 20 per cent of the leaf surface infected increased as the plants matured. At 3 months after planting only one cultivar showed a low level of disease (less than 20 per cent disease) whereas 12 per cent of the cultivars showed disease ratings of less than 20 per cent at 5 months after planting.

The apparent shift in resistance with plant age could have been due to an adult resistance mechanism, or it might have been related to changes in the microenvironment on the surfaces of leaves during the maturation period of plant growth. Plucknett and de la Pena (1971) considered that, during the maturation period, each successive leaf produced by taro was smaller than its predecessor and that very little canopy existed in mature plants. This change in plant morphology may have produced a microenvironment which was less favourable for the development and dispersal of *P. colocasiae*.

In general there was no correlation between disease severity and the yield obtained from cultivars in each disease rating group. The cultivars showing high levels of disease did not necessarily produce lower yields than those showing a low disease score (*Table* 1). There was however a positive correlation between corm yield and mean number of leaves produced per plant. Similarly, a positive correlation existed between mean number of leaves per plant and disease rating.

Because the disease ratings used in this study were based on the percentage of leaf tissue destroyed, a plant with small leaves would score a similar disease rating as one with large leaves if the percentage of leaf tissue destroyed was similar. However, plants with larger leaves would have more absolute photosynthetic area than those with smaller leaves. This factor, together with the possibility mentioned by Schafer (1971) that some cultivars are more tolerant to the effects of *P. colocasiae* in terms of yield, may explain the lack of correlation between disease incidence and yield.

The reduced levels of infection in some taro cultivars appeared to have been due to the presence of fewer individual lesions rather than to differences in the rate of development of individual lesions.

Effect of fungicides on disease incidence and yield

Several fungicidal sprays including cuprous oxide (4.5 kg/ha of 50 per cent w/w a.i.), copper oxychloride (4.5 kg/ha of 50 per cent

Table 1.—Phytophthora leaf blight assessment and yields in 181 Solomon Island cultivars of *Colocasia esculenta*

Leaf Blight Assessment (percentage of leaf affected)	Period between Planting and Disease Assessment: 3 months			4 months			5 months		
	Number of Cultivars	% of Cultivars	Mean Yield t/ha	Number of Cultivars	% of Cultivars	Mean Yield t/ha	Number of Cultivars	% of Cultivars	Mean Yield t/ha
11-20	1	0.6	3.51^{b*}	3	1.7	2.44^{c}	22	12.2	4.47^{a}
21-30	14	7.7	4.17^{ab}	32	17.7	4.67^{a}	102	56.4	4.47^{a}
31-40	70	36.7	4.95^{a}	99	54.7	4.64^{a}	52	28.7	4.87^{a}
41-50	80	44.2	4.78^{a}	45	24.9	5.35^{a}	5	2.7	5.27^{a}
51-60	16	8.8	4.59^{a}	2	1.0	3.39^{b}	0	0	0
		r = −0.00309			r = 0.1526			r = 0.08258	

* Figures with the same small letter are not significantly different at 0.05 probability level (Duncan's multiple range test).

w/w a.i.), Bordeaux mixture (1:1:100), Maneb[1] (2.2 kg/ha of 80 per cent w/w a.i.), Zineb[2] (1.7 kg/ha of 80 per cent w/w a.i.), Mancozeb[3] (3.4 kg/ha of 80 per cent Zn ion and maneb), Ziram[4] (1.7 kg/ha of 80 per cent w/w a.i.), Benomyl[5] (0.6 kg/ha of 50 per cent w/w a.i.), and copper oxychloride plus Zineb (4.5 kg/ha of 33.5 per cent copper oxychloride—15 per cent zineb) were applied to developing taro plants as foliar sprays at weekly intervals. The fungicides were applied with a knapsack spray fitted with a cone nozzle at the rate of 843 1/ha. A wetting and sticking agent ("Agral 60") was added to each fungicide mixture at a concentration of 0.04 per cent.

Three trials were conducted during 1970 and 1971 and were arranged according to a randomised block design consisting of 4 or 5 replicates. The harvestable plot size for each replicate consisted of 24 plants. The weekly spray schedules were commenced at either 56, 63, or 29 days after planting depending on the trial, and corms were harvested at 165 days after planting. The amount of disease resulting from natural infection was assessed at 2, 3, 4 and 5 months after planting using the assessment key shown in *Figure* 1. In these trials

[1]Maneb (manganese ethylene bisdithiocarbamate)

[2]Zineb (Zinc ethylene bisdithiocarbamate)

[3]Mancozeb (Zinc ion and manganese ethylene bisdithiocarbamate)

[4]Ziram (Zinc dimethyl dithiocarbamate)

[5]Benomyl (Methyl 1-(butrylcarbomyl)-2-benzimidazolecarbamate)

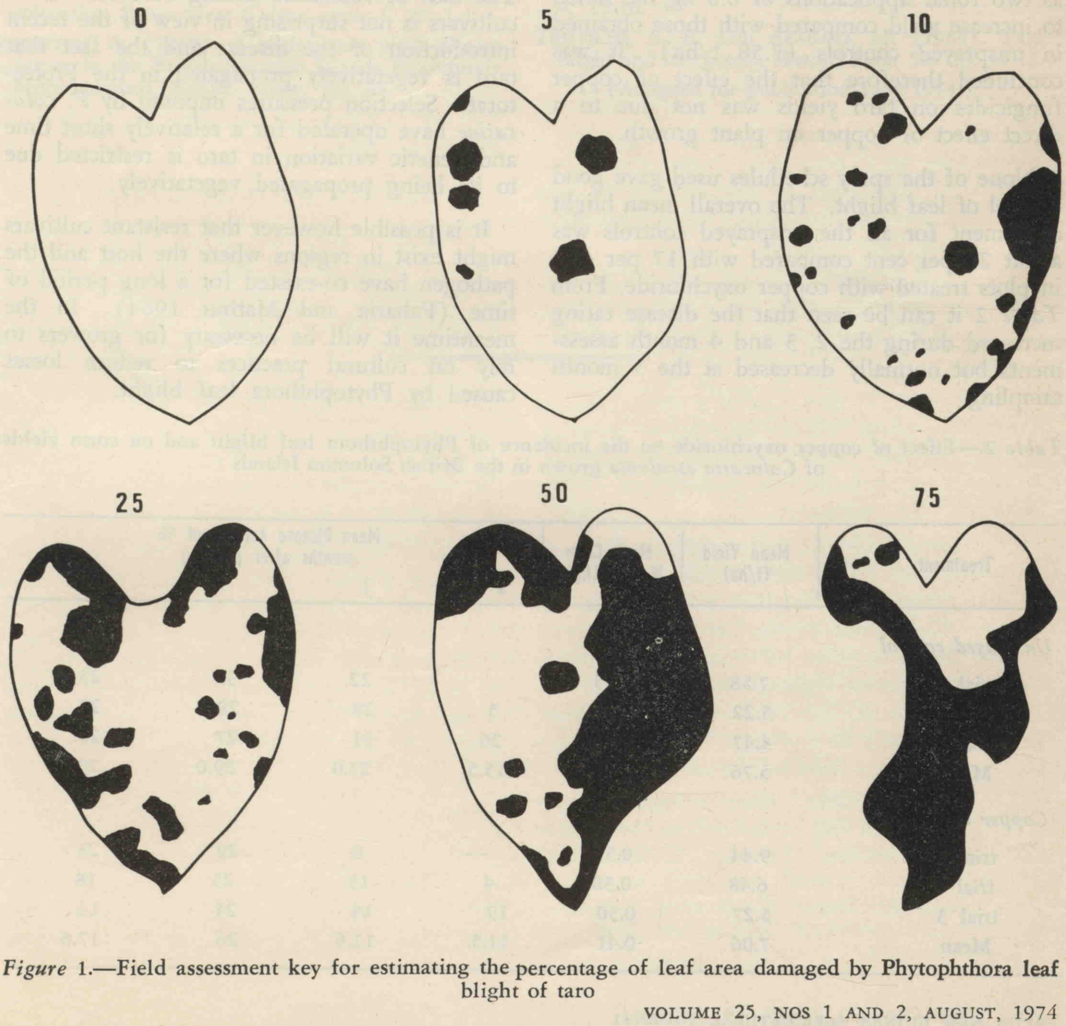

Figure 1.—Field assessment key for estimating the percentage of leaf area damaged by Phytophthora leaf blight of taro the susceptible cultivar, known as "Akolomale initoa" in the Kwara'ae district of Malaita, was used because of its resistance to the lethal virus disease known locally as "Alomae" (Gollifer and Brown 1972).

In all three trials, only applications of copper oxychloride resulted in significant (P > 0.05) yield increases compared with those in unsprayed controls. The yields of corms from plots sprayed with copper oxychloride in the three trials were 9.44, 6.48 and 5.27 t/ha and from the unsprayed controls were 7.58, 5.22 and 4.47 t/ha respectively (*Table* 2). Thus the application of copper oxychloride resulted in yield increases of about 25, 24 and 18 per cent respectively.

The application of copper sulphate, applied as two foliar applications of 0.8 kg/ha, failed to increase yield compared with those obtained in unsprayed controls (7.58 t/ha). It was concluded therefore that the effect of copper fungicides on taro yields was not due to a direct effect of copper on plant growth.

None of the spray schedules used gave good control of leaf blight. The overall mean blight assessment for all the unsprayed controls was about 24 per cent compared with 17 per cent in plots treated with copper oxychloride. From *Table* 2 it can be seen that the disease rating increased during the 2, 3 and 4 month assessments but normally decreased at the 5 month sampling.

DISCUSSION

The poor control of leaf blight obtained by weekly application of copper and dithiocarbamate fungicides indicates that protective fungicides show little potential as a means of economically controlling *P. colocasiae* in the British Solomon Islands. It is possible however that future development of improved fungicides (either protectants or chemotherapeutants) and methods of application might make chemical control of leaf blight an economically feasible proposition.

The most promising means of controlling the disease in the future might be through the use of resistant cultivars. However, at the moment there is no evidence for the presence of resistant cultivars in the Solomon Islands. The lack of resistance among Solomon Island cultivars is not surprising in view of the recent introduction of the disease and the fact that taro is vegetatively propagated in the Protectorate. Selection pressures imposed by *P. colocasiae* have operated for a relatively short time and genetic variation in taro is restricted due to its being propagated vegetatively.

It is possible however that resistant cultivars might exist in regions where the host and the pathogen have co-existed for a long period of time (Paharia and Mathur 1964). In the meantime it will be necessary for growers to rely on cultural practices to reduce losses caused by Phytophthora leaf blight.

Table 2.—Effect of copper oxychloride on the incidence of Phytophthora leaf blight and on corm yields of *Colocasia esculenta* grown in the British Solomon Islands

Treatment	Mean Yield (t/ha)	Mean Corm Weight (Kg)	Mean Disease Assessment % months after planting 2	3	4	5
Unsprayed control						
trial 1	7.58	0.45		22	32	23
trial 2	5.22	0.30	5	28	28	28
trial 3	4.47	0.25	26	31	27	20
Mean	5.76	0.33	15.5	27.0	29.0	23.6
Copper oxychloride						
trial 1	9.44	0.55	—	8	29	23
trial 2	6.48	0.38	4	13	25	18
trial 3	5.27	0.30	19	14	24	14
Mean	7.06	0.41	11.5	11.6	26	17.6

REFERENCES

BARRAU, J. (1958). *Subsistence agriculture in* Melanesia. Bull. 219, Bernice P. Bishop Museum, Honolulu.

BERQUIST, R. R. (1972). Efficiency of fungicides for control of Phytophthora leaf blight of taro. *Ann. Bot.* 36, 281-287.

BROWN, J. F. AND FRIEND, D. (1974). Diseases of cacao in the British Solomon Islands. Tech. Paper, South Pacific Commission, Noumea (In Press).

DESHMUKH, M. J. AND CHHIBBER, K. (1960). Field resistance to blight, Phytophthora colocasiae Rac. in *Colocasia antiquorum Schott. Curr. Sci.* 29, 320-321 (cited in Rev. appl. Mycol. 40, 262).

GOLLIFER, D. E. AND BROWN, J. F. (1972). Virus diseases of Colocasia esculenta in the British Solomon Islands. *Plant Disease Reptr.* 56, 597-599.

GOMEZ, E. T. (1925). Leaf blight of gabi. *Philipp. Agric.* 14, 429-440.

HICKS, P. G. (1967). Resistance of Colocasia esculenta to leaf blight caused by Phytophthora colocasiae. *Papua New Guinea agric. J.* 19, 1-4.

JOHNSTON, A. (1960). A preliminary plant disease survey in the British Solomon Islands Protectorate Mimeographed, F.A.O. Rome, pp. 34.

PAHARIA, K. D. AND MATHUR, P. N. (1964). Screening of Colocasia varieties for resistance to Colocasia blight (Phytophthora colocasiae Racib.). *Sci. and Cult.* 30, 44-46 (cited in Rev. appl. Mycol. 43, 451).

PARHAM, B. E. V. (1947). Economic botany notes 3. Diseases of taro. *Agric. J. Fiji* 18, 80.

PLUCKNETT, D. L. AND DE LA PENA, R. S. (1971). Taro production in Hawaii. *World Crops*, 23, 244-249.

PLUCKNETT, D. L., DE LA PENA, R. S. AND OBRERO, F. (1970). Taro (*Colocasia esculenta*). *Field Crop Abs.* 23, 413-426.

SCHAFER, J. F. (1971). Tolerance to plant disease. *Ann. Rev. Phytopathology* 9, 235-252.

TRUJILLO, E. E. (1965). The effect of humidity and temperature on Phytophthora blight of taro. *Phytopathology* 55, 183-188.

TRUJILLO, E. E. (1967). Diseases of the genus *Colocasia* in the Pacific and their control. Proc. Inter. Sym. Trop. Root Crops. Trinidad, 2 Sect., 4, 13-18.

TRUJILLO, E. E. AND ARAGAKI, M. (1964). Taro blight and its control. *Hawaii Farm Sci.* 13, 11-13.

(Accepted for publication June 1974.)