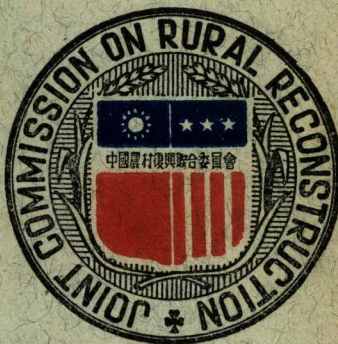


CHINESE-AMERICAN
JOINT COMMISSION ON RURAL RECONSTRUCTION

Plant Industry Series No. 23

A BRIEF REPORT ON THE PLANT DISEASES AND
THEIR CONTROL IN TAIWAN

By
Tsong-Tseat Lo
Senior Plant Pathologist
Plant Industry Division



TAIPEI, TAIWAN, CHINA

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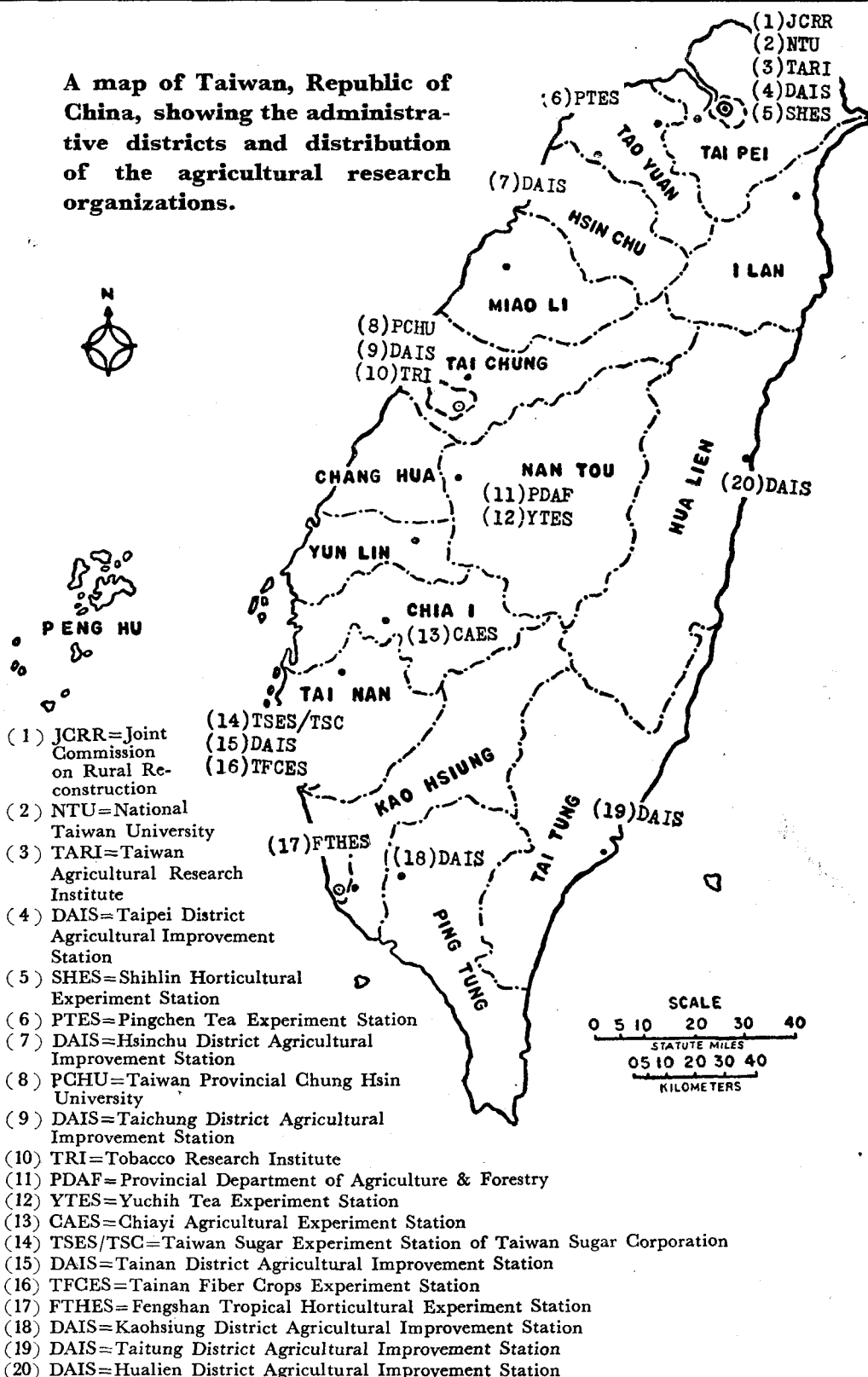
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A map of Taiwan, Republic of China, showing the administrative districts and distribution of the agricultural research organizations.



FOREWORD

Taiwan lies in the subtropical and tropical zones. Its high temperature and humidity is favorable to the growth of the pathogens of many crop diseases. It has been roughly estimated that the loss of the main crops from important diseases is around NT\$1,000,000,000 annually as shown in the following table:

Crop	Loss of production (ton)	Percentage among total production (%)	Value (NT\$)
Rice	100,000	6	330,000,000
Sweet potato	140,000	5	70,000,000
Wheat	5,000	10	16,000,000
Soybean	7,000	12	40,000,000
Sugar cane	750,000	10	125,000,000
Peanut	15,000	15	75,000,000
Banana	50,000	5	90,000,000
Citrus	18,000	25	74,000,000
Vegetable	80,000	10	80,000,000
Tobacco, pineapple, jute, cotton, etc.			100,000,000
Total:			NT\$1,000,000,000

Unfortunately, while Taiwan has a fairly large number of trained specialists in the fields of plant breeding, soils and fertilizers, agronomy, it has relatively few trained entomologists and even fewer plant pathologists. The plant disease control work not only was started later than most other lines of control work, but also proceeded at a slower pace. During the past few years, the pathological work, even if slow, has produced some effect on the over-all crop production through the use of effective fungicides, development of resistant crop varieties and improvement of cultural practices.

Phytopathological work has been carried out by various research institutions in Taiwan; including the phytopathological laboratories of the National Taiwan University (NTU), College of Agriculture of the Taiwan Provincial Chung Hsin University (PCHU) (formerly Taiwan Provincial College of Agriculture), the Taiwan Agricultural Research Institute (TARI), the Taiwan Sugar Experiment Station of the Taiwan Sugar Corporation (TSC), the Tobacco Research Institute (TRI), the six TARI branch stations, namely, Shihlin Horticultural Experiment

Station, Chiayi Agricultural Experiment Station, Tainan Fiber Crops Experiment Station, Fengshan Tropical Horticultural Experiment Station, and Yuchih and Pingchen Tea Experiment Stations, and the seven District Agricultural Improvement Stations (DAIS) of the Taipei, Hsinchu, Taichung, Tainan, Kaohsiung, Taitung and Hualien districts directly under the administration of the Provincial Department of Agriculture & Forestry (PDAF).

In the past decade, most of the major pathological projects carried on by the above-mentioned institutions belonging to PDAF were conducted with the financial and technical assistance of the Joint Commission on Rural Reconstruction (JCRR) in one way or another; while those on sugar cane and tobacco were conducted with the funds of the Taiwan Sugar Corporation and Taiwan Tobacco & Wine Monopoly Bureau, respectively.

Since 1958, an annual conference on plant protection has been organized by PDAF with the assistance of the Society of Plant Protection of the Republic of China, which meets annually. All the experimental results obtained in the current year are presented by the technicians and discussed in the conference. A handbook embodying the effective and economical control methods for the important insect and disease pests has been published by PDAF.

New methods of pest control established are first disseminated through field demonstrations sponsored by the PDAF, with its DAISs, the county or municipal governments, the township offices, the farmers' associations or fruit cooperatives carrying out the actual work in the field. JCRR usually provides technical and financial assistance for such field demonstrations and for the subsequent extension.

Necessary pesticides are supplied by the provincial government, the manufacturers, formulators or importers. While JCRR and government organizations usually provide pesticides for demonstration, farmers buy their own pesticides from the local township farmers' associations or township offices after the demonstration stage. The total cost of annual consumption of pesticides in Taiwan in 1960 is estimated at about NT\$64,000,000 (approximately equivalent to US\$1,600,000), of which fungicides take up about NT\$5,000,000.

In 1960, regulations governing the registration and standardization of pesticides were promulgated by the Taiwan Provincial Government with the aim of protecting the farmers against the infiltration of inferior or adulterated pesticides on the local markets.

In the present report, Mr. T. T. Lo, Senior Pathologist of the Plant Industry Division of JCRR, presents a brief report on the present status of pathological studies on major diseases of major crops in Taiwan. In doing so, he draws freely on information made available by the pathologists of the various institutions mentioned above, especially those presented at the annual conferences of the Society of Plant Protection in Taiwan.

H. T. Chang
Chief
Plant Industry Division

September 1961

INTRODUCTION

With the rapid development of pesticides after World War II, the work of plant protection has entered a new era in Taiwan. Although the progress of plant disease control is not comparable to that of insect pest control, the efforts made by the pathologists in this direction and some of their achievements deserve a more than passing notice.

Conditions in Taiwan are particularly favorable for the spread of plant diseases. Various disease pathogens exist in the field and the environment (temperature and humidity) is good for their penetration and development. Once a susceptible crop variety is cultivated, it is liable to be seriously damaged. However, the work of disease control has played an important role in the over-all crop improvement program in Taiwan, many diseases of such crops as rice, wheat, sugar cane, citrus, tobacco, etc. have been satisfactorily placed under control through the use of either resistant varieties or effective fungicides.

Economy is emphasized in the control of plant diseases. In some cases, the control work depends upon the resistant varieties; but, in other cases, upon effective fungicides, or a combination of both. At all events, the farmers' benefit is the chief consideration.

The phytopathological work in Taiwan is still developing. Besides the practical studies to be continued, the basic research work has also to be strengthened. The virus disease, soil fungi, physiological races (or strains) of the pathogens, nematode, establishment of mycological museum, etc. are all important problems to be tackled.

This is only a brief report. Some crops such as peach, pear, apple and grape that are newly cultivated in the mountainous areas are omitted in this report owing to the lack of sufficient information.

The writer wishes to acknowledge his indebtedness to Messrs. H. J. Su, T. Y. Chuan, T. L. Huang and Y. P. Tsai for their generous assistance in providing the lists of crop diseases in Taiwan.

RICE DISEASES

Rice is the main crop in Taiwan. Its annual acreage is about 780,000 hectares for two crops. Varieties cultivated are of two types, *japonica* and *indica*. The first crop is planted in January in the south and February in the central and north. The second crop is planted from July to August. Growing period is about five months for each crop. Unit yield ranges from 1,500 kg. to 5,000 kg. of brown rice per hectare. According to recent statistics, average production of the total area is 2,400 kg. of brown rice per hectare.

Over 40 kinds of diseases of rice have been identified in Taiwan. Among these diseases, blast and sheath blight are the two major ones. White tip disease and bacterial leaf blight have been found jeopardizing the economic value of the crop in recent years. "Bakanae" disease, once found causing serious loss to the crop, has been satisfactorily controlled by means of seed treatment. Other diseases have been of minor importance under present conditions.

Blast. Blast (*Piricularia oryzae* Cav.) is most prevalent in the first crop of rice in Taiwan. The disease is most damaging to the *japonica* type of rice and, more recently, it has also become serious on some *indica* varieties. During late March through early May of each year, about 35—50 days following transplanting of the rice plants, the disease appears on the susceptible varieties which are heavily applied with nitrogen fertilizer (over 100 kg. of N₂ per hectare), or in the fields which are located in the valleys with cooler irrigation water or where dew formation is abundant. Disease on rice plants in this stage is termed "leaf blast". Loss from leaf blast varies from very slight to complete damage of the crop. When the weather is favorable for the pathogen during the heading stage of rice, the basal parts of the panicle and the pedicel are infected, thus resulting in empty grains. This is termed "neck blast". When the glumes are attacked and discolored, resulting in light grains, it is termed "kernel blast". Hashioka.⁽⁷⁾ who studied the disease in Taiwan concluded that the prevalence of the rice blast disease in subtropical and tropical types is conditioned by such factors as the following:

1. Relation of temperature to the growth of the blast fungus (20-32°C with optimum 26-28°C).
2. Relation of temperature to the growth of the rice plant—Nitrogenous

compounds are accumulated at the lower temperature while, in higher temperature, the N-content is decreased but silicic accumulation is increased. Thus, the disease is more serious in the first crop and less serious in the second.

3. Relation of age of rice plants to resistance—The leaves of the rice plants are susceptible during the seedling and tillering stages, then they become resistant at the late tillering stage and are further increased in resistance during the reproductive stage. The resistance of the necks of ears is also enhanced in proportion to the length of time after heading.
4. Inherent resistance of varieties—The varieties native for the temperate regions are congenitally susceptible to leaf blast, but most of the varieties endemic to the tropical regions are quite resistant to it. As to the resistance of neck blast, the tendency is not so clearly recognizable.

Acreage constantly suffering from the severe outbreak of the disease is estimated at 20,000 hectares.⁽⁴⁾

Blast disease may be controlled in two ways, one is through the breeding of resistant varieties and the other is through the application of effective fungicides. The work of breeding resistant varieties is carried out by the TARI and its Chiayi Branch Station and also the Taipei, Hsinchu, Taichung, Tainan, Kaohsiung and Taitung DAISs. Promising varieties being extended are Chianung 242 and Taichung (native) 1.

Host range for the pathogen includes some species of *Graminae* and “Chiaopei” (*Zizania aquatica* L.) commonly cultivated in the drainage ditches around the rice fields; these doubtless form one of the important sources of the secondary inoculum for the rice plant. Physiological races of the pathogen are strongly believed to exist in the field; differentiation and identification work has been carried out by TARI and PCHU.

Phytoalexin, a possible short-cut method for selecting resistant varieties, has been tested by NTU.

Fungicides now used for controlling the disease on fairly resistant or susceptible rice varieties are mercury compounds. Granosan is used for seed treatment. The 1:1,000 solution of the chemical is recommended for the treatment of the seeds for one hour prior to planting. With this treatment, the “Bakanae” disease

(*Gibberella fujikuroi* (Saw.) Wr.) is completely controlled as well. Ceresan-lime or Fumiron tablet is used for controlling the leaf and neck blasts in the field. The former is in powdery form, and 35-40 kg. per hectare is dusted. The latter, being in tablet form, is diluted with water for spraying, with 167-250 tablets to 1,000-1,500 liters of water. Two applications of both of these fungicides are enough for controlling the disease. Mercury compounds recently used may cause leaf injury on *indica* type of rice; and, therefore, testing with other fungicides has been underway.

Sheath blight. sheath blight (*banded sclerotial* disease) incited by *Corticium Sasakii* (Shirai) Matu. is the most serious disease attacking the sheath and sometimes extending to the leaves of rice plant in the second crop in Taiwan. The disease begins to appear on rice plants during the grand period of tillering, around 40-45 days after transplanting. Its distribution is Island-wide. The pathogen attacks the sheath of the stem, weakening the straw strength. The leaf may also be affected in serious cases. In the southern area, where both temperature and humidity are higher, the disease is more rampant. Under the present situation in Taiwan, the *japonica* type of rice is more susceptible. Yield loss from this disease is around 14-17%.

Since 1959, the fungicide "Tuzet" or "Asozin" has been recommended for controlling the disease, and the method is practised on some farms. Concentrations of these two fungicides are recommended at 3,000 times of 80% Tuzet W. P. and 2,500 times of 5% Asozin W. P.. The first application of the fungicide is made 40-45 days after the transplanting of rice, and the second application two weeks after the first one. The fungicides are compatible with the organo phosphorous compounds now used for controlling the stem borer, a major insect pest on rice.

Other sclerotial-forming fungi, such as small black sclerotial disease or stem rot (*Helminthosporium Sigmoidum* Cav. var. *irregular* Cralley et Tullis) and small round sclerotial disease (*H. Sigmoidum* Cav.), are sometimes grouped in this category. In some cases, the diseases may cause considerable damage.

White tip of rice. White tip of rice is incited by a nematode (*Aphelenchoids besseyi* Christie). The disease is prevalent on a newly extended variety, Chianung 242, especially planted in the southern area. It is a seed-borne disease, loss from which is not yet determined. Testing on seed treatment to control it has been carried out by the Kaohsiung DAIS since 1960.

A List of Rice Plant Diseases in Taiwan

Disease	Cause	Chinese Name
Bacterial leaf blight	<i>Xanthomonas oryzae</i> (U. et. I.) Dow.	白葉枯病
Bacterial yellowsis of rice-grains	<i>Pseudomonas</i> sp.	細菌黃變米
Bakanae disease	<i>Gibberella fujikuroi</i> (saw.) Wr.	稻苗徒長病
Black eye-spot of rice-grains	<i>Xanthomonas atrovidigena</i> (M. et. I.) Dow.	米黑點病
Black mould	<i>Cladosporium kerbarum</i> (Persoon) Link	黑變病
Black rot of rice-grains	<i>Xanthomonas itoana</i> (Tochi.) Dowson	米黑腐病
Black smut	<i>Tilletia horrida</i> Takahashi	黑穗病
Blast	<i>Piricularia oryzae</i> Cav.	稻熱病
Brachysporium blatch	<i>Curvularia lunata</i> (Walker) Boeddijn	煤紋病
Brine injury	Salt injury	鹽害
Brown sclerotial disease	<i>Sclerotium oryzae-sativae</i> Saw.	褐色菌核病
Brown spot	<i>Cochliobolus miyabeanus</i> (Ito et Kur.) Drechsler	胡麻葉枯病
Bunga	<i>Aeginetia indica</i> L.	野蒜寄生
Cinnamon speck of rice-grain	<i>Bacterium cinamonus</i> Miyake et Tsunoda	赤米病
Deformed rice-grains	Undetermined	腰缺米
Downy mildew	<i>Phytophthora macrospora</i> (Sacc.) I. et T.	露菌病
False rice-blast	<i>Alternaria oryzae</i> . Ito et Ishiyama	擬稻熱病
False smut	<i>Ustilaginoidea virens</i> (Cooke) Tak.	稻麴病
Glume blight	<i>Phoma glumarum</i> Ell. et Tr.	穀枯病
Greyish sclerotial disease	<i>Sclerotial fumigatum</i> Nakata	灰色菌核病
Leaf rip	<i>Phoma (Phyllosticta) oryzicola</i> Hara	葉切病
Leaf smut	<i>Entyloma dactylidis</i> (Pass.) cif	黑腫病
Marasmius root rot	<i>Marasmius plicatus</i> Walker	傘菌根腐病
Milky white rice	<i>Epicoccum hyalopes</i> Miyake	乳白米
Mottling	Inheritance	斑稻
Narrow brown leaf spot	<i>Sphaerulina oryzina</i> Hara	褐條葉枯病
Pestalotia leaf spot	<i>Pestalotia kawakamii</i> Saw.	紋斑病
Red sclerotial disease	<i>Rhizoctonia oryzae</i> Ryker et Gooch	赤色菌核病
Rice dwarf	Virus	萎縮病
Round sclerotial disease	<i>Sclerotium hydrophilum</i> Sacc.	球狀菌核病
Scab	<i>Gibberella zeae</i> (Schw.) Petch	赤微病

Disease	Cause	Chinese Name
Sheath blight	<i>Corticium sasakii</i> (Shirai) Matu.	紋 枯 病
Sheath rot	<i>Acrocylindrium oryzae</i> Saw.	鞘 腐 病
Seedling rot	{ <i>Achlya flagellata</i> Coker., <i>Dictyuchus</i> sp., <i>Fusarium</i> sp., <i>Rhizoctonia</i> sp., <i>Pythium</i> sp.,	苗 立 枯 病
Small ^{er} black sclerotial disease	<i>Helminthosporium sigmoideum</i> Cav. var. <i>irregulare</i> Cralley et Tullis	小黑菌核病
Small brown Sclerotial disease	<i>Sclerotium xoryzicola</i> Nak. et Saw.	褐色小粒菌核病
Small round sclerotial disease	<i>Helminthosporium sigmoideum</i> Cav.	小球菌核病
Southern sclerotial blight	<i>Corticium rolfsii</i> (Sacc.) Cur.	白 絹 病
Stifle	Undetermined	赤 枯 病
Stripe	Virus	條 葉 枯 病
White tip	<i>Aphelenchoides besseyi</i> christie	白 尖 病
Yellow blight	<i>Pyrenochaeta oryzae</i> Shirai	黃 枯 病
Yellow dwarf	Virus	黃 萎 病
Yellowsis of rice grains	{ <i>Penicillium islandicum</i> Sopp., <i>P. toxicarium</i> Miy., <i>P. citrinum</i> Tom. etc.	黃 變 米

WHEAT DISEASES

Wheat is one of the important winter crops in central Taiwan. More than 25,000 hectares are cultivated annually. Commercial varieties are locally bred lines including Taichung 31, Taichung 32, Tainan 2 and Tainan 3. Seeds are sown in late October to early November and harvested in February to March. Production is around 2,000 kg. per hectare.

Rust is the major disease commonly found on this crop. In eastern Taiwan (Hualien area) where precipitation is heavy during the heading stage of wheat plant, scab is endemic, and the disease is a limiting factor of wheat cultivation in that area. Other diseases such as powdery mildew (*Erysiphe graminis* DC.) and smut (*Ustilgs tritici* (Pers.) Bostr.), being important diseases in most countries, are seldom found in Taiwan.

Rust. The disease found on the wheat plant is mainly orange leaf rust incited by *Puccinia triticina* Eriks. In general, it appears in early January when the wheat plant begins to head. Seriousness of the disease varies from year to year depending upon the weather condition.

Life cycle of the pathogen is not completely known in Taiwan, with only the uradial stages found on the lesions. So far as the barberry or mahonia collected, no pynia and aecia are found.

In the later stage of the growth of wheat plant, the black stem rust (*Puccinia graminis* Pers.) is common. However, it does not affect the host so severely than the orange leaf rust does.

Rust has been controlled through resistant varieties and spraying with Dithane Z 78. Dosage of the fungicide recommended is a dilution with 400 times of water. First spray is made in early January and the second and third sprays at 2-week intervals. A new fungicide, Sabithane (03818-B), developed by the Rohm & Hass Company has been tested. The fungicide is promising as an eradicant for controlling the disease.

Scab. Scab disease (*Gibberella saubinetii* (Mont.) Sacc.) is endemic in eastern Taiwan. Difference in varietal resistance to the disease is not significant. Screening test on fungicides to control the disease was made by the Hualien DAIS in 1960. Dithane M22 seems effective, and the test is being repeated.

A List of Wheat Diseases in Taiwan

Disease	Cause	Chinese Name
Black stem rust	<i>Puccinia graminis tritici</i> Eriks. & Henn.	黑銹病(桿銹病)
Foot rot	<i>Ophiobolus sativus</i> (P. K. et B.) Ito et Kurib.	斑點病
Glume blotch	<i>Septoria nodorum</i> Berk.	桴枯病
Leaf spot	<i>Helminthosporium tritici-valgaris</i> Nishikads	黃斑病
Loose smut	<i>Ustilago tritici</i> (Pers.) Jens.	散黑穗病
Orange leaf rust	<i>Puccinia triticina</i> Eriks.	赤銹病
Powdery mildew	<i>Erysiphe graminis</i> DC.	白粉病
Scab	<i>Gibberella saubinetii</i> (Mont.) Sacc.	赤霉病
Yellow mosaic	<i>Virus</i>	縞萎縮病
Yellow rust	<i>Puccinia glumarum</i> (Schmidt) Eriks. et Henn.	黃銹病(條銹病)

SWEET POTATO DISEASES

Sweet potato is another major crop just next to rice in importance in Taiwan. It is used mainly for feed and sometimes for supplemental food in the coastal areas. Acreage cultivated is about 250,000 hectares annually. Varieties planted are Tainung 31, 53 & 57 and Tainan 14. The crop may be cultivated the whole year round; but most farmers plant it in August to October and harvest it in February to April. Production is around 10,000 kg. per hectare. Because of the lack of necessary storage facilities on most farms, harvested products easily succumb to the soft-rot fungus (*Rhizopus nigricans* Ehrb.). Therefore, about two-thirds of the products are shredded into slides and stored up after being sun-dried. Diseases found on the crop in the field are stem rot, bud atrophy and black rot. In some cases, severe damage by the diseases has been reported.⁽²⁰⁾

Stem rot. The disease is incited by *Fusarium bulbigenum* var. *batatatis* Wr. The typical symptom is lesions somewhat resembling knife-cuts on the stem. Grown of the plant is apparently weakend. Selecting of the healthy cuttings is recommended as an economical control measure.

Bud atrophy. The disease is incited by *Sphaceloma batatas* Sawada. Infected young shoots are reduced in size and deformed. Treatment with 1% of Per-enox or sulfur was once recommended as a means to control the disease. But the cost of fungicide could not be covered by the profit gained, and, therefore, the method is not practical. Obtaining disease-free cuttings for multiplication is the effective method now adopted.

A List of Sweet Potato Diseases in Taiwan

Disease	Cause	Chinese Name
Black rot	<i>Ceratostomella fimbriata</i> (Ell. & Hals.) Ell.	黑 斑 病
Bud atrophy	<i>Sphaceloma batatas</i> Saw.	縮 芽 病
Cercospora leaf spot	<i>Cercospora batatae</i> Zimm.	葉 斑 病
Dry rot	<i>Diplodia fubericola</i> (E. & E.) Tanb.	炭 化 病

Disease	Cause	Chinese Name
Mottle necrosis	<i>Pythium spinosum</i> Saw.	白 腐 病
Pox (Soil rot)	Undetermined	痘 斑 病
Sclerotial disease	<i>Sclerotinia sclerotiorum</i> (Lib.) DBy.	菌 核 病
Scurf	<i>Monilachaetes infuscans</i> Ell. & Hals.	黑 痣 病
Soft rot	<i>Rhizopus nigricans</i> Ehrb.	軟 腐 病
Southern sclerotial blight	<i>Corticium rolfsii</i> (Sacc.) Curz.	白 絹 病
Stem rot	<i>Fusarium bulbigenum</i> var. <i>batatatis</i> Wr.	蔓 割 病
Stem blight	<i>Hypochnus sasakii</i> Shir.	紋 枯 病
Violet root rot	<i>Helicobasidium mompa</i> Tanaka	紫 紋 羽 病

POTATO DISEASES

Earlier, potato was cultivated on a small scale in central Taiwan. During recent few years, its acreage has been considerably increased. It is grown as a cash crop in the winter season. As the seed tubers are mostly imported from Japan, some diseases have been introduced along with the tubers. Recently, diseases found on this crop are ring rot, late blight, and some virus diseases.

Ring rot. This is a bacterial disease incited by *Corynebacterium sepe-donicum* (Spieck. and Kotth.) Skapt. and Burkh.. The first sign on the tuber is the creamy exudation forced out from the vascular ring when a cross section is cut. The organism is transmitted mainly by the knife used for cutting the seed tubers prior to planting. Disinfection of the knife with chemicals is a rather tedious work and difficult in practice. However, the disease may be controlled through resistant varieties. No control method has yet been practised by the growers at the present time.

Mosaic. Potato mosaic is incited by a group of viruses which are grouped as follows:

1. Latent-mosaic virus: This is a symptomless carrier of the virus with no insect vector observed. It is transmitted readily by mechanical means.

2. Mild-mosaic virus: The virus includes a number of strains, showing mottled symptoms on susceptible varieties. It is transmitted by mechanical means and by several species of aphids.

3. Veinbanding virus: Early symptoms show rugosity and curling of the surface of the leaflets together with some stunting and finally the leaves die, sometimes dropping but often clinging to the stem. It is transmitted mechanically and by several species of aphids.

In 1959 and 1960, a certain number of the seed tubers imported from Japan were found to be badly infected with virus diseases, leaf roll and purple top. Since the host range of the virus includes tobacco and several other solanaceous species, the problem has been brought to the attention of the government.

Control measures recommended are roguing of the diseased plants and use of Malathion etc. to control the aphids. A plan on multiplying disease-free seed tubers in Taiwan has been worked out by PDAF.

Late blight. Late blight (*Phytophthora infestans* (Mont..) DBY.) is commonly found in the fields when the weather is foggy and cloudy. The disease is controlled by the application of Orthocide (1:400) or Dithane Z 78 (1:500).

SOYBEAN DISEASES

In 1960, more than 60,000 hectares of soybean were cultivated in Taiwan. The main varieties are Palmetto, Sankuo, Shih-shih, etc. Planting time of soybean varies in different areas. In the north, it is planted in July and harvested in October. In central Taiwan, two crops are cultivated, one in the summer planted in July and the other in the fall in October. In the south, three crops are planted in February, June and October. Average production is 1,000 kg. per hectare.

Based on the study made by the Taiwan Agricultural Research Institute (TARI), the insect problem of this crop is more serious than that of disease.

In 1958, a survey on soybean diseases was made by TARI and Agricultural College of the Taiwan Provincial Chung Hsin University ⁽⁸⁾, rust has been ranked as a major disease, while mosaic, purple speck and downy mildew are occasionally serious in some locations and others are of minor importance.

Rust. Rust (*Phakopsora Saiae* (F. Hem.) Sawada) is commonly found on the newly extended varieties, especially the Palmetto variety grown in the south. In some severe cases, the crop completely failed before harvesting. Zineb (Dithane Z 78) has been recommended to control the disease. The fungicide is diluted in 300-350 times of water. The first spray is made in 50 days following the germination of the seeds, and the next two or three sprays are made at 7-day intervals. It is also recommended that the fungicide be mixed with insecticides when timed for the simultaneous controlling of insects.

Purple speck or purple stain seed (*Cercospora kikuchii* (Mats. and Tomoyasu) Gardner) is occasionally found, especially in eastern Taiwan. It is a seed-borne disease. Control method was studied by PCHU. It is recommended that the fungicide Dithane M22 or Phygon XL be used for seed treatment.

A List of Soybean Diseases in Taiwan

Disease	Cause	Chinese Name
Anthrachnose	<i>Glomerella glycines</i> Lehman et Wolf	炭疽病
Bacterial blight	<i>Pseudomonas glycinea</i> (Coerper) Stapp.	細菌斑點

Disease	Cause	Chinese Name
Bacterial pustule	<i>Xanthomonas phaseoli</i> (S.) var. <i>sojense</i> (Hedges) Starr. et Burk.	葉 燒 病
Downy mildew	<i>Peronospora manshurica</i> (Naum) Syd.	露 菌 病
Frog eye spot	<i>Cercospora sojae</i> Hora	斑 點 病
Fusarium pod rot	<i>Fusarium oxysporium</i> f. <i>tracheiphilum</i> (E. F. Sm.) Snyder et Hansen	赤 黴 病
Magnesium deficiency	Physiological	缺 鎂 病
Mosaic	Virus	嵌 紋 病
Pod blight	<i>Macrophoma mame</i> Hara	莢 枯 病
Potassium deficiency	Physiological	缺 鉀 病
Purple speck (Purple stain seed)	<i>Cercospora kikuchii</i> (Matsu. et Tomoyasu) Gardner	紫 斑 病
Rosette	Virus	簇 葉 病
Rust	<i>Phakospora sojae</i> (F. Hem.) Saw.	銹 病
Sclerotinia rot	<i>Sclerotinia sclerotiorum</i> (Lib.) DBy.	菌 核 病
Seed rot	<i>Fusarium</i> sp.	種 腐 病
Southern sclerotial blight	<i>Corticium rolfsii</i> (Sacc.) Curzi	白 絹 病
Violet rot	<i>Helicofasidium monpa</i> Tanaka	紫 紋 羽 病

PEANUT DISEASES

Over 100,000 hectares of peanut is cultivated annually along the upland areas in Taiwan. Varieties planted are hybrid lines bred by the Tainan DAIS.

Two crops of peanut are grown in a year, with the spring crop planted in February to March and harvested in June to July and the fall crop planted in August to September and harvested in December to January. Production is around 1,000 kg. per hectare.

Major diseases on peanut are *Corticium* wilt, rosette and, in some cases, leaf spots.

Corticium wilt. The disease is incited by *Corticium sasakii* (Shir.) Matu. The pathogen has a wide host-range including more than ten genera of plants in Taiwan. The fungus is a facultative saprophyte in nature. When previous crop infected by the disease is harvested, sclerotia in the soil or mycelia in the tissues of debris are the main sources of the primary inoculum to infect the peanut plant.

Loss of crop production from the disease reaches 20-30% in some severe cases. Since 1958, control measures have been studied by the Tainan DAIS.

Rosette. Rosette is a virus disease mostly found in southern and eastern Taiwan. Infected plant produces small leaves. The growth is apparently stunted, and very few pods are developed.

Based on the tests conducted by the Tainan DAIS, the disease is not transmitted through seeds. Field evidence indicates that it spreads from one plant to another during the middle stage of peanut growth. Some species of aphids and leaf hoppers have been strongly suspected of being the vectors, as a result of studies made by Tainan DAIS.

Early roguing of the diseased plants is the only control method now recommended.

Leaf spot. Leaf spot of peanut is incited by two species of fungi. One is *Mycosphaerella arachidicola* (Hori) Jenkins and the other *M. berkeleyi* Jenkins. The former appears in the early stage (about the flowering stage) of peanut growth, spots being bigger in size with a yellowish halo, while the latter appears in the advanced stage of the growing plant with spots darker in color. This spot disease is universally found in the peanut areas in Taiwan. No control method has yet been in practice.

CORN DISEASES

Around 10,000 hectares of corn are cultivated annually in Taiwan. Of this acreage, 2,000 hectares are planted to Tainan No. 5, a hybrid line newly bred by the Tainan DAIS.

Corn is mainly grown in the south, It is usually planted in September to November and harvested in December to February. In the central part of Taiwan, It is always intercropped with the second crop of rice in November and harvested in February.

Production is 1,000-1,500 kg. per hectare and hybrid corn may yield 4,000-5,000 kg.

Leaf blight and downy mildew are the major diseases on corn. The diseases seem especially important on the hybrid line. Smut is very seldom found, and, therefore, it is of minor importance in Taiwan.

Leaf blight. Leaf blight is incited by *Helminthosporium turcicum* Pass. The optimum temperature for the growth of pathogen is 28-30°C.; and, therefore, the disease is more serious in the southern area. No information about losses from this disease has been recorded. Control measures either through the use of resistant varieties or application of effective fungicides are being studied by the Tainan DAIS.

Downy mildew. Downy mildew of corn is incited by *Sclerospora sacchari* Miy., the same pathogen that attacks sugar cane. The disease is more severe whenever the crop is planted near susceptible varieties of sugar cane, such as P.T.43-52 or POJ2878. During the years of 1956-1957, the disease spread widely on both sugar cane and corn in Taiwan. In order to carry out the eradication work, a special set of regulations was promulgated by the Provincial Government, which prohibited the planting of corn together with the sugar cane variety P.T.43-52. Infected plants are stunted and the yield fail almost completely. It seems that the disease is first found on sugar cane and then transmitted to corn, which is more susceptible; and more conidia are then yielded to infect the sugar cane again. Roguing of diseased plants is recommended as a control measure in practice.

SUGAR CANE DISEASES

Sugar cane is an important crop in Taiwan. Cultivated acreage is around 95,000 hectares yielding about 850,000 M. T. of sugar annually. More than 80% of the product is exported.

Planting of canes is started from July to September and the canes are grown for eighteen months, but the ratoon canes are started from December to March and are grown for twelve months.

Diseases of sugar cane are closely related to the varieties planted. During the early years, commercial cane varieties adopted were *Saccharum sinensis* which were susceptible to smut and mosaic. After the varieties were replaced by *S. Barberi*, red rot and downy mildew were prevalent. Then the P.O.J. seedlings (2725, 2878 etc.) were extended, and Fusarium top rot (Pokkah boeng) and downy mildew became important. When the P.O.J. varieties were replaced by the local bred varieties F108, F134 etc., mosaic and pineapple disease were prevalent. Some years ago, leaf scorch was epidemic on Co. varieties and caused considerable loss of canes. It was not until the release of the variety N:Co310 that the spreading of the disease was checked. However, N:Co310 is found to be susceptible to ratoon stunting, a virus disease which is considered as a main cause of varietal degeneration.

Application of fungicides on the growing canes is not practical because the crop is grown for 12 to 18 months and cane stalks may always fall down during the stormy summer. N. I. Granosan was once used for seed-pieces treatment to control the pineapple disease. However, most of sugar cane diseases are controlled through resistant varieties.

Downy mildew. Downy mildew is incited by *Sclerospora sacchari* Miy. The disease had caused great damage to POJ 2878, F134, and P. T. 43-52 in particular which was a very promising variety in Taiwan. The planting of this variety was prohibited because of this disease.

In general, transmission of this disease is through disease cuttings, with the conidia (sporangia) serving as the secondary inoculum. Sexual spores (Oospores) on the shredded leaves in the advanced stage have been recorded. However, they

are seldom found in the field.

Testing on sugar cane varietal reaction to the disease is done by means of natural infection. A testing nursery is established in Hsinchu. New varieties to be tested are planted alternately with the disease susceptible varieties and diseased corn plants to provide the necessary quantity of inoculum.

The leaf splitting disease incited by *Sclerospora Miscanthi* Miy. is occasionally found in the field. The symptoms of this disease resemble much that of downy mildew, except that shredded leaves with abundant oospores are easily found. Host range includes *Miscanthus* sp.. The disease is of minor economical importance.

Mosaic. Mosaic is a virus disease often found on sugar cane. The disease was serious on F108, an important variety planted in the past ten years in Taiwan.

In 1953, three virus strains are differentiated by Liu et al. ⁽¹⁰⁾ of the Taiwan Sugar Experiment Station. Based on the different symptoms on the differential cane leaves, degree of infectionsness, length of incubation period, etc. the strains are named as follows:

- (1) Short stripe type (Ss)
- (2) Yellow stripe type (Ys)
- (3) Fine stripe type (Fs)

Corn aphid (*A. maidis*) is the main insect vector in the field. The insect harbors in the grass grown in cane fields and migrates to sugar canes after weeding. Recently, varieties newly bred must be tested by artificial inoculation with the virus and only highly resistant ones are selected and extended.

Ratoon stunting disease. This is another virus disease commonly found on the commercial variety N:Co310. Loss due to this disease is 17-21% in tonage. However, seriousness of the disease varies with the soil type and rainfall of the current year.

The disease is controlled by treating the seed-pieces with 50°C. of hot water for 2 hours, or 54°C. of hot air for 8 hours, as recommended by the research quarter in Australia. The hot water treatment has been adopted in Taiwan since 1953. Treated seed-pieces are planted in the nurseries for multiplication. Based on the records obtained by TSC in 1960, the disease was significantly placed under control.

Leaf scorch. Leaf scorch (*Stagonospora sacchari* Lo & Ling) had caused serious damage on Co. and Hawaiian seedlings. During 1950-54, cane varieties such as Cox, Co290, Co281, H37-1933, and H44-3098 were badly damaged in the field. In the case of Co290, sugar yield of the diseased canes was 13% less than that of the healthy ones ⁽¹²⁾.

Transmission of the disease is mainly by rain. After the wide extension of N:Co310, a resistant variety, spreading of the disease has been checked.

Red rot. Red rot (*phyalospora tucumanensis* Speg.) was prevalent on F109, a commerical variety planted in eastern Taiwan. The pathogen is more or less a weak parasite and usually penetrates through the host tissue through wound often injured by stem borers. Conidial stage is found on the acervuli formed on the mid-rib of cane leaves. Pathogen of sexual stage has also been found abundantly on dry leaves.

The disease is controlled through the selection of resistant varieties.

Pineapple disease. Pineapple disease (*Ceratostomella paradoxa* (de Seynes) Dade) causes the failure in germination of the sugar cane seed-pieces. It is a soil-borne disease. Macro-and micro-conidia inflict infection through the unprotected cut-ends of the susceptible seed-pieces. In the case of cold weather or any other factors delaying the germination of the seed-pieces, the whole sugar cane field is completely destroyed. The disease is controlled by treating the seed-pieces with Granosan (1:1000) for a few seconds. Commercial varieties recently planted in Taiwan are disease resistant ones.

A List of Sugar Cane Diseases in Taiwan

Disease	Cause	Chinese Name
Banded chlorosis	physiological	低 溫 變 白
Banded sclerotial disease	<i>Corticium sasakii</i> (Shir.) Matu.	虎 斑 病
Black rot	<i>Ceratostomella adiposum</i> (Butler) Sartoris	黑 腐 病
Black stripe	<i>Cercospora atrofiliiformis</i> Yen, Lo & Chi	黑 條 病
Brown stripe	<i>Cochliobolus stenospilus</i> (Carp.) Matsumoto et Yamamoto	褐 條 病
Bunga	<i>Aeginetia indica</i> L.	野 菰 寄 生

Chlorotic streak	Virus	枯 條 病
Cover smut	<i>Sphacelotheca macrospora</i> Yen et Wang	種子堅黑穗病
Downy mildew	<i>Sclerospora sacchari</i> Miy.	露 菌 病
Eye spot	<i>Helminthosporium sacchari</i> (v. Breda de Haan) Butler	眼 點 病
Internal stalk necrosis	Undetermined	內 崩 潰 病
Leaf blast	<i>Didynosphaeria taiwanensis</i> Yen et Chi	葉 焦 病
Leaf blight	<i>Leptosphaeria taiwanensis</i> (Matu. et Yam.) Yen et Chi	葉 枯 病
Leaf buckle	Mechanical	扣 形 病
Leaf burn	Physiological	灼 傷
Leaf fleck	Undetermined	葉 點 病
Leaf scald	<i>Xanthomonas albilineans</i> Ashby	白 條 病
Leaf scorch	<i>Stagonospora sacchari</i> Lo & Ling	葉 燒 病
Leaf splitting disease	<i>Sclerospora miscanthi</i> Miy.	白 髮 病
Leaf variegation	Genetical	葉 彩 條 病
Lightning injury	Elemental	雷 殛
Multiple buds	Genetical	聚 芽
Marasmius root rot	<i>Marasmius sacchari</i> Wakker	傘 菌 根 腐 病
Mosaic	Virus	嵌 紋 病
Nematode injury	<i>Heterodera marioni</i> (Cornu) Goodey; <i>Tylenchus similis</i> Coff., etc.	線 蟲 根 瘤
Pineapple disease	<i>Ceratostomella paradoxa</i> (de Seynes) Dade	鳳 梨 病
Pokkah boeng	<i>Gibberella fujikuroi</i> (Saw.) Wr.	梢 腐 病
Purple spot	<i>Eriosphaeria sacchari</i> (V. Breda de Haan) Went	紫 斑 病
Pythium root rot	<i>Pythium</i> spp.	根 腐 矮
Ratoon stunting disease	Virus	矮 化 病

Red line disease	<i>Fusarium</i> sp.	赤 線 病
Red rot	<i>Phyalospora tucumanensis</i> (Went) Speg.	赤 腐 病
Red rot of (leaf) sheath	<i>Corticium rolfsii</i> (Sacc.) Curzi.	白 絹 病
Red spot of leaf sheath	<i>Cerospora vaginae</i> Krueger	葉 鞘 赤 斑 病
Red stripe	<i>Xanthomonas rubrilineans</i> (Lee et al) Starr et Burkh.	赤 條 病
Rind disease	<i>Plaochyta sacchari</i> (Mass.) Petr. et Syd.	外 皮 病
Ring spot	<i>Leptosphaeria sacchari</i> V. Breda de Haan	輪 斑 病
Rust	<i>Puccinia kuehnii</i> (Krueger) Butler	銹 病
Schizophyllum rot	<i>Schizophyllum commune</i> Fr.	扇 菌 病
Sereh	Undetermined	萎 縮 病
Sheath rot	<i>Cytospora sacchari</i> Butler	鞘 枯 病
Smut (Culmicolous)	<i>Ustilago scitaminea</i> Syd.	黑 穗 病
Sooty mold	<i>Fumago vagans</i> Pers, and <i>Caldariomyces fasciculatus</i> Yam.	煤 病
Stalk variegation	Genetical	莖 彩 條 病
Stem galls	Undetermined	莖 癭
Tangle top	Mechanical	纏 梢 病
Yellow flesh	Undetermined	黃 肉 病
Yellow leaf spot	<i>Cercospora kopkei</i> Krueger	葉 片 赤 斑 病

BANANA DISEASES

Around 12,000 hectares of banana are cultivated in Taiwan. There are two main areas where the plants are grown, one is on the mountainous area in central Taiwan and the other is on the plains of the south.

Varieties planted are mainly common banana (*Musa sapientum* Linn.) and some Chinese banana or dwarf banana (*Musa cavendishii* Lamb.). Production varies from 5,000 to 11,000 kg. per hectare. Over 20 diseases are found on banana, ⁽¹⁹⁾ among them, bunchy top, Sigatoka, stalk rot and green-ripening in transit are the major ones.

Bunchy top. Bunchy top is a virus disease. It is very serious in the mountainous area of central Taiwan. In some severe cases, over 50-70% of the plants may be diseased. Infected plants are stunted bearing no fruits. The aphids, *Pentolonia nigronervosa* Coq., have been proved to be the vector. Transmission test was made by S. K. Sun of PCHU ⁽¹⁶⁾ who found that the incubation period of the virus varied from 39 to 60 days, depending upon the temperature. Eradication of the diseased plants is recommended as an effective means of controlling the disease. Diseased plants are sprayed with kerosene. (Using 100 c.c. to 300 cc. depending upon the age of the plants). This practice is not only to kill the plants within a few days but also the aphids living on them.

Selection of resistant clones of banana in the disease area is underway.

Sigatoka. Sigatoka is a leaf spot disease incited by *Cercospora musae* Zimm. The disease is commonly found on banana plantations and is believed to cause considerable loss. However, no sufficient information has been derived, nor has any control method been in practice.

Stem-end rot. Stem-end rot is incited by *Ceratostomella paradoxa* (de Seynes) Dade. The fungus is a wound parasite, It infects the stalk through the cut end, and then extends its mycelia to cause rot of the whole hand of fruits. The disease is often very serious after the packing of fruit, causing loss by over 20%. Since 1951, the disease has been controlled by smearing the cut ends with 300 times of Granosan solution, and satisfactory result has been reported.

Green-ripeness disease. Green-ripeness is a physiological disease occurring

during transit. High temperature is the main cause. It causes great loss in some cases. However, the disease can be prevented through the improvement of shipping condition

A List of Banana Diseases in Taiwan

Disease	Cause	Chinese Name
Anthracnose	<i>Glomerella cingulata</i> (Ston.) Spaul. et Schr.	炭 疽 病
Bacterial leaf blight	<i>Xanthomonas</i> sp?	細菌葉斑病
Bacterial wilt	<i>Pseudomonas solanacearum</i> E. F. Sm.	細菌萎凋病
Black spot	<i>Macrophoma musae</i> (Cke.) B. et V.	黑 星 病
Botryodiploida fruit rot	<i>Botryodiploida theofromae</i> Pat.	黑 腐 病
Bunchy top	Virus	萎 縮 病
Cercospora streak- spot	<i>Cercospora musaecola</i> Saw.	細 線 病
Chilling	Physiological	寒 害
Cordana leaf spot	<i>Cordana musae</i> (Zimm.) Hohn	圓 星 病
Corticium root rot	<i>Pellicularia filamentosa</i> (Pat.) Rogers.	根 腐 病
Dothiorella fruit- rot	<i>Dothiorella ribis</i> Gros. et Dug.	果 腐 病
Fruit-end rot	<i>Fusarium</i> sp.	果頂腐敗病
Green-ripeness	Physiological	青 膨 病
Heart rot	Virus	心 腐 病
Helminthosporium black-spot	<i>Helminthosporium torulosum</i> (Syd.) Ashby	黑 斑 病
Ring spot	<i>Pestalotia leprogena</i> Speg.	輪 紋 病
Root knot	<i>Meloidogyne arenaria</i> (Neal) Chitwood	根瘤線蟲
Sigatoka	<i>Cercospora musae</i> Zimm.	葉 斑 病
Sclerotium rot	<i>Pellicularia rolfsii</i> (Sacc.) West.	果實白絹病
Smoke injury	Physiological	烟 害
Soft rot	<i>Rhizopus stolonifer</i> (Fr.) Lind.	軟 腐 病
Sooty blotch	<i>Chaetothyrium musarum</i> Speg.	煤 病
Stem & root rot	<i>Marasmius semiustus</i> Berk. et Cust.	莖及根腐病
Stem-end rot	<i>Ceratostomella paradoxa</i> (de Seynes) Dade	軸 腐 病

CITRUS DISEASES

More than 12,000 hectares of citrus are cultivated in Taiwan. Varieties planted are mainly Ponkan (*Citrus poonenses*) and Tunkan (*C. tunkan*). Root-stock variety used is sunki which possesses the characteristics of good root system and wide adaptability.

In general, 500 groves are planted on each hectare. Average production is about 6,000 kg. per hectare. Major diseases on citrus trees are tristeza, foot rot, black spot, canker and scab. Green and blue molds are sometimes serious on packed fruits during transit.

Tristeza. Tristeza has long existed in Taiwan. Earlier, it was sporadically found among the orchards. During recent years, it has spread so rapidly that it has now become a chief menace to the citrus growers. The disease has been studied by the phytopathological laboratory of NTU since 1956. In 1958, it was verified by the NTU laboratory to be a virus disease as reported in South America and the disease scions and citrus aphids were proved to be the source of its transmission. It has been further proved that tristeza virus involves several strains in the orchards of Taiwan. When such strains are roughly grouped into two types, namely, "Severe" and "Mild", the former shows typical symptoms in a period of several months after planting of the young trees or infecting of the growing trees, and the latter may have a latent period for some ten years. Scions from diseased groves with mild strain virus are no doubt the source of disease spreading.

A survey on this disease was made in 1959 and records were compiled by PDAF. Average percentage of the diseased groves is 22.4%.

Tristeza virus is mainly transmitted from the upper part of a grove to the root system either through disease scions or insect vectors. If root-stock variety is resistant or tolerant to the disease, the virus will not affect the function of the roots, the necessary nutrition is normally supplied, and the whole plant remains vigorous. On the other hand, if the root-stock is susceptible, the roots would decay and the whole grove dry up. Sunki, the rootstock variety now used in Taiwan, is a susceptible one. With the rampant vectors, *Toxoptera citricidus*, *Aphis spiraeicola*, *Aphis gossypii*, etc., commonly found in orchards planted to this variety, the disease will never stop spreading.

Control of this disease is recommended through two ways:

1. Inarching the disease-resistant seedlings to save the grown citrus groves:

In order to save those healthily grown citrus groves budded on sunki stock, scion rooting may be practised by inarching with seedlings of trifoliolate orange (a disease tolerant variety proved by NTU laboratory and field evidence) and Rangpur lime (another disease-resistant stock variety reported and proved by field evidence) to give them a tolerant root system when they are infected with tristeza virus. The two-year old seedlings of these tolerant varieties are suitable for this purpose. Number of the seedlings used depends upon the age of the citrus groves. In general, three seedlings are needed for a ten-year old grove. The operation is easily successful and most of the citrus growers in Taiwan have become familiar with the technique.

2. Using the disease tolerant varieties for root-stock:

When young trees are developed, trifoliolate orange and Rangpur lime are recommended to be used for root-stock. Although the growth of such young trees may be less vigorous than that of sunki stock, nevertheless the amount of the fruits born is always more. Because they are a bushy type, one-fourth of the groves may be grown in a unit area and the total amount of fruits will undoubtedly be increased.

Black Spot. Black spot is incited by *phoma citricarpa* McAip. (= *Guignardia citricarpa*). The fungus attacks the fruit to develop spots on the rind, thus depreciating eventually the market value of the fruit. The fungus invades the young fruit during 2-3 weeks after petal fall, and the spots then appear after latent period until the fruit becomes mature or is even packed in box. Mycelia are also abundant in tissues of leaves and twigs without showing symptoms. Orchards with wet soil and warm climate and under poor management are liable to suffer serious loss from the disease.

Measures for controlling the disease are recommended as follows:

1. Bordeaux mixture (3-3-1)* added with Dithane Z 78 (225gm. per 100 L) is used for spraying two weeks after petal fall, four successive sprays will be made at 3-to 4-week intervals.

* $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ 3 gm.
CaO 3 gm.
H₂O 1 litre

2. Removal of the drying leaves and twigs and diseased fruits in the orchard. This sanitary measure is important to minimize many kinds of diseases other than black spot.

Canker. Canker is a bacteria disease incited by *Xanthomonas citri* (Harse) Dowson. In Taiwan, the bacteria attacks the sunki variety used for root-stock in every nursery. Fruits of valencia, navel orange, lemon, etc. are also susceptible to this disease. Control method recommended in the past was to spray with Bordeaux mixture (6-6-1). However, as Bordeaux mixture is not compatible with many pesticides now commonly used such as lime-sulfur and summer oil, the method is not very practical. Copper is effective in controlling the disease but excessive application of this element will affect the growth of the citrus trees under the conditions of Taiwan. Other better fungicides are being tested by TARI.

Scab. Scab (*Elsinoe fawcetti* (Jenk.) Bitancourt et Jenkins) is found on ponkan and tunkan varieties. Lesions occur on leaves, twigs and fruits. It takes the form of warts with affected areas being elevated about the normal surface of the host. In most cases, it is serious on the fruits.

Based on the test made by TARI, the fungicide, Phaltan, is effective to control the disease. The fungicide is diluted in 400 times of water added with neutral sticker. During the period just before flowering, the first spray is made. Second spray is made after the young fruits are developed. The third spray, if necessary, is made 3 weeks after the second one.

Foot-rot. Foot-rot is incited mainly by *Rhizotinia* sp. as identified in Taiwan. The disease is commonly found in the orchards where the soil is wet or the drainage is poor.

Lesions are always found at the basal part of the bark at the ground level. Infected tree results in weakness of growth and may die when lesions extend to the girdle around the whole bark.

Controlling method has long been established in Taiwan. When initial lesion is found, infection tissues are peeled off with a sharp knife, then the exposed tissues are smeared with 0.5% Granosan or the paste-form Bordeaux mixture (one pound of copper sulfate and two pounds of calcium oxide added with 56 gm. of sticker), and after the fungicide dries up then a protective coating of asphalt is applied to protect against wash by rain.

In some cases, infected trees are inarched with seedlings to give new root system.

A List of Citrus Diseases in Taiwan

Disease	Cause	Chinese Name
Algal disease	<i>Cephaleuros parasititus</i> Karst	藻 斑 病
Anthonis disease (Mompa disease)	<i>Anthina Citri</i> Sawada	花 紋 羽 病
	<i>Anthina brunnea</i> Sawada	褐 紋 羽 病
	<i>Helicobasidium albicans</i> Sawada	白 紋 羽 病
Anthrocnose	<i>Colletotrichum gloeosporioides</i> penz.	炭 疽 病
Black rot	<i>Alternaria citri</i> Ellis et Pierce	黑 腐 病
Black spot	<i>Phoma citricarpa</i> McAlp.	黑 星 病
Blue mold	<i>Penicillium italicum</i> Wehmer	青 黴 病
Baron, copper, magne- sium, manganese or zinc deficiency	Physiological	缺 硼，鐵， 鎂，錳， 鋅 病
Brown rot	<i>Phytophthora citricola</i> Sawada	褐 腐 病
Canker	<i>Xanthomonas citri</i> (Hasse) Dowson	潰 瘍 病
Diplodia rot	<i>Diplodia natalensis</i> Pole-Evans	蒂 腐 病
Dry rot	<i>Nematospora coryli</i> Peglion	果 肉 乾 腐 病
Exanthema on fruit	Undetermined	疹 病
Felt fungus infection	<i>Septobasidium acaciae</i> Sawada	膏 藥 病
	<i>Septobasidium citricolum</i> Sawada	白 膏 藥 病
	<i>Septobasidium pedicellatum</i> (Schw.) pat.	灰 膏 藥 病
Fomes rot	<i>Fomes applanatus</i> (Pers.) Wall.	朽 腐 病
Foot rot	<i>Rhizoctonia</i> sp.	裾 腐 病
Greasy spot	Undetermined	油 脂 病
Green mold	<i>Penicillium digitatum</i> Sacc.	綠 黴 病

Gummosis	<i>Botrytis cinerea</i> Pers.	
	<i>Diplodia cineria</i> Pers.	
	<i>Dothiorella ribis</i> Gros. and Dug.	流 膠 病
	<i>Sclerotinia sclerotiorum</i> (Lib) DBy.	
	<i>Phomopsis</i> sp.	
Lichen	<i>Physcia</i> spp.	地 衣 表 生
Melanose	<i>Diaporthe citri</i> (Fawc) Wolf	黑 點 病
Multipatina disease	<i>Multipatina citricola</i> Sawada	椽 病
Mycosphaerella leaf spot	<i>Mycosphaerella</i> sp.	葉 斑 病
Pink disease	<i>Corticium salmonicolor</i> Berk. et Br.	赤 衣 病
Scab	<i>Elsinoe fawcetti</i> (Jenk) Bitancourt et Jenkins	瘡 痂 病
Sclerotium blight	<i>Corticium rolfsii</i> (Sacc.) Curzi	白 絹 病
Small-round-brown spot	<i>Phyllosticta currispora</i> Hori	褐小圓星病
Sooty mold	<i>Chaetothyrium citricola</i> Saw. et Yam. etc.	煤
Sour rot	<i>Oosporoides citri-aurantii</i> (Ferr.) Sumstine	酸 腐 病
Splitting	Physiological	裂 果
Stem-end rot	<i>Phomopsis citri</i> Faw.	軸 腐 病
Tristeza	Virus	黃 龍 病

PINEAPPLE DISEASES

Pineapple is cultivated on more than 12,000 hectares of land in Taiwan. The crop is distributed along the hillsides of the central, southern and eastern areas.

There are two seasons suitable for planting pineapple, one in August/September and the other in March/April. Smooth Cayenne is the main variety cultivated. The crop is grown for five years with three harvests. Production is about 40, 20, 10 tons per hectare for the first, second and third harvests, respectively.

Around 11 kinds of diseases are commonly found on pineapple in Taiwan.⁽⁵⁾ Among these diseases, mealybug wilt, heart rot and marble fruit disease are the major ones.

Mealybug wilt. Mealybug wilt was very destructive on pineapple plants. The disease was an important factor limiting the extension of the crop in Taiwan. Concerning the causal factor of the disease, Carter⁽¹⁾ in Hawaii has stated that: " . . . the etiology of mealybug wilt does not fit that of any known virus diseases nor can it be ascribed to a simple pineapple-to-pineapple feeding sequence of the mealybug. The suggestion was made, however, that a latent virus precursor may be involved". It has been manifested that the causal factor seems to be of a particular nature in the category of virus disease and mealybug plays an important role to make the latent virus precursor active in the host. However, complete elimination of the mealybugs is an effective way to control the disease. Practically, the following control schedule has been very satisfactory in Taiwan.

1. Place for pineapple-sets treatment is sprayed with 50 times of 23% Aldrex 2.
2. Sets cut for one to two weeks are immersed into 2,000 times of 47% Parathion for three minutes to kill the mealybugs prior to planting.
3. When the sets are planted for about one month, 100 c. c. of the same concentration of Parathion is poured through the crown of each plant to kill the mealybug that have escaped from the set-treatment during the growth of the crop. The insecticide is poured 3 or 4 times at 3-month intervals.
4. The 50 times of 23% Aldrex 2 is sprayed on the soil surface of the pine-

apple plantation to control the ants which are symbiosis with the mealybugs.

Heart rot. Heart rot is incited by *phytophthora parasitica* Dustur. The disease causes rot at the basal part of the crown. Infected young leaves are easily pulled up. The fungus is soil borne. In general cases, loss from the disease is below 3% of the total production. In case of the disease occurs in fields where soil is wet and drainage is poor the loss may reach 70-80%. Spraying with Bordeaux mixture may control the disease to some extent. However, to improve the plantation management is very important for checking the spreading of the disease.

Marbled fruit disease. This is a bacterial disease incited by *Erwinia ananas* Serrano. The flesh of infected fruit becomes brown to dark-brown in color, dry and stiff, tasting more or less bitter.

The disease is found more serious on the summer fruits harvested in May to September. According to a survey made by the Fengshan Tropical Horticultural Experiment Station in 1960, diseased fruits reached 14.84% of the yield of a plantation. The optimum pH value for the bacteria ranges from 4 to 5.5. It infects the fruits during the flowering stage of the crop.

Controlling of the disease with some fungicides has been tested by the Fengshan Station since 1959. Some mercuric compounds have been reported promising.

A List of Pineapple Diseases in Taiwan

Disease	Cause	Chinese Name
Black eye (eye rot)	Undetermined	黑 目 病
Black rot	<i>Ceratostomella paradoxa</i> (de Seyn.) Dade	黑 腐 病
Cleft	Physiological	裂 口
Heart rot	<i>Phytophthora</i> spp., <i>Pythium</i> spp., <i>Fusarium</i> spp.	心 腐 病
Leaf spot	{ <i>Cyclodermis comosi</i> Saw. <i>Pestalotia ananae</i> Saw. <i>Phyllosticta ananasae</i> Saw.	葉 斑 病
Marbled fruit disease	<i>Erwinia ananas</i> Serrano	花 瘰 病
Mealybug milt	<i>Pseudococcus brevipes</i> and virus-like substance?	姜 凋 病
Nematode root rot	To be identified	根 瘤 線 蟲
Pink diseases	<i>Phytomonas amaranthi</i> ?	赤 色 病
Root rot	<i>Pythium</i> spp., <i>Phytophthora</i> spp.	根 腐 病
Sun scald	Physiological	日 燒 病

TEA DISEASES

Tea is cultivated on some 48,000 hectares of land in Taiwan, as estimated in 1960. The plant is distributed along the mountainous areas of northern Taiwan. It is perennial. Average production is about 360 kg. of crude tea per hectare. The low production is due to the varieties cultivated (almost 98% of the varieties planted are the native ones with small leaves) and the poor management of the plantations. It is planned to extend better varieties such as Assam, Tainan Nos. 8. & 29, and FKK Nos. 1 & 511 in the coming years.

Nine diseases on tea are recorded in Taiwan, of which blister blight, net blister blight and twig blight are the major ones ⁽⁹⁾. Methods of disease control have been recommended by the Pingchen and Yuchih Tea Experiment Stations.

Blister blight. Blister blight (*Exobasidium vexans* Masee) is found on the leaves and young twigs of tea. The disease is prevalent during the rainy weather. Infected leaves show light-yellowish round spots on the upper surface. The spots then form depression and show white, round, raised lesions under the lower surface.

The disease is controlled with 15 grams of Copper Sandoz diluted in 2 liters of water for spraying. Sprays are made at 10-day intervals.

Net blister blight. The disease is incited by *Exobasidium reticulatum* Ito et Sawada. It is mainly found on the young leaves of tea. Lesions appear to be yellowish green at first, and then extend to become red-brown on the upper surface of the leaf, with the lower surface of the corresponding lesions becoming a net form of milky white color. No definite controlling method has been recommended as yet.

Twig blight. The pathogen of the disease is to be identified, probably *Phomopsis* sp. The disease is prevalent in June to September when the weather is dry. Lesions are found on the leaves. They are yellowish-green with reddish color along the midrib, and then whole leaf turns yellowish brown. In the advanced stage, all leaves fall down and the twigs become blight.

Based on tests made by the Pingchen Tea Experiment Station, Bordeaux mixture (6-6-1) and Orthocide (1:300-400) seem effective in controlling the disease.

A List of Tea Diseases in Taiwan

Disease	Cause	Chines Name
Anthracnose	<i>Gloeosporium theae-sinensis</i> Miy.	炭 疽 病
Birds-eye spot	<i>Cercospora theae</i> Bread De Haan.	圓 赤 星 病
Blister blight	<i>Exobasidium vexans</i> Massee	茶 餅 病
Brown blight	<i>Guignardia cammelliae</i> (Cooke) Butler	葉 枯 病
Canker	<i>Nectria diversispora</i> Petch.	潰 瘍 病
Grey blight	<i>Pestalotia theae</i> Saw.	輪 斑 病
Net blister blight	<i>Exobasidium reticulatum</i> Ito et Saw.	網 餅 病
Twig blight	<i>Phomopsis</i> sp.	枝 枯 病
Velvet blight	<i>Septobasidium acaciae</i> Saw.	膏 藥 病

TOBACCO DISEASES

Tobacco is cultivated in Taiwan under the administrative control of the Taiwan Tobacco & Wine Monopoly Bureau. Tobacco farmers must enter into contracts with the Bureau prior to planting the crop.

Acreage of tobacco is limited to around 8,000 hectares annually. Central, southern and eastern parts of Taiwan are the main tobacco producing areas. Seeds are sown in August to September and transplanting is made 35 to 45 days later. The crop is harvested in December through February.

Varieties now planted are Hicks, Vam-hicks (hybrid of Vamorr crossed with Hicks), Vam-vagold (hybrid of Vamorr crossed with Virginia gold), Bright yellow, etc. Average production is around 2,000 kg. per hectare.

Around 38 diseases on tobacco have been recorded in Taiwan. ⁽¹³⁾ Among them, virus diseases, Granville wilt, pythium, damping-off, frog eye, powdery mildew, black shank, and root-knot nematode are the major ones.

Tobacco diseases were investigated by NTU and PCHU in early years, and by the Tobacco Research Institute (TRI) at present.

Virus diseases. Tobacco virus diseases in Taiwan have been identified by Matsumoto ⁽¹³⁾ in 1946 as falling into the following five groups:

1. Mosaic group:

- Common, or ordinary mosaic
- Mild mosaic, type 1
- Mild mosaic, type 2
- Yellow mosaic

2. Necrosis group:

- Necrotic mosaic
- Etch-like necrotic spot
- Scald-necrotic mosaic

3. Ringspot group:

- Ring spot, type 1
- Ring spot, type 2

4. Leaf-curl group:

Leaf-curl

5. Composite disease group:

A composite disease

In recent years, cucumber mosaic on this crop has also been found in the field. Common mosaic virus, referred to as *Nicotiana virus 1* K. M. Smith or *Marmor tobaci var. vulgare*, Halmes, is widely distributed in Taiwan. It affects both the yield and quality of tobacco very seriously in many cases. The disease is transmitted mechanically during transplanting of young plants to the field from the seedbed, and, for the grown plants, it is transmitted by hand during topping. The implements or hands contaminated with the virus readily transmit the disease to the healthy plants. Cucumber mosaic virus is, on the other hand, transmitted by aphids. It tends to increase in the field according to the survey records maintained by TRI since 1956. The ratio between the common and cucumber mosaic scored 70.54: 29.45 in 1959/1960 crop year.

Common mosaic is controlled satisfactorily by planting the resistant varieties, such as Vam-hicks and Vam-vagold. However, they are not resistant to cucumber mosaic.

Roguing of disease seedlings in the seedbed and disinfecting of hands with soap water during topping are recommended to be the practical measures for checking the spread of the disease.

Granville wilt. Granville wilt is a bacterial disease incited by *Pseudomonas solanacearum* E. F. Smith. According to Okabe, there are at least four types, i. e. F, OP, C and SS in the tobacco fields of Taiwan. ⁽¹³⁾.

The disease is found in the seedbed. In some cases, it is very destructive on the grown plants. Infected plants finally result in wilt. The stem of a wilted plant first shows brownish or dark brown discoloration in the xylem portion then extending to the cortex, the surface of the stem corresponding to these lesions becomes blackened, and the central portion of the stem reveals a ladder-like appearance.

The bacteria persist in the soil in association with the crop residue. Improvement of the cultural environment including crop rotation, balanced fertility, etc., is recommended as a means for controlling the disease.

Pythium damping-off. The disease is incited by *Pythium aphanidermatum* (Eds.) Fitz. attacking the seedlings in the seedbed. The fungus is soil-borne; it first infects the seedlings from the ground level and finally causes them to rot. In general, the disease is found in patches in the seedbed with wet soil or poor drainage. In some severe cases, seedlings are completely destroyed by the disease. The disease is controlled by soil treatment. Fungicide now used is 2,000 to 4,000 times of Granosan. The chemical is sprayed after the seeds are sown and mulched with rice straws. Three liters of the diluted fungicide is applied for each square foot of the seedbed. Application of the fungicide is made at 4-to-6-day intervals after the seeds are germinated. The chemical can also be applied after the disease has been found. In such case, the interval between sprays will be shortened to two or three days.

Frog eye. Frog eye is incited by *Cercospora nicotianae* Ell. et Ev. The fungus infects the leaves to produce spots which are apparently circular with somewhat raised borders, and are characterized by their grayish white color in the center in the advanced stage. The disease occurs in any stage of the leaves, though predominantly on the mature ones. Leaf spots are also observed when the leaves look apparently healthy and are kept in the curing barn. According to Matsumoto, such case is due to the presence of the invaded leaf tissues which show symptoms in later stage

The disease is transmitted by conidia and is commonly found throughout the tobacco fields in Taiwan. Quality of the infected leaves is greatly lowered.

The disease can be controlled with zineb (Dithane Z 78) to some extent. The fungicide is diluted in 400 to 600 times of water for spraying. First and second sprays are made immediately before and after the topping of plants for prevention purpose. When the disease is found, sprays are made at 7-to 10-day intervals until two weeks before harvesting.

Powdery mildew. Powdery mildew is incited by *Erysiphe tabaci* Saw. is prevalent in the hillside areas during mid-December to January. Infected leaves are covered with a layer of powdery material which is the conidiophores and the hyaline conidia of the pathogen. The fungus is an obligate parasite; the mycelia invade the tissue of the leaf and cause it necrosis. Diseased leaves become black after curing and quality is much poorer. Loss from this disease is estimated at about 5% of the total production.

The disease may be controlled satisfactorily with the fungicide Karathane. The chemical is diluted in 1,000 to 1,500 times of water for spraying when the

disease is initially found. A schedule of two or three sprays is enough to control the disease.

In recent years, a plan for breeding disease-resistant varieties has been carried out by TRI.

Black shank. Black shank (*Phytophthora parasitica* var. *nicotianae* Tucker), is a well known, to be an important disease on tobacco crop. Its occurrence has been recorded in Taiwan. The fungus invades the basal part of the tobacco plant and causes rot of the tissues, and then the plant dies. When infected stem is longitudinally split, the ladder-like symptom appears to be one of the characteristics of the disease. The disease had not been epidemic in the field until 1959. According to the record of TRI, areas infected by the disease reached 42.7 hectares in Chiayi and 11.5 hectares in Pingtung in 1960. Percentage of the diseased plants ranges from 26.33% to 52.2%.

No practical measure has been recommended as yet. Testing on effective fungicides and resistant varieties has been carried out by TRI since 1960.

Root-knot nematode. Root-knot nematode (*Meloidogyne javaniac* (Treub.) Chitwood) causes the tobacco roots to produce the knot-like enlargement which affects the development of the plant root system.

The disease is more prevalent on the sandy soil in the southern area (Pingtung), especially under hot and dry conditions.

Nematode can be controlled by applying nematocides such as D-D mixtures or Nemagon; but the chemicals are not practical for use in Taiwan due to their high cost. Since 1959, testing has been made by TRI to determine the loss of the crop yield from the disease.

A List of Tobacco Diseases in Taiwan

Disease	Cause	Chinese Name
Anthracnose	<i>Colletotrichum tabacum</i> Böning	炭 疽 病
Black shank	<i>Phytophthora parasitica</i> var. <i>nicotianae</i> Tucker	疫 病
Brown leaf spot	<i>Ascochyta nicotianae</i> Pess.	褐 斑 病
Brown spot	<i>Alternaria longipes</i> (Ell. & Ev.) Mason	赤 星 病

Chicory leaf spot	<i>Bacterium formosanum</i> Okabe	葉 枯 病
Common mosaic	Virus	普 通 鑲 嵌 病
Composite diseasc	Virus	混 合 毒 素 病
Cucumber mosaic	Virus	胡 瓜 型 鑲 嵌 病
Etch-like necrotic spot	Virus	刻 裂 病
Frenching	Undetermined	細 葉 病
Frog eye	<i>Cercospora nicotianae</i> Ell. & Ev.	白 星 病
Granville wilt	<i>Pseudomonas solanacearum</i> E.F. Smith	立 枯 病
Leaf curl	Virus	捲 葉 病
Leaf spot	<i>Phyllosticta tobaci</i> Pass.	斑 點 病
Mild mosaic type 1	Virus	輕 症 鑲 嵌 病
Mild mosaic type 2 (Veinbanding)	Virus	脈 斑 病
Necrotic mosaic	Virus	壞 疽 鑲 嵌 病
Nitrogen hunger	Physiological	缺 氮 病
Potash hunger	Physiological	缺 鉀 病
Powdery mildew	<i>Erysiphe tabaci</i> Saw.	白 粉 病
Pythium damping-off	<i>Pythium aphanidermatum</i> (Eds.) Fitz.	猝 倒 病
Ring-spot, type 1	Virus	一 型 輪 點 病
Ring-spot, type 2	Virus	二 型 輪 點 病
Root knot	<i>Meloidogyne javanica</i> (Treub.) Chitwood	根 瘤 線 蟲 病
Scald-necrotic mosaic	Virus	紋 枯 病
Sclerotinia disease	<i>Sclerotinia sclerotiorum</i> (Lib.) Dby.	菌 核 病
Sooty mold	<i>Fumago vagans</i> Pers.	煤 病
Sore shin	<i>Rhizoctonia solani</i> Kuhn	腰 折 病
Stem rot	<i>Corticium rolfsii</i> (Sacc.) Curzi	白 絹 病
Yellow mosaic	Virus	黃 型 鑲 嵌 病

COFFEE DISEASES

Around 260 hectares of coffee are grown in Yunlin, Nantou, Chiayi, Pingtung, Hualien, and Taitung counties. *Coffea arabica* is the main variety. The average production is 1,141 kg. per hectare as recorded in 1960. ⁽¹⁷⁾

No sufficient information about coffee diseases is available in Taiwan. The variety recently cultivated is reported to be susceptible to rust disease (*Hemileia vastatrix* Berk. & Br.) ⁽¹⁵⁾, and field observation has proved that the disease is common on the leaves of coffee trees. In general, the disease is found in June through July. Bordeaux mixture (8-8-1) has been used for its control. The first spray is made in late May to mid-June, the second one in late June, and the third one in September when the rainy season is over.

In 1958, most of the seedlings grown in Yunlin county produced one or two pairs of very slender leaves on the top and the plant growth was apparently retarded. The abnormal case was then studied by the Chiayi Branch Station of TARI and it was found that the undesirable growth was due to the injury done by "usplun", an organic mercury compound used for controlling the diseases in the nursery.

MINT DISEASES

Around 4,600 hectares of mint are grown mainly in Yunlin and Changhua counties. The plant is cultivated in February to March and harvested in May to July. Okayama Acamaloo is the main variety. The yield is 120-150 kg. of oil per hectare. Varietal improvement to increase the oil content has been under way. Based on the preliminary results, such as Oka-ku Maruba No. 1, San-mei and Szechuan have been proven to yield more than the existing ones currently under cultivation.

Information about mint diseases is very scanty in Taiwan. Under field observation, rust (caused by *Puccinia menthae* Pers.) seems the most rampant disease. In some cases, urediospores of the pathogen are numerous on the leaves. It is believed that the premature defoliation does affect the yield to any extent.

Zineb should be effective in controlling the disease. However, the fungicide has not been tested and no control method is practised in the field.

JUTE DISEASES

Around 16,000 hectares of jute are cultivated mainly in southern Taiwan. The crop is planted in April and harvested in July to August. Commercial varieties are Shuishang Green Bark and Huwei Green Bark No. 7. Production is 1,000 to 1,500 kg. of retted jute per hectare. The crop is commonly cultivated in paddy fields, especially in the Chiayi area where a three-year crop rotational system has been practised.

There are 11 kinds of diseases on jute. Among them, anthracnose and nematode are the major ones.

Anthracnose. This disease is incited by *Colletotrichum corchorum* Ikata et Tanaka. The fungus invades through the wounds of the host. Infected seedlings result in death in most cases. Stems of the grown plants infected show symptoms of small black spots, thus decreasing eventually the quality of the fiber.

Use of resistant varieties is recommended as the main means to control the disease. A new variety, Y-6-466, selected by the Tainan Fiber Crops Experiment Station (FCES) has proved to be resistant to the disease. Seeds treated with Spergon may eliminate the disease in seedling stage. Dosage used is one kg. of seeds to eight gm. of the fungicide.

Root-knot nematode. Root-knot nematode on jute is caused by *Meloidogyne javanica* (Treub.) Chitwood. When the crop is cultivated on upland soil, it is badly affected and the growth is retard. And in severe cases, the quality of fiber is deteriorated and the amount of seeds harvested greatly reduced. However, as jute is commonly cultivated in paddy fields following the harvesting of rice crop, nematode problem is not serious due to the fact that the worms are controlled by flooding.

Nematode problem is serious on kenaf (Ambari hemp.). The crop was once planted on a small scale in Taiwan and was found badly affected. Selection of soils free from root-knot nematodes for planting the crop is recommended by the Tainan FCES upon experimentation.

In August to October, fields ready for planting kenaf are planted with tomato

or bean as indicating plants. These plants are uprooted after 1—1½ month to measure the severity of nematode infestation.

The problem of kenaf extension is expected to be solved by using the effective nematocide in the future.

A List of Jute Diseases in Taiwan

Disease	Cause	Chinese Name
Anthraxnose	<i>Colletotrichum corchorum</i> Ikata et Tanaka	炭 疽 病
Ascochyta stem rot	<i>Ascochyta corchori</i> Hara	胴 枯 病
Bacterial leaf spot	<i>Xanthomonas nakatae</i> (Okabe) Dowson	細菌斑點病
Black-band disease	<i>Diplodia corchori</i> Syd.	莖 枯 病
Damping-off	<i>Pellicularia filamentosa</i> (Pat.) Rogers	腰 折 病
Helminthosporium leaf rot	<i>Helminthosporium corchori</i> Sawada et Katsuki	葉 枯 病
Nematode root knot	<i>Meloidogyne javanica</i> (Treub.) Chitwood	根瘤線蟲病
Powdery mildew	<i>Microsphaera polygoni</i> (DC.) Saw.	白 粉 病
Seedling blight	<i>Macrophomina phaseoli</i> (Maub.) Ashby	立 枯 病
Soft rot (Sclerotium disease)	<i>Corticium rolfsii</i> (Sacc.) Curzi.	白 絹 病
Spotted disease	<i>Phyllosticta corchori</i> Sawada.	斑 點 病

A List of Kenaf Diseases in Taiwan

Disease	Cause	Chinese Name
Ahthracnose	<i>Colletotrichum hibisci-cannabini</i> Saw.	炭 疽 病
Cercospora leaf spot	<i>Cercospora hibisci - cannabini</i> Saw.	葉 煤 病
Damping-off	<i>Pellicularia filamentosa</i> (Pat.) Rogers	腰 折 病
Gray mold	<i>Botrytis cinerea</i> Pers.	灰 霉 病
Nematode root knot	<i>Meloidogyne javanica</i> (Treub.) Chitwood	根瘤線蟲病
Sclerotium disease	<i>Corticium rolfsii</i> (Sacc.) Curzi	白 絹 病
Stem rot	<i>Macrophomina phaseoli</i> (Maubl.) Ashby	立 枯 病

COTTON DISEASES

Cotton is a crop newly developed in Taiwan in the past few years, with its acreage being around 6,000 to 7,000 hectares annually. The crop is mainly distributed in the central-southern area (Yanlin, Chiayi and Tainan counties). It is planted in May to June and harvested in November to December. Commercial varieties planted are Empire and Kwantung No. 119. Production in recent years has fluctuates greatly owing to the typhoons. Average yield is around 700 to 800 kg. per hectare. Over 15 kinds of cotton diseases have been recorded in Taiwan, among which Angular leaf spot and Diplodia boll-rot are of major importance.

Angular leaf spot. Angular leaf spot is incited by *Xanthomonas malvacearum* (E.F.Sm.) Dows. The bacteria survive in the midst of fuzz on the seed, probably in the seed, and on crop residue. The first symptom is the appearance of small round spots on the cotyledons during the early stage of growth, and lesions on mature leaves are angular spots. It also infects the boll if weather condition is favorable. Soaking the cotton seeds in sulphuric acid or 1,000 times of Granosan for one to three hours prior to planting may prevent the disease in the seedling stage. However, lesions on mature leaves are very commonly found. So far, no sufficient information has been obtained to estimate the loss due to the disease in Taiwan.

Diplodia boll-rot. Diplodia boll-rot is incited by *Diplodia gossypina* Cooke. The disease infects the boll through wound either due to bollworm or wind. Lesions of the infected boll appears to be dull-brown in color with an abundance of tiny dots (the pycnidia). In advanced stage, a part of or even the whole boll results in rot. The disease is commonly found in the fields where wind velocity is faster or where bollworm control is not complete.

Granosan (1:1,000) has been recommended by the Taiwan Fiber Crops Experiment Station for controlling the disease. During the operation of bollworm control, the fungicide may be mixed to make a combination spray.

A List of Cotton Diseases in Taiwan

Disease	Cause	Chinese Name
Angular leaf spot	<i>Xanthomonas malvacearum</i> (E.F.Sm.) Dows.	角斑病

Anthracnose	<i>Glomerella gossypii</i> Edg.	炭 疽 病
Areolate mildew	<i>Mycosphaerella oreola</i> Ehrlich et Wolf	白 霉 病
Ascochyta blight	<i>Ascochyta gossypii</i> Sydow.	輪 斑 病
Black leaf spot	<i>Alternaria macrospora</i> Zimm.	黑 斑 病
Brown boll spot	<i>Helminthosporium gossypii</i> Tucker.	棉鈴褐斑病
Diplodia boll rot	<i>Diplodia gossypina</i> Cooke.	黑 化 病
Furarium boll rot	<i>Fusarium</i> sp.	紅 腐 病
Leaf blight	<i>Mycosphaerella gossypina</i> (Cooke) Atk.	葉 燒 病
Nematode root knot	<i>Meloidgyne</i> sp.	根 瘤 線 蟲
Phyllosticta leaf spot	<i>Phyllosticta gossypina</i> Ell. et Mart.	葉片褐斑病
Rust	<i>Phakopsora gossypii</i> (Arth.) Hiratsuka	銹 病
Sclerotium disease	<i>Corticium rolfsii</i> (Sacc.) Curzi	白 絹 病
Sore shin	<i>Pellicularia filamentosa</i> (Pat.) Ragers	腰 折 病
Wilt	<i>Fusarium vasinfectum</i> Atk.	萎 凋 病

VEGETABLE DISEASES

Vegetables are cultivated in small acreages on all farms of Taiwan. Total acreage is estimated at about 80,000 hectares annually. In recent year, several important diseases, such as late blight of tomato, powdery mildew of cucurbit, purple blotch of onion, rust of onion and scallion and downy mildew of crucifer, have been controlled with effective fungicides to some extent.

Late blight of tomato. Late blight of tomato (*Phytophthora infestans* (Mont.) de Bary) is widely distributed in Taiwan especially in areas of Tainan, Taichung and Taipei. The disease is found from December to April. When the weather is cold and wet, loss from the disease may reach over 50% of the total yield or complete destruction in severe cases.

The disease is controlled by spraying with Dithane M 22 or Dithane Z 78 (1:400). Sprays are made at 5-to 7-day intervals until seven days before harvesting.

Powdery mildew of cucurbit. Powdery mildew of cucurbit (*Erysiphe cichoracearum* DC.) is commonly found in the fields. The fungus mainly attacks the leaves thus bringing powdery symptoms on the surface (these are conidiophores and conidia). Growth of the plant is apparently retarded.

The disease is controlled by spraying with Karathane (1:1,000). Sprays are made at 10-day intervals until seven days before harvesting.

Purple blotch of onion. Purple blotch of onion (*Macrosporium porri* Ell.) is an important disease during the growth of the plant. The fungus attacks the leaves thus causing symptom blotches and, in severe cases, the plant may die. The disease is controlled with Dithane Z 78 (1:400-500). Sprays are made at 7-to 10-day intervals until one week before harvesting.

Rust of onion and scallion. Rust of onion and scallion is incited by *Puccinia allii* (DC.) Rudlphi. The disease is commonly found on the plants in Taiwan.

Rust is satisfactorily controlled with Dithane Z 78 (1:400). First spray is made when the disease is found. Next sprays are made at 10-to 14-day interval depending

upon the severity of the disease. When the spray could be timed simultaneously with that of thrips control with Malathion (1:1,000), both the fungicide and insecticide may be mixed together for a combination spray.

Downy mildew of crucifer. Downy mildew of crucifer is incited by *Peronospora brassicae* Gäum. The fungus attacks the leaves of the host. Lesions show irregular spots with yellowish to light brown color covering a layer of mold-like material (Sporangiophores and Sporangia).

The disease is controlled with Dithane Z 78 or Dithane M 22 (1:400). Sprays are made at 7-day interval until seven days before harvesting. In general, the disease is satisfactorily controlled by 3-4 sprays.

A List of Vegetable Diseases in Taiwan

1. Radish

Disease	Cause	Chinese Name
Anthraxnose	<i>Colletotrichum higginsianum</i> Saccardo	炭 疽 病
Black rot	<i>Xanthomonas campestris</i> (Pammel) Dowson	黑 腐 病
Black spot	<i>Alternaria brassicae</i> (Berk.) Sacc.	黑 斑 病
Club root	<i>Plasmodiophora brassicae</i> Woronin	根 瘤 病
Downy mildew	<i>Peronospora brassicae</i> Gäum	露 菌 病
Mosaic	Virus	炭 紋 炭
Soft rot	<i>Erwinia aroideae</i> (Townsend) Holland	軟 腐 病
White rust	<i>Albugo candida</i> (Pers.) Kuntze	白 銹 病
White spot	<i>Cercospora albomaculans</i> Saccardo.	白 斑 病

2. Carrot

Alternaria leaf blight	<i>Alternaria caratae</i> (E. et L.) Ell.	葉 黑 枯 病
Cercospora leaf spot	<i>Cercospora apii</i> var. <i>carotae</i> Pass.	褐 斑 病
Sclerotium rot	<i>Corticium rolfsii</i> (Sacc.) Curzi.	白 絹 病
Sclerotinia disease	<i>Sclerotinia libertiana</i> Fuck	菌 核 病
Soft rot	<i>Erwinia carotovora</i> (Jones) Holland	軟 腐 病

3. Onion

Black mould	<i>Mycosphaerella schonoprasii</i> (Rabb.) Schrot	黑 霉 病
Downy mildew	<i>Peronospora destructor</i> (Berk.) Casp.	露 菌 病
Phytophthora blight	<i>Phytophthora allii</i> Saw.	疫 病
Purple blotch	<i>Macrosporium porri</i> Ellis.	紫 斑 病
Rust	<i>Puccinia allii</i> (DC.) Rudolph	锈 病
Sclerotinia disease	<i>Sclerotinia allii</i> Saw.	小 菌 核 病

4. Chinese cabbage

Club root	<i>Plasmodiophora brassicae</i> Wor.	根 瘤 病
Downy mildew	<i>Pernospora brassicae</i> Gäum	露 菌 病
Mosaic	Virus	嵌 紋 病
Pale spot	<i>Cercospora albo-maculans</i> Sacc.	白 斑 病
Soft rot	<i>Erwinia aroideae</i> (Townsend) Holland	軟 腐 病

5. Cabbage

Black spot	<i>Alternaria brassicae</i> (Berk) Sacc.	黑 斑 病
Black rot	<i>Xanthomonas campestris</i> (Pam.) Dows.	黑 腐 病
Sclerotinia disease	<i>Sclerotinia libertiana</i> Fuck	菌 核 病

6. Lettuce

Anthracoze	<i>Gloeosporium chrysanthemi</i> Hori	炭 疽 病
Leaf blight	<i>Cercospora chrysanthemi-coronarii</i> Saw.	葉 枯 病
Leaf spot	<i>Septoria lactacue</i> Pass.	葉 斑 病
Sclerotinia disease	<i>Sclerotinia libertinia</i> Fuck	菌 核 病

7. Spinach

Anthracoze	<i>Colletotrichum spinaceae</i> Ell. et Halst.	炭 疽 病
Downy mildew	<i>Peronospora spinaceae</i> Lauabert	露 菌 病
Sclerotinia disease	<i>Sclerotinia libertinia</i> Fuck	菌 核 病

8. Cucurbit

Anthracoze	<i>Colletotrichum lagenarium</i> (Pass.) Ell. et Halst.	炭 疽 病
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Bacterial wilt	<i>Erwinia tracheiphila</i> (E. F. Sm.) Holland	青 枯 病
Downy mildew	<i>Pseudoperonospora cubensis</i> (B. et C.) Rostow.	露 菌 病
Fusarium wilt	<i>Fusarium bulbigenum</i> var. <i>niveum</i> (Sm.) Wr.	蔓 割 病
Gummy stem blight	<i>Mycosphaerella citrulina</i> Gross.	蔓 枯 病
Mosaic	Virus	胡瓜型鑲嵌病
Powdery mildew	<i>Erysiphe cichoracearum</i> DC.	白 粉 病
Sclerotium rot	<i>Corticium rolfsii</i> (Sacc.) Curzi	白 絹 病

9. Tomato

Anthracnose	<i>Colletotrichum phomoides</i> (Sacc.) Chester	炭 疽 病
Bacterial wilt	<i>Pseudomonas solanacearum</i> E.F. Smith	青 枯 病
Blossom-end rot	Physiological (Irregular water supply)	頂 腐 病
Early blight	<i>Alternaria solani</i> (Ell. et Martin) Jones and Crout	夏 疫 病
Fruit rot	<i>Phoma destructiva</i> Plowright	果 腐 病
Fusarium wilt	<i>Fusarium lycopersici</i> Sacc.	萎 凋 病
Late blight	<i>Phytophthora infestans</i> (Mont.) DBy.	晚 疫 病
Leaf spot	<i>Septoria lycopersici</i> Speg.	白 星 病
Leaf mold	<i>Cladosporium fulvum</i> Cooke	葉 黴 病
Mosaic	Virus	嵌 紋 病
Powdery mildew	<i>Erysiphe cichoracearum</i> DC.	白 粉 病
Sclerotinia disease	<i>Sclerotinia libertiana</i> Fuck	菌 核 病
Sclerotium rot	<i>Corticium rolfsii</i> (Sacc.) Curzi	白 絹 病
Soft rot	<i>Erwinia aroideae</i> (Townsend) Holland	軟 腐 病

10. Bean

Angular leaf spot	<i>Phaeoisariopsis griseola</i> (Sacc.) Frank	角 斑 病
Anthracoze	<i>Colletotrichum lindemuthianum</i> (Sacc. & Magn.) Briosi and Cav.	炭 疽 病
Bacterial blight	<i>Xanthomonas phaseoli</i> (Sm.) Dowson	葉 燒 病

Mosaic	Virus	萎 縮 病
Rust	<i>Uromyces appendiculatus</i> (Pers.) Link	銹 病
11. Pea		
Foot rot	<i>Mycosphaerella pinodes</i> (Berk. et Blox.) Stone	黑 斑 病
Leaf spot	<i>Ascochyta pisi</i> Libert	褐 斑 病
Powdery mildew	<i>Erysiphe pisi</i> DC.	白 粉 病

FOREST DISEASES

More than 1,960,000 hectares of forest are distributed mainly along the central mountain range of Taiwan. Trees grown include many genera of coniferae, among which *Cryptomeria japonica* introduced from Japan has been proved to be adaptable to the belt between 800 to 2,100 meter counter lines, so it is one of the important kinds of trees in Taiwan.

Forest diseases are studied by NTU, PCHU, the Taiwan Forestry Bureau and the Taiwan Forestry Research Institute. However, as all studies have been only started not long ago, information is very scanty. Evaluation of some experimental results is mainly made on the diseases controlled in nurseries, for instance, the needle-blight of *Cryptomeria*, damping-off of coniferous seedlings, etc.

Needle-blight of *Cryptomeria*. The disease is incited by a number of fungi. *Cercospora Cryptomeria* Shirai has been reported to be the main pathogen in the seedling stage of the host. According to the study made by NTU, ⁽³⁾ damage caused by the disease ranges from 28.17 to 100%. The primary infection of the disease seems to occur during March to April, and the second infection from June to early September. The disease is controlled satisfactorily by spraying with Bordenax mixture (4-4-1) with the addition of a sticker. Sprays are made from early April to November at 15-day intervals (10-day intervals in August).

Damping-off of coniferous seedlings. Damping-off is the important disease in nurseries. Based on the study made by NTU ⁽³⁾, pathogens isolated are *Rhizoctonia solani* Kuhn, *Fusarium* spp. and *Botritis* sp.

The following methods for controlling the disease are practised in Taiwan:

1. Seeds are treated with 1,000 times of Granosan for one hour prior to sowing.
2. After the seeds are sown, 100 to 300 grams of aluminum sulfate or ferrous sulfate (technical grade) solution is sprayed on each square meter of the soil, depending upon the soil texture in the nursery; and then an additional spray with eight liters of Granosan (1:2,000) is made.

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