

ICRR



A BRIEF REPORT ON CROP DISEASES IN TAIWAN

TAIPEI, TAIWAN
REPUBLIC OF CHINA
APRIL 1972

CHINESE-AMERICAN
JOINT COMMISSION ON RURAL RECONSTRUCTION

A BRIEF REPORT ON CROP DISEASES IN TAIWAN

T. T. Lo
Senior Plant Pathologist
Plant Industry Division



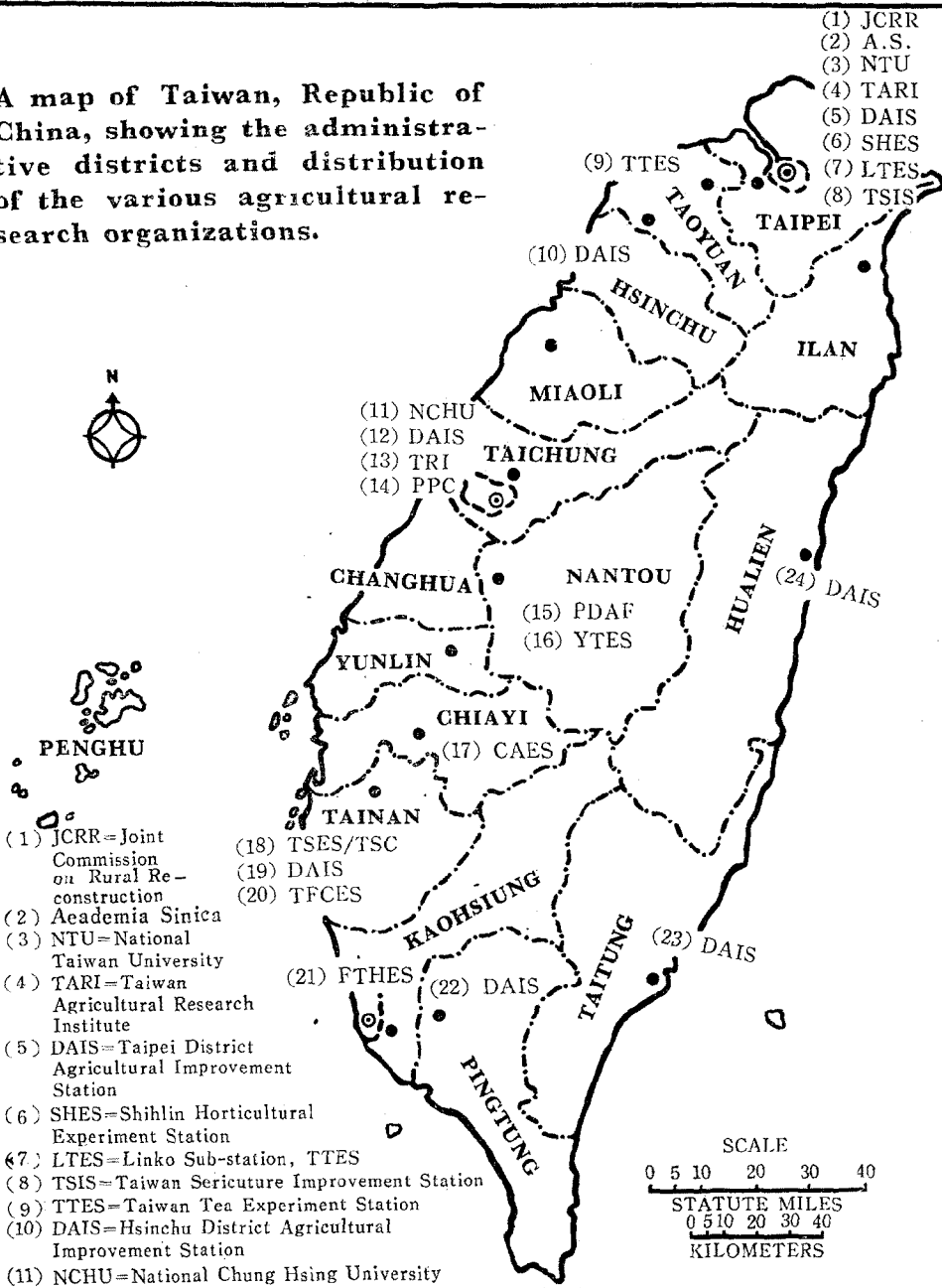
Taipei, Taiwan, China

1972

CONTENTS

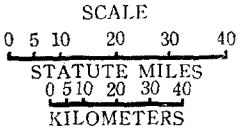
	Page
A map of Taiwan	i
Introduction	1
Rice Diseases	3
Wheat Diseases	9
Sweet Potato Diseases	11
Soybean Diseases	13
Peanut Diseases	15
Corn Diseases	17
Cassava Diseases	19
Sugar Cane Diseases	20
Banana Diseases	26
Citrus Diseases	29
Pineapple Diseases	34
Tea Diseases	37
Tobacco Diseases	39
Flax Diseases	44
Jute Diseases	45
Cotton Diseases	48
Sisal Diseases	50
Vegetable Diseases	51
Potato Diseases	57
Asparagus Diseases	59
Mushroom Diseases	60
Diseases of miscellaneous crops	62
Literature cited	63
Symptoms of some major diseases	Fig. 1-16

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



- (1) JCRR
- (2) A. S.
- (3) NTU
- (4) TARI
- (5) DAIS
- (6) SHES
- (7) LTES
- (8) TSIS

- (9) TTES
 - (10) DAIS
 - (11) NCHU
 - (12) DAIS
 - (13) TRI
 - (14) PPC
 - (15) PDAF
 - (16) YTES
 - (17) CAES
 - (18) TSES/TSC
 - (19) DAIS
 - (20) TFCES
 - (21) FTHES
 - (22) DAIS
 - (23) DAIS
 - (24) DAIS
- (1) JCRR=Joint Commission on Rural Reconstruction
 (2) Academia Sinica
 (3) NTU=National Taiwan University
 (4) TARI=Taiwan Agricultural Research Institute
 (5) DAIS=Taipei District Agricultural Improvement Station
 (6) SHES=Shihlin Horticultural Experiment Station
 (7) LTES=Linko Sub-station, TTES
 (8) TSIS=Taiwan Sericulture Improvement Station
 (9) TTES=Taiwan Tea Experiment Station
 (10) DAIS=Hsinchu District Agricultural Improvement Station
 (11) NCHU=National Chung Hsing University
 (12) DAIS=Taichung District Agricultural Improvement Station
 (13) TRI=Tobacco Research Institute
 (14) Plant Protection Center, Taiwan.
 (15) PDAF=Provincial Department of Agriculture & Forestry
 (16) YTES=Yuchih Sub-station, TTES
 (17) CAES=Chiayi Agricultural Experiment Station
 (18) TSES/TSC=Taiwan Sugar Experiment Station of Taiwan Sugar Corporation
 (19) DAIS=Tainan District Agricultural Improvement Station
 (20) TFCES=Tainan Fiber Crops Experiment Station
 (21) FTHES=Fengshan Tropical Horticultural Experiment Station
 (22) DAIS=Kaohsiung District Agricultural Improvement Station
 (23) DAIS=Taitung District Agricultural Improvement Station
 (24) DAIS=Hualien District Agricultural Improvement Station



INTRODUCTION

The high temperature and humidity of Taiwan are favorable to the growth of pathogens of many crop diseases. It has been roughly estimated that the annual loss of main crops from important diseases is around 10 percent, or over three billion New Taiwan Dollars in total value.

Phytopathological work in Taiwan is conducted by the various research institutions (map of Taiwan). They include the phytopathological laboratories of the Academia Sinica; the College of Agriculture of the National Taiwan University (NTU); the College of Agriculture of the National Chung Hsing University (NCHU); the Taiwan Agricultural Research Institute (TARI); the Taiwan Sugar Experiment Station (TSES) of the Taiwan Sugar Corporation; the Tobacco Research Institute (TRI); the four TARI branch stations, i.e. Shihlin Horticultural Experiment Station, Chiayi Agricultural Experiment Station, Tainan Fiber Crops Experiment Station, and Fengshan Tropical Horticultural Experiment Station; the Taiwan Tea Experiment Station and its Yuchih and Linkuo Sub-stations; the seven District Agricultural Improvement Stations (DAIS) at Taipei, Hsinchu, Taichung, Tainan, Kaohsiung, Taitung and Hualien, of the Provincial Department of Agriculture and Forestry (PDAF); and the newly established Plant Protection Center at Taichung.

In the past decade, most of the major pathological projects carried out by the institutions under PDAF were supported financially and technically by the Joint Commission on Rural Reconstruction (JCRR); while those on sugar cane and tobacco were financed by the Taiwan Sugar Corporation and the Taiwan Tobacco and Wine Monopoly Bureau, respectively.

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.

In 1960, a Technical Committee on Plant Protection (TCPP) was established by the Taiwan Provincial Government. The main activity of

this organization is to examine and decide on measures of plant protection before recommending them officially for general practice. Since 1969, the Committee has been functioning under the Ministry of Economic Affairs.

When a new pest control method is ready to be extended, the research unit concerned should submit the experimental data to the Committee for study and approval. Special consideration is given to the effectiveness, toxicity, plant injury, residue problem and feasibility of any new pesticide to be adopted.

The phytopathological work in Taiwan is still in a developing stage. Besides practical studies, basic research on crop diseases must be strengthened. The virus diseases, mycoplasma, soil fungi, physiological races (or strains) of pathogens, nematodes, etc. are some of the important problems to be tackled.

This report presents only a general picture of crop diseases in Taiwan. Detailed information is obtainable from the various research institutions concerned.

The writer wishes to acknowledge his indebtedness to the plant pathologists of the various research institutions for their assistance in obtaining color slides of disease symptoms for this report.

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 northern parts of Taiwan. The second crop is planted from July to August. The growing period is about 120 days for the first crop and 110 days for the second, and the unit yield ranges from 1,000 to 5,000 kg. of brown rice per hectare. According to a recent statistical study, the average production for the whole island is around 3,000 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. Virus diseases and bacterial leaf blight have proved harmful to 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 are of minor importance under present conditions.

Blast. Blast (*Pyricularia oryzae* Cav.) is most prevalent in the first crop of rice in Taiwan. The disease is more destructive 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, the disease appears on the leaves of susceptible varieties which have been 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 named "leaf blast." Loss from leaf blast varies from very slight to complete damage of the crop. When the weather is favorable for the growth of 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 called "neck blast." When the glumes are attacked and became discolored, resulting in light grains, it is called "kernel blast." Hashioka (1950) 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 blast fungus (20-32°C, optimum 26-28°C).

2. Relation of temperature to the growth of rice plant. Nitrogenous compounds are accumulated at lower temperature, while, in higher temperature, the N-content is decreased with the increase in silicic accumulation. Thus, the disease is more serious in the first crop than in the second.

3. Relation of age of rice plant to resistance - The leaves of rice plant are susceptible during the seedling and tillering stages, then become resistant at the late tillering stage and the resistance is further increased 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 to 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 to neck blast, the tendency is not so clearly recognizable.

Blast disease may be controlled in two ways, one through the breeding of resistant varieties and the other through the application of effective fungicides. The work of breeding resistant varieties has been carried out by the TARI and its Chiayi branch station and also the Taipei, Hsinchu, Taichung, Tainan, Kaohsiung and Taitung DAISs. One highly resistant variety, Tainan No. 5, has been extended widely on this island.

The host range of the pathogen includes some weeds 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 found to exist in the field, and the differentiation and identification work has been carried out by TARI.

Fungicides now used for controlling the disease on fairly resistant or susceptible rice varieties are organic phosphate compounds and antibiotics. Organic mercuric compounds such as Granosan are used for seed treatment. The 1:1,000 solution of the chemical is recommended for the treatment of

seeds for one hour prior to planting. With this treatment, the "Bakanae" disease (*Gibberella fujikuroi* (Saw.) Wr.) is completely controlled as well. Fungicide used for controlling the leaf and neck blast is generally applied two to three times. The first spray is made 35 to 50 days after transplanting when the disease is initially found, the second spray is required about 7 days before heading, and one more spray may be necessary after the heading stage if the disease is still prevalent.

Sheath blight. Sheath blight (banded sclerotial disease) incited by *Thanatephorus cucumeris* (Frank) Donk 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 areas, 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 almost all the commercial varieties are susceptible to the disease, organic arsenic compounds such as "mon" or "Neo-Asozin" have been recommended for its control, and the method is practised popularly. Concentrations of the fungicides are recommended at 1:2,500 for 16.5% mon E. C. and 1:2,000 for 6.5% Neo-Asozin. The first application of the fungicide is made 30-45 days after the transplanting of rice when the disease is found, and the second application two weeks after the first one.

Other sclerotial-forming fungi, such as small black sclerotial disease or stem rot (*Helminthosporium sigmoideum* Cav. var. *irregular* Cralley et Tullis) and small round sclerotial disease (*H. sigmoideum* Cav.), are sometimes grouped in this category. In some cases, the diseases may cause the rice plants to lodge before harvesting, resulting in reduced yield.

Bacterial leaf blight. Bacterial leaf blight is caused by *Xanthomonas Oryzae* (Uyeda and Ishiyama) Dow. The bacteria infects the leaves of rice plant, causing great damage to the susceptible varieties especially after a typhoon attack when leaves are injured by strong winds. The famous

variety Taichung Native No. 1 bred in Taiwan is highly susceptible.

The initial symptom is a waving streak with yellowish color starting from the tip of infected leaf and then extends downward along the leaf edge. Finally, a large part of mesophyll becomes dark yellow and then dries up (Fig. 1).

No chemical can control the disease effectively at present. Selection of resistant varieties is an important approach to the solution of this problem.

Since bacteriophage can destroy bacteria under natural conditions, research on this project has been conducted by the Academia Sinica to select strains of bacteriophage for controlling the disease.

Virus diseases. There are several virus diseases on rice plant in Taiwan, among which, transitory yellowing and yellow dwarf are the two most important ones.

Transitory yellowing. The disease was first found in 1960. Over 20,000 hectares of rice were badly infected during 1960-62. Diseased plant shows mottling of younger leaves and yellowing with rusting spots of the older ones. Tillers are much fewer than the healthy plants. Complete failure of the crop is common in severe cases (Fig. 2).

Cause of the disease was unknown at first. In 1965 it was identified to be a virus disease transmitted by leaf hopper (*Nephotettix apicelis* and *N. cincticeps*).

The disease is more prevalent in the second crop due to a higher population of insect vectors in the fields.

Varietal resistance to the disease is significant. For instance, Tainan No. 3 is highly susceptible, while Taichung Native No. 1 is highly resistant. Only through the use of resistant varieties may this disease problem be solved.

Application of insecticides to control the insect vector on a large scale is also effective for checking the spread of the disease.

Yellow dwarf. Yellow dwarf was identified as a virus disease and sphere particles of the virus have been reported. However, abundant mycoplasma has been found in the sieve tube element of diseased plant since 1967, the question as to whether the disease is of a complex cause or induced by mycoplasma has yet to be answered.

Infected plant produces profuse tillers, whose leaves are pale green to yellow, panicles are shorter and paddy grains are not fully developed.

The disease is sporadically found in the field. It is transmitted by the leaf hopper *Nephotettix impleticeps*. Use of resistant rice varieties and control of the insect vector are the means currently applied in Taiwan to check the disease.

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>Pyricularia 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

Disease	Cause	Chinese Name
False smut	<i>Ustilaginoidea virens</i> (Cooke) Tak.	稻 麩 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) oryzae</i> Hara	葉 切 病
Leaf smut	<i>Entyloma daclylidis</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 黴 病
Sheath blight	<i>Thanatephorus cucumeris</i> (Frank) Donk.	紋 枯 病
Sheath rot	<i>Acrocyndrium oryzae</i> Saw.	鞘 腐 病
Seedling rot	{ <i>Achlya flagellata</i> Coker., <i>Diclyuchus</i> sp., <i>Fusarium</i> sp., <i>Rhizoctonia</i> sp., <i>Pythium</i> sp.,	苗 立 枯 病
Small black sclerotial disease	<i>Helminthosporium sigmoideum</i> Cav. var. <i>irregularare</i> Cralley et Tullis.	小黑菌核病
Small brown Sclerotial disease	<i>Sclerotium oryzae</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
Transitory yellowing	Virus	黃 葉 病
White tip	<i>Aphelenchoides besseyi</i> christie	白 尖 病
Yellow blight	<i>Pyrenochaeta oryzae</i> Shirai	黃 枯 病
Yellow dwarf	Virus? mycoplasma?	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 winter crops in central Taiwan. Its acreage was more than 25,000 hectares in 1960. Since then the acreage has been decreasing every year, and it amounts to only around 5,000 hectares at present. Commercial varieties are of locally bred lines including Taichung 31 and Taichung 33. Seeds are sown in late October to early November and harvested in February to March. Production is around 2,000 kg. per hectare.

Rust and powdery mildew are the major diseases commonly found on this crop. In east 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. Smut (*Ustilago tritici* (Pers.) Bostr.), an important disease in most countries, is 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 condition of weather.

The life cycle of the pathogen is not completely known in Taiwan, with only the uradial stage found on the lesions. On the barberry or mahonia collected so far, no pynia and aecia stages were found.

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

Rust has been controlled through the use of resistant varieties and spraying of Zineb. Dosage of the fungicide recommended is a dilution with 400 parts of water. First spray is made in early January and the second and third sprays at 2-week intervals.

Scab. Scab disease (*Gibberella zeae* (Schw.) Petch.) is endemic in

eastern Taiwan. Difference in varietal resistance to the disease is not significant. A screening test on fungicides to control the disease was made by the Hualien DAIS in 1960. Dithane M22 seems effective, but it is not economical in practice.

A List of Wheat Diseases in Taiwan

Disease	Cause	Chinese Name
Black stem rust	<i>Puccinia graminis tritici</i> Eriks. & Henn.	黑銹病(稈銹病)
Foot rot	<i>Cochliobolus sativus</i> (P.K. et B.) S. 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 zeae</i> (Schw.) Petch.	赤霉病
Yellow mosaic	<i>Virus</i>	編萎縮病
Yellow rust	<i>Puccinia glumarum</i> (Schmidt) Eriks. et Henn.	黃銹病(條銹病)

SWEET POTATO DISEASES

Sweet potato is a major crop in Taiwan. It is used mainly for feed and sometimes as supplementary food for people in the coastal areas. Annual acreage is about 230,000 hectares. The main varieties planted are New Tainung 31 and Red-tuber-tail. The crop may be cultivated the whole year round; but most farmers plant it from August to October and harvest it from February to April. Production is around 13,000 kg. per hectare. For 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 slices and stored up after being sun-dried. Diseases found on the crop in the field are witches broom, stem rot, bud atrophy and black rot. In some cases, damage by the diseases has been serious.

Witches' broom. Witches' broom of sweet potato is prevalent in Miaoli, Hsinchu and Penghu areas. In some serious cases, percentage of diseased plants reached 60-70%. In other areas the disease occurs only occasionally.

Infected plants produce smaller leaves and tubers of lower quality or even fail to produce tubers in severe cases (Fig. 3).

The pathogen of the disease has been identified as mycoplasma by NCHU, and the leaf hopper, *Orosius ryukyuensis* Ishihara, has been found to be the vector by the Tainan DAIS. Different varietal reactions to the disease have been tested by the Chiayi AES.

The disease is controlled by use of resistant varieties and application of insecticides to kill the insect vectors.

Stem rot' The disease is incited by *Fusarium oxysporum* f. *batatatis* Sny. et Han. The typical symptom is lesions somewhat resembling knife-cuts on the stem. The crown of the plant is apparently weakened. Selection of 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. Scabs are found on the old lesions. Treatment with 1% Perenox 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; therefore the method is considered not practical. Use of disease-free cuttings for multiplication has proved an effective control measure.

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
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>Monilochaetes 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 oxysporum</i> f. <i>batatatis</i> Sny. et Han.	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

SOYBEAN DISEASES

More than 40,000 hectares of soybean is cultivated in Taiwan annually. The main varieties are Shih-shih, Palmetto, and Wakashima. The 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 July and the other in October; while in the south, three crops are planted in February, June and October. The average yield is 1,500 kg. per hectare.

According to a study made by TARI, the insect problem of this crop is more serious than that of disease. A survey made by TARI and the Agricultural College of NCHU in 1968 found rust as the most important soybean disease. Other diseases like mosaic, witches' broom, purple speck and downy mildew have been found occasionally in some locations, but they are of minor importance.

Rust. Rust (*Phakopsora saiae* (F. Hem.) Sawada) is commonly found on cultivated varieties, especially on Palmetto which is grown in the south. In some severe cases, the crop completely failed before harvesting. Zineb or Maneb has been recommended to control the disease. The fungicide is diluted in 400 parts of water. The first spray is made 20-30 days after germination of the seeds when the disease is found, and the next two or three sprays made at 7-day intervals. It is also recommended that the fungicide be mixed with insecticides for the simultaneous control of insects. Breeding of disease resistant varieties has been conducted jointly by NTU, TARI and the Kaohsiung DAIS.

Purple speck or purple stain seed. Incited by *Cercospora kikuchii* (matsu. and Tomoyasu) Gardner, this disease is occasionally found, especially in eastern Taiwan. It is a seed-borne disease. Its control was studied by NCHU, and the fungicide Maneb was recommended for the treatment of seed.

Mosaic and witches' broom. Mosaic is occasionally found in the field. In a study made by NCHU, several strains of the virus were

identified. The virus is transmitted by aphids (*Myzue persicae* and *M. solani*).

Witches' broom is also occasionally found in the field. The causal organism has been identified to be Mycoplasma. and the leaf hopper (*Nesophrosyne orientalis*) is the vector. Both diseases can be controlled through resistant varieties.

A List of Soybean Diseases in Taiwan

Disease	Cause	Chinese Name
Anthracnose	<i>Glomerella glycines</i> Lehman et Wolf.	炭 疽 病
Bacterial blight	<i>Pseudomonas glycinea</i> (Coerper) Stapp.	細 菌 斑 點
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 sojina</i> Hora.	斑 點 病
Fusarium pod rot	<i>Fussrium 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
Rust	<i>Phakospsora saiae</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
Witches' broom	Mycoplasma.	簇 葉 病

PEANUT DISEASES

About 100,000 hectares of peanut is cultivated annually in the upland areas of Taiwan. Varieties used are all hybrid lines bred by the Tainan DAIS. The most popular variety at present is Tainan Selected No. 9.

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. Yield is around 1,400 kg. per hectare.

Major diseases on peanut are wilt, leaf spots, and witches' broom.

Wilt. The disease was identified as *Corticium sasakii* (Shir.) Matu. in the past years. However, the results of recent studies and laboratory isolation together with plant inoculation indicated that there were a number of distinct fungi causing peanut wilt in the different stages of growing season. The organisms associated with preemergence disease were found to be the fungi belonging to *Pythium* and *Rhizoctonia*. In addition to the above-mentioned two fungi, *Aspergillus* and *Botrytis* were also found to be associated with the post-emergence damping-off. Nevertheless, *Pythium* causes pod rot in the later stage of peanut growth, whereas *Sclerotium rolfsii*, *Botryodiplodia* sp. and *Fusarium* sp. brings about peanut wilt throughout the growing stages. Since the various causal organisms reflect peanut wilt in different growth stages, further studies on the pathogenic entities of the disease are being carried out by NTU.

Witches' broom. This disease is mostly found in southern and eastern Taiwan. Infected plant produces small leaves with apparently stunted growth and very few pods are developed. The causal organism is believed to be mycoplasma.

According to 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 leaf hoppers were strongly suspected of being the vectors in the

studies made by the Tainan DAIS.

Early roguing of the diseased plants is the only method now used to control the disease.

Leaf spot. Leaf spot of peanut is incited by two species of fungi, i. e. *Mycosphaerell arachidicola* (Hori) Jenkins and *M. berkeleyii* Jenkins. The former appears in the early stage (about the flowering stage) of peanut growth, the spots being bigger in size with a yellowish halo, and 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 of Taiwan. Some fungicides such as Zineb, Maneb, etc. are effective in its control, but the cost of fungicidal spray and profit return are to be justified.

CORN DISEASES

About 22,000 hectares of corn is cultivated in Taiwan. In 1971, 9,000 hectares were planted to Tainan No. 5, a hybrid line bred by the Corn Research Center of the Tainan DAIS.

Corn is mainly grown in the south, and 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 2,000-2,5000 kg. per hectare and Tainan No. 5, may yield as much as 4,000-5,000 kg.

Downy mildew and leaf blight are the major corn diseases. Smut is rarely found in Taiwan.

Downy mildew. Downy mildew of corn is incited by *Sclerospora sacchari* Miy., the same pathogen that attacks sugar cane. Tainan No. 5 is especially susceptible to it. The disease is more severe in places where the crop is planted near susceptible varieties of sugar cane. During 1956-1957, the disease spread widely on both sugar cane and corn in Taiwan. In order to carry out the control work, a special set of regulations was promulgated by the Provincial Government, prohibiting the planting of corn together with the susceptible cane varieties. Infected plants are stunted and the ears are smaller and abnormal (Fig. 4). Use of resistant varieties is recommended as the best method of control. Two new hybrid lines, namely, Tainan No. 11 and Tainan No.12, are strongly resistant to the disease and their yields, especially Tainan No. 12, are even higher than Tainan No. 5. Roguing of diseased plants is also recommended as a practical control measure.

Leaf blight. The northern leaf blight is incited by *Helminthosporium turcicum* Pass. Disease spots are large, linear to irregular, somewhat elliptical in shape on the leaf blade and extending into the sheath. Pale green, powdery conidia are always developed at the center of old lesions (Fig. 5).

The southern leaf blight is incited by *Cochliobolus heterostrophus* Drechs. Its asexual stage is *Helminthosporium maydis*. Disease spots are smaller and more definite than those of northern leaf blight. Spots are elongated between the veins with limited and parallel margins, usually less than 0.5 m.m., buff to reddish brown in color. Since the outbreak of T race of the pathogen in 1970-71 in the United States, great loss of the crop has been reported. Identification of the race is being carried out by the Corn Research Center in Taiwan.

Both leaf blights are found in Taiwan. The former is more prevalent in the spring crop and the later in the fall crop when temperature is high.

Use of resistant varieties is considered effective in controlling the disease.

CASSAVA DISEASES

The cassava acreage of about 25,000 hectares is mainly distributed on the slope lands in central and southern Taiwan. The plant is seeded with mature stem-cuttings in March to April and harvested in January to March of next year, or seeded in August to September and harvested in February to March of the year after next. Average production is about 14,500 kg. per hectare.

Tubers harvested are used for making starch. In 1902, 1934 and 1938, a number of varieties were introduced from South Asian countries, but there has been some confusion of names of most varieties cultivated at present.

There are several diseases on cassava plants. Mosaic is occasionally found and bacterial wilt is relatively important.

Bacterial wilt. The disease is incited by *Xanthomonas manihotis* (Arthaud-Berthet) Starr. Infected plant has wilt of leaves and gummosis on the stem. The disease occurs the year round, and high temperature after a storm will render it more serious. Diseased plants finally die off.

Because the disease is mainly transmitted by infected seed-cuttings, to avoid using diseased cuttings is a matter of importance. Rotation with other crops in diseased field is also recommended as a means of control.

SUGAR CANE DISEASES

Sugar cane is an important industrial crop in Taiwan, whose cultivated acreage is around 90,000 hectares, with an annual yield of about 800,000 M.T. of sugar. More than 80% of the product is exported.

Canes planted from July to September are fully grown in eighteen months, but the spring and ratoon canes planted from December to March can be harvested in about twelve months.

Diseases of sugar cane have much to do with the varieties used. In the early days, the commercial varieties used in Taiwan were *Saccharum sinensis* which were susceptible to smut and mosaic. After they were replaced by *S. Barberi*, red rot and downy mildew became prevalent. And when P.O.J. seedlings (2725, 2878, etc.) were extended, *Fusarium* top rot (Pokkah boeng) and downy mildew occurred. The P.O.J. varieties were later replaced by locally bred varieties F108, F134, etc., resulting in the prevalence of mosaic and pineapple disease.

Some years ago, leaf scorch was epidemic on CO. varieties, causing considerable damage to the crop. It was not until the release of the variety N:CO310 that the spread of the disease was checked. However, N:CO310 was found to be susceptible to ratoon stunting, a virus disease considered the main cause of varietal degeneration. This variety was lately found also susceptible to smut disease in some plantations, which has caused great loss to the ratoon crop and is a limiting factor in the cultivation of the variety. Since 1958, White leaf, a newly found disease in Taiwan has attacked N:CO310 and other promising varieties. F. Varieties are popularly cultivated at present.

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

Downy mildew. Downy mildew is incited by *Sclerospora sacchari* Miy. The disease did great damage to P.O.J. 2878, F134, and P.T. 43-52 in

particular which was a very outstanding variety in Taiwan. The planting of this variety was prohibited because of the disease.

In general, transmission of this disease is through diseased 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 fields of central and southern Taiwan.

Testing of varietal reaction of cane to the disease is done by means of natural infection. There is a testing nursery now in Nantou. New varieties to be tested are planted alternately with the susceptible varieties and diseased corn plants to provide a necessary quantity of inocula.

The leaf splitting disease incited by *Sclerospora miscanthi* Miy. is occasionally found in the field. Symptoms of the disease resemble those of downy mildew, except that shredded leaves with abundant oospores are easily observed. The host range includes *Miscanthus* sp.. The disease is of minor importance economically.

Mosaic. Mosaic, a virus disease often found on sugar cane, was serious on F108, an important variety planted in the past 20 years in Taiwan.

In 1953, three virus strains were differentiated by Liu et al. of the Taiwan Sugar Experiment Station. According to the different symptoms on the differential cane leaves, degree of infectiousness and length of incubation period, the strains are classified into three types: (1) short stripe type (Ss), (2) yellow stripe type (Ys), and (3) fine stripe type (Fs). The virus is transmitted by mechanical means, and corn aphid (*A. maidis*) is also the insect vector in the field. The insect lives in the grass grown in cane fields and migrates onto sugar canes after weeding. A new practice requires all newly bred varieties to be tested by artificial inoculation with the virus, and only highly resistant ones are selected for extension.

Ratoon stunting disease. This is another virus disease commonly found on the variety N:CO310. Yield loss due to this disease is 17-21%. However, seriousness of the disease varies with the soil types and rainfall of the year.

The disease can be controlled by treating the seed-pieces with 50°C hot water for two hours, or 54°C hot air for eight hours as recommended by agricultural research in Australia. The hot water treatment has been adopted in Taiwan since 1953. Treated seed-pieces are planted in nurseries for multiplication. Incidence of disease on the commercial varieties is inspected by technicians every year. When it is found to have exceeded the limit range, the seed-pieces will be treated.

White leaf. White leaf disease was first found on N:CO310 in 1958. Infected plant produces white leaves or white stripes along the veins on the green leaves. The plant would finally die due to deficiency of chlorophyll for photosynthesis (Fig. 6).

The disease was identified first as leaf scald of bacterial pathogen, then as a virus disease, and finally as Mycoplasma in 1968. It is transmitted by leaf hopper (*Epitettix hiroglyphicus* Mats.) and diseased seed-pieces.

Some *graminaceous* weeds producing the same symptoms are also hosts of the pathogen.

The antibiotic Tetracycline is known to be effective in controlling mycoplasma, and testing with this chemical has been conducted by the TSES. However, breeding for resistant varieties is considered the most economical way of control.

Smut. Smut incited by *Ustilago scitaminea* Syd. was found in the cane fields recently.

The typical symptom of the disease is a long whip-like structure produced from the apex of the affected stalk. It is made up of parenchyma tissue surrounded by numerous powdery chlamydospores of the fungus.

The outbreak of smut has already become a menace to the cultivation of N:CO310 in Taiwan. It is particularly serious on ratoon crops. Planting of resistant varieties is considered the best method for controlling the disease.

Leaf scorch. Leaf scorch (*Stagonospora sacchari* Lo and Ling) caused

serious damage to CO. and Hawaiian seedlings. Initial lesions of the disease are small, red or reddish-brown spots. They then develop into a spindle shape with a definite yellow halo. When further developed, they coalesce and extend along the vascular bundles, becoming scorchy in appearance (Fig. 7). During 1950-54, such cane varieties as COX, CO. 290, CO. 281, H. 37-1933, and H. 44-3098 were badly damaged in the field. In the case of CO. 290, the sugar yield of the diseased canes was 13% less than that of the healthy ones.

Transmission of the disease is mainly by rain water. After the wide extension of resistant varieties, spread of the disease has been checked.

Red rot. Red rot (*physalospora tucumanensis* Speg.) was prevalent on F. 109 and P.O.J. 2725, the commercial varieties planted in eastern and coastal Taiwan formerly. The pathogen is more or less a weak parasite and usually enters the host tissue through wounds caused by stem borers. The conidial stage is found on the acervuli formed on the mid-rib of cane leaves. The pathogen of the sexual stage has also been found on dry leaves.

The disease is controlled through the selection of resistant varieties.

Pineapple disease. Pineapple disease (*Ceratocystis paradoxa* (de Seynes) Moreau) causes 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 case of cold weather or any other factors delaying the germination of the seed-pieces, the whole sugar cane field is likely to be completely destroyed. The disease is controlled by treating the seed-pieces with organic nurensic compound for a few seconds. Commercial varieties recently planted in Taiwan are all resistant to this disease.

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>Trichodorus christiei</i> , <i>Meloidogyne</i> sp., <i>Tylenchorhynchus</i> sp. etc.	線蟲根瘤
Pineapple disease	<i>Ceratocystis paradoxa</i> (de Seynes) Moreau.	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>Physalospora 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>Cersospora 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</i> <i>fasciculatus</i> Yam.	煤 病
Stalk variegation	Genetical	莖 彩 條 病
Stem galls	Undetermined	莖 癭
Tangle top	Mechanical	纏 梢 病
White leaf disease	Mycoplasma	白 葉 病
Yellow flesh	Undetermined	黃 肉 病
Yellow leaf spot	<i>Cercospora kopkei</i> Krueger	葉片赤斑病

BANANA DISEASES

Banana acreage in Taiwan is around 45,000 hectares. There are two main producing areas, i.e. the mountainous region in central Taiwan, and the plains of the south.

Varieties planted are mainly "Fairy banana" and "North banana" (*Musa cavendishii* Lamb.). The former is a mutant selected from the latter. Number of plants per hectare varies from 1,200 to 1,800 and the yield per plant is 10 to 20 kg. More than 20 diseases have been found among which bunchy top, Sigatoka, stalk rot and green-ripening in transit are the major ones. The Panama disease caused by *Fusarium oxysporum* has been found affecting southern plantations. A study is underway to find out whether a new race of the pathogen has occurred on those cultivated varieties which have long been regarded as resistant to this disease.

Bunchy top. Bunchy top is a virus disease. It is very serious in the mountain areas of central Taiwan. In severe cases, over 50-70% of the plants may be affected. Infected plants are stunted bearing no fruit (Fig 8). The aphids, *Pentolonia nigronervosa* Coq., have been proved to be the vector. In 1954 a transmission test was made by Sun of NCHU who found that the incubation period of the virus varied from 39 to 60 days, depending upon the temperature.

Destruction of the diseased plants with the spray of kerosene is recommended as a means for controlling the disease (100 c.c. to 300 c.c. depending upon the age of the plants). This practice not only kills the plants within a few days but also the disease vector (aphids) living on them.

Selection of resistant clones of banana and further study of the pathogen are underway.

Cercospora leaf spot. According to a study of NTU, both black leaf streak (*Mycosphaerella fijiensis*) and Sigatoka (*Mycosphaerella musicola*) are found on banana plantations, and the former seems more common than the latter. They form spots to reduce the green part of leaf area and results in low yield of fruit per bunch as well as irregular ripening of the fruit fingers.

The disease is controlled by aerial spray, and oil and Maneb have been used in recent years.

Stem rot and Black rot. Stem rot is incited by *Ceratocystis paradoxa* (de Seynes) Moreau and black rot by *Botryodiplodia theobromae* Pat. The fungi are wound parasites. They infect the stalk through the cut end, and then extended mycelia to cause rot of the whole hand of fruit. The two diseases often become serious after the packing of fruit, when both temperature and humidity are high. They have been controlled by smearing the cut ends with "SPF", the sodium benzoates.

Green-ripeness. Green-ripeness is a physiological disease occurring during transit. High temperature is the main cause. It has caused great loss in some cases. However, the disease can be prevented through the improvement of shipping conditions.

A List of Banana Diseases in Taiwan

Disease	Cause	Chinese Name
Anthraxnose	<i>Glomerella cingulata</i> (Ston.) Spaul. et Schr.	炭疽病
Bacterial leaf blight	<i>Xanthomonas</i> sp?	細菌葉斑病
Black spot	<i>Macrophoma musae</i> (Cke.) B. et V.	黑星病
Botryodiplodia fruit rot	<i>Botryodiplodia theobromae</i> Pat.	黑腐病
Bunchy top	Virus	萎縮病
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
Panama disease	<i>Fusarium oxysporum</i> f. <i>cubense</i> (E. F. Sm.) Sny. & Han.	巴 拿 馬 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 musicola</i> (Zimm.) Leach	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>Ceratocystis paradoxa</i> (de Seynes) Moreau.	軸 腐 病

CITRUS DISEASES

Some 30,000 hectares of citrus fruits are cultivated in Taiwan. Commercial varieties include mandarin orange, Ponkan (*Citrus poonenses*), Tungan (*C. tungan*), and sweet orange, Liu-cheng (*C. sinensis*). Root-stock varieties used are mainly sunki, which has a good root system and wide adaptability, and the quick growing Ramgpur lime.

There are generally, 500 to 600 groves to a hectare. The average yield is about 19,000 kg. per hectare. Major diseases on citrus trees are "Li-ku-bin", foot rot, black spot, canker and scab. Green and blue molds are sometimes serious on packed fruit during transit.

"Li-ku-bin" or "Huang-lung bin" (yellowing shoot) is a most serious citrus disease in Taiwan. On a Ponkan tree, the initial symptom is the appearance of one to several young shoots with yellow-veined leaves (Fig.9). Spreading of such leaves always occurs very rapidly. In many cases, a whole tree about 10 years old would become diseased within two to three years. The yellow-veined leaves of the diseased tree fall off finally, and the new leaves that sprout out are much smaller in size and deficient in zinc or other minor elements. Flowers are abundant but with abnormal timing. Following a large crop of small fruit, the whole tree die.

The disease has been studied by the phytopathological laboratory of NTU since 1956. In 1958, it was verified to be a virus disease called Tristeza in South America, and the disease scions and citrus aphids (*Toxoptera citricidus*, *A. Spiracola*, *A. gossypii*, etc.) were the vectors. It has been further proved that the virus of the disease found in the orchards of Taiwan are of several strains which can be roughly grouped into two types, "Severe" and "Mild".

In recent years, the thread-like particles of Tristeza virus have been observed under electron microscope by NCHU. This is direct proof that Tristeza does exist in Taiwan.

Tristeza virus is mainly transmitted from the upper part of a grove to the root system either through disease scions or insect vectors. If a rootstock

variety is resistant to or tolerant of 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.

Control of Tristeza is possible with the use of resistant root-stock varieties. In Taiwan, two resistant varieties, Sunki and Ramgpur lime, have been widely adopted and, therefore, Tristeza is not a serious problem. However, citrus trees continue to die. This makes the plant pathologists believe that other pathogens may exist in Taiwan.

In the fifth Conference of the International Organization of Citrus Virologists (IOCV) held in Japan in 1969, the Greening disease of South Africa was reported to be identical with the "Li-ku-bin" of Taiwan.

Greening and "Li-ku-bin" have now been found to associate with mycoplasma. It is transmitted by psylla (*Diaphorina citri*) which is very commonly found in the orchards of Taiwan.

Further study aimed at the formulation of a disease control method is being conducted by NTU and TARI.

Black Spot. Black spot is incited by *Guignardia citricarpa* (MCAIP) Kiely. Fruits develop spots on the rind after being attacked by the fungus (Fig.10). The fungus invades the young fruit 2-3 weeks after petal fall, and the spots then appear after the latent period even when the fruit has become mature and are 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 serious losses from the disease.

The recommended measures for controlling the disease are as follows:

1. Bordeaux mixture (3-3-1) added with Dithane Z 78 (225 gm. per 100 l) is used for spraying one week after petal fall; successive sprays are to be made at 2 to 3 week intervals until mid-August.

Spray with 80% Difolatan (1:600-800) or 70% Dalan (1:1,000) is also recommended.

2. Removal of the drying leaves and twigs and diseased fruits in the orchard. This sanitary measure will minimize the primary inocula of many citrus diseases.

Canker. Canker is a bacterial disease incited by *Xanthomonas citri* (Harse) Dowson. In Taiwan, the bacteria attack the sunki variety widely used for root-stock in the nurseries. Fruits of valencia, navel orange, lemon, etc. are also susceptible to the disease. The control method recommended in the past was to spray with Bordeaux mixture (6-6-1). However, as Bordeaux mixture is not compatible with many common insecticides such as lime-sulfur and summer oil, the method is considered not quite practical. Copper is effective in controlling the disease, but excessive application of this element will affect the growth of citrus trees under the conditions of Taiwan. Other fungicides are being tested.

Scab. Scab (*Elsinoe fawcetti* (Jenk.) Bitancourt et Jenkins) is occasionally found on ponkan and tunkan varieties. Lesions occur on leaves, twigs and fruit. It takes the form of warts with the affected areas raising above the normal surface of the host. In most cases, it lowers the quality of the fruit.

The fungicide, 50% Folpet W.P., is effective for the control of the disease. It is diluted in 400 parts of water added with neutral sticker. The first spray is made just before flowering, and the second spray is made after 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 *Phytophthora citrophthora* (Sm. & Sm.) Leonian, and in some cases 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 girdle round the whole bark.

A control measure has long been in practice in Taiwan. When an initial lesion is found, infected tissues are peeled off with a sharp knife.

Then the exposed tissues are smeared with one part of Tuzet plus 20 parts of calcium, or with the paste-form Bordeaux mixture (one pound of copper sulfate and two pounds of calcium oxide mixed with 56 gm. of sticker). After the fungicide dries up, a protective coating of asphalt is applied as protection against wash by rain.

In some cases, infected trees are inarched with seedlings of Ramgpur lime to give them a new root system.

A List of Citrus Diseases in Taiwan

Disease	Cause	Chinese Name
Algal disease	<i>Cephaleuros parasititus</i> Karst	藻斑病
Anthinis 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>Guignardia citricarpa</i> (McAlp) Kiely	黑星病
Blue mold	<i>Penicillium italicum</i> Wehmer	青霉病
Baron, copper, magnesium, 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>Phytophthora citrophthora</i> (Sm. & Sm.) Leonian; <i>Rhizoctonia</i> sp.	裾 腐 病
Greasy spot	Undetermined	油 脂 病
Green mold	<i>Penicillium digitatum</i> Sacc.	綠 霉 病
Gummosis	{ <i>Botrytis cinerea</i> Pers. <i>Diplodia cineria</i> Pers. <i>Dothiorella ribis</i> Gros. and Dug. <i>Sclerotinia sclerotiorum</i> (Lib) DBy. <i>Phomopsis</i> sp.	流 膠 病
	<i>Physcia</i> spp.	地 衣 表 生
	<i>Virus+mycoplasma</i> ?	黃 龍 病
	<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 病
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

PINEAPPLE DISEASES

Pineapple is cultivated on more than 16,000 hectares distributed on the hillsides of central, southern and eastern Taiwan.

There are two planting seasons for pineapple in Taiwan, one in August/September and the other in March/April. Smooth Cayenne is the main variety cultivated. The growth period of pineapple is four years with two harvests. Production is 60-70 tons per hectare for the first crop and 20-30 tons for the second.

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

Mealybug wilt. Mealybug wilt was highly destructive to pineapple plants, and was an important factor limiting the extension of the crop in Taiwan. The actual cause of the disease is believed to be virus, it is induced by mealybug feeding on the pineapple leaves. Complete elimination of mealybugs is an effective way to control the disease. The following procedure has been followed in Taiwan.

1. Spray the place for pineapple set-treatment with 23% Aldrin E.C. (1:50).

2. Immerse the sets cut for one to two weeks in a dilution of 47% Parathion (1:2,000) for three minutes to kill mealybugs prior to planting.

3. When the sets have been planted for about one month, pour 100 c.c. of the same concentration of Parathion through the crown of each plant to kill the mealybugs that have survived the set-treatment during the growth of the crop. The insecticide is poured 3 or 4 times at 3-month intervals.

4. Spray 23% Aldrin (1:50) on the soil surface of the pineapple plantation to control ants which are symbiotic with 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 can be easily pulled up (Fig. 11). The fungus is soil borne. In normal cases, loss from the disease is less than 3% of the total production. In case the disease occurs in fields where soil is wet and drainage is poor, the loss may reach 70-80%. Spraying with 50% Captan W.P. or Zineb (1:300-400) or 80% Difolatan W.P. (1:200-300) may control the disease. However, improvement of drainage is essential for checking the spread of the disease.

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

The disease is more serious on the fruit harvested in May to September. The optimum pH value for the bacteria ranges from 4 to 5.5. It infects the fruit during the flowering stage.

A study for the control of the disease is being conducted at The National Chung Hsing university.

Pink disease Pink disease is incited by *Pseudomonas amaranthi* E.F. Sm. As the bacteria infect the internal flesh of pineapple fruit, no marked external symptoms are shown. Diseased fruit sliced for canning becomes brown to pink in color after heating. The disease is reportedly prevalent on mature fruits in February and March.

No control measure has been recommended so far.

A List of Pineapple Diseases in Taiwan

Disease	Cause	Chinese Name
Black eye (eye rot)	Undetermined	黑 目 病
Black rot	<i>Ceratocystis paradoxa</i> (de Seyn.) Moreau.	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>Cyclodermus 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 棹 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 37,000 hectares of dry land distributed in the mountainous areas of northern and central Taiwan. The average unit yield of this perennial crop is about 800 kg. of crude tea per hectare. Assam and small leaf varieties such as "Chinhsin-Tapon", "Chinhsin-Oolong", "Yingchih-Hunghsin" and "Tayeh-Oolong" are commonly grown.

Nine diseases on tea have been recorded in Taiwan, of which blister blight, net blister blight and twig blight are the major ones.

Blister blight. Blister blight (*Exobasidium vexans* Masee) is found on the leaves and young twigs of tea. The disease occurs during the rainy season. Infected leaves show light yellowish round spots on the upper surface. The spots then form depressions and show white, round, raised lesions under the lower surface. The disease is sporadically found in the field; no chemical control method has been tried.

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 become red-brown on the upper surface of the leaf, with the lower surface of the corresponding lesions assuming a net form milky white in color. No positive control measure has been recommended to date.

Twig blight. The pathogen of the disease is yet to be identified. The disease is prevalent in June to September. Lesions are found on the leaves, which first become yellowish-green with a reddish midrib, and then the whole leaf turns yellowish brown. In the advanced stage, all leaves die but cling to the stem, and finally they fall and cause die back of the twigs. The disease is particularly serious on the old "Chinhsin-Oolong" variety.

A . . . Diseases in Taiwan

Disease		Chines Name
Anthracnose	<i>Gloeosporium theae</i> .	炭 疽 病
Birds-eye spot	<i>Cercospora theae</i> Bread De Ha.	圓 赤 星 病
Blister blight	<i>Exobasidium vexans</i> Masee	病
Brown blight	<i>Guignardia cammelliae</i> (Cooke) Butler	葉 枯
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	Undetermined	枝 枯 病
Velvet blight	<i>Septobasidium acaciae</i> Saw.	膏 藥 病

TOBACCO DISEASES

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

The acreage of tobacco has been about 10,000 hectares in recent years. Seeds are sown in August to September and transplanting is done 35 to 45 days later. The crop is harvested in December through February with an average yield of 1,700 to 1,800 kg. per hectare.

Varieties now used are Vam-hicks (hybrid of Vamorr crossed with Hicks), Hicks, and T.T. No. 4.

Over 30 diseases on tobacco have been recorded in Taiwan. Among them, virus diseases, Granville wilt, pythium, damping-off, frog eye, powdery mildew, black shank, root-knot nematode and leaf fleck of undetermined cause are the major ones.

Virus diseases. Tobacco virus diseases in Taiwan were classified by Matsumoto in 1946 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

Common mosaic virus (TMV) is widely distributed in Taiwan. It affects both the yield and quality of tobacco seriously. The disease is transmitted mechanically during the transplanting of young plants to the field from the seedbed, and, in the case of 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 (CMV) is transmitted by aphids and mechanical means. It tends to increase in the field. Vein-banding mosaic, which has invaded some fields, is being studied by TRI.

Leaf curl caused distortion of the plant (Fig. 12) is prevalent particularly in the fields of TRI. In 1968, the disease was found to be transmitted by the white fly, *Bemisia tabaci* Genn. which has a very wide host range in Taiwan.

Common mosaic can be controlled by planting 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 disinfection of hands with soap water during topping are recommended as 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.

The disease is found in the seedbed. Often, it is very destructive to the grown plants. Infected plants would finally wilt. The stem of a wilted plant first shows brownish or dark brown discoloration in the xylem portion before extending to the cortex, and then the surface of the stem corresponding to these lesions becomes blackened. The bacteria ooze from the affected stems.

The bacteria persist in the soil in association with the crop residue. Use of resistant varieties is effective in controlling the disease. Roguing in the early stage and improvement of the cultural environment including crop rotation, balanced fertility, etc., may check the spread of the disease to some extent.

Pythium damping-off. The disease is incited by *Pythium aphanidermatum* (Eds.) Fitz.. The fungus is soil-borne, it first infects the seedlings at the ground level and eventually causes them to rot. The disease is generally found in patches in the seedbed with wet soil or poor drainage. In a severe case, the seedlings may be completely destroyed by the disease. The disease can be controlled by treating the soil with Granosan (1:2,500). The chemical is sprayed after the seeds are sown and mulched with rice straws, at the rate of three liters of the dilution for each square foot of the seedbed. Application is repeated at 4-6 day intervals after the seeds are germinated. The chemical can also be applied after the disease has been found. In such a case, the interval between sprays will be 5 days. Since the problem of chemical residue became a public concern, a screening test of non-mercuric compounds has been carried out by TRI.

Frog eye. Frog eye is incited by *Cercospora nicotianae* Ell. et Ev. The fungus infects the leaves to produce circular spots with somewhat raised borders. The spots become grayish white at the center in the advanced stage. The disease may occur in any stage of the leaves, though mature leaves are more susceptible. Leaf spots are also observed when the leaves look apparently healthy and are kept in the curing barn. According to Matsumoto, this is due to the presence of diseased leaf tissues which show symptoms in the 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 to some extent. The fungicide is diluted in 400 to 600 parts of water for spraying. First and second sprays are made immediately before and after the topping of plants for prevention purposes. When the disease is found, sprays are made at 7-10 day intervals until two weeks before harvesting.

Powdery mildew. Powdery mildew is incited by *Erysiphe tabaci* Saw. It is prevalent in the foothill areas from mid-December to January. Infected leaves are covered with a layer of powdery material which is the conidiphores and the hyaline conidia of the pathogen. The fungus is an obligate parasite; the mycelia invade the tissue of the leaf and cause necrosis. Diseased leaves become black after curing. Loss from the 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 parts 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 an important disease on tobacco crop. The fungus invades the basal part of the tobacco plant and causes rot of the tissue, and then the plant dies off. When the infected stem is longitudinally split, the ladder-like symptom that will show one of the characteristics of the disease. The disease occurred in Taiwan in 1959 and 1960. According to the record of TRI, the area infected was 42.7 hectares in Chiayi and 11.5 hectares in Pingtung. Percentage of the diseased plants ranges from 26.33% to 52.2%.

Roguing of disease plants in the early stage and improvement of drainage are the control measures recommended.

Root-knot nematode Root-knot nematode (*Meloidogyne incognita* (Kofoid & white) Chitwood) causes tobacco roots to produce knot-like swellings which affect the development of the plant root system.

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

Nematode can be satisfactorily controlled by applying nematocides, DBCP, such as Nemagon and Fumazone.

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 (TMV)	普 通 鑲 嵌 病
Composite disease	Virus	混 合 毒 素 病
Cucumber mosaic	Virus (CMV)	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 tabaci</i> Pass.	斑 點 病
Mild mosaic	Virus	輕 症 鑲 嵌 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 nematode	<i>Meloidogyne incognita</i> (Kofoid & White) 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
Veinbanding mosaic	Virus	脈 綠 嵌 紋 病
Yellow mosaic	Virus	黃 型 鑲 嵌 病

FLAX DISEASES

Around 10,000 hectares of flax is cultivated annually, with most of the crop grown in the rice fields of central Taiwan. Seeds are sown in early November and the crop is harvested in March when one-third of the stems turn yellow and over 50% of the seeds are mature. The yield is 3,100 kg per hectare on an average.

The major variety is Taichung Selection No. 1. Powdery mildew and Fusarium wilt are the two major diseases found in Taiwan. The former is distributed widely, while the latter is found occasionally in some fields.

Powdery mildew. The disease is caused by *Erysiphe polygoni* Dc., and occurs during February to March. Infected plant turns white with gray powder on the leaves and stems. Severe defoliation finally results. Application of "Karathane" (1:1,000-1,500) when the disease first appears will check its spread. One to two additional sprays are necessary to put the disease under full control.

Fusarium wilt. Fusarium wilt is caused by *Fusarium oxysporum* f. *lini* (Bolley) Snyder and Hansen. The leaves of infected plant turn yellow or grayish yellow and then fall prematurely. When the main stem dies, new lateral branches will develop from the first node. Complete failure of the crop would result in severe cases.

The disease has been found in some flax fields in central Taiwan. The causal fungus is soil borne, attacking the roots of the plant, and it may persist for many years in the soil. Crop rotation and use of resistant varieties are the control methods recommended.

JUTE DISEASES

Jute is cultivated in southern Taiwan on some 4,200 hectares. The crop is planted in April and harvested in July to August. Commercial varieties are Tainung Selection No. 1 and Tainung No. 3. Yield ranges from 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 is practised.

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

Stem rot. The disease occurs at any time during the growth of jute. However, serious damage is caused to the crop in the late growing period. Sandy soil or soil carrying nematodes constitutes a favorable environment for the disease.

The causal fungus is *Macrophomina phaseoli* (Maub.) Ashby. Infection commonly occurs on the lower part of stem about 10 cm. above the soil level. Lesions are brown or blackish brown in color with black specks. When the lesions are extended to the girdle round the stem, the whole plant dies off. The host range of the fungus is wide, as it covers more than 100 species of plants including sesame, kenaf, sweet potato and soybean.

Since the pathogen is soil-borne, formulation of an effective control is rather difficult. Studies on resistant varieties, biological control and crop rotation are being carried out by the Tainan FCES.

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

Use of resistant varieties is recommended as the main control measure. Tainung Selection No. 1 has been found resistant to the disease. Seeds

treated with Spergon may eliminate the disease in the seedling stage. Dosage 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 and *M. incognita* (Kofoid & white) chitwood. When the crop is cultivated on upland soil, the growth of the affected plants will be retarded. In severe cases, the quality of fiber will be deteriorated and the amount of seeds harvested greatly reduced. However, as jute is commonly cultivated in paddy fields following the harvest of rice, the nematode problem is not quite serious due to the fact that the worms are mostly controlled by flooding.

The nematode problem was once serious on kenaf (Ambari hemp.), which was planted on a small scale in Taiwan formerly. Selection of soils free from root-knot nematodes for this crop is recommended by the Tainan FCES.

In August to October, fields ready for kenaf are first planted with tomato or beans as indicating plants. These plants are to be uprooted after 1-1½ months to measure the severity of nematode infestation.

Thai Kenaf, which is highly resistant to the root-knot nematode, has been introduced into Taiwan, but it has not been extended owing to its inferior quality and longer growing time.

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

A List of Jute Diseases in Taiwan

Disease	Cause	Chinese Name
Anthracnose	<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>Thanatephorus cucumeris</i> (Frank) Donk.	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 <i>M. incognita</i> (Kofoid & white) Chitwood	根瘤線蟲病
Powdery mildew	<i>Microsphaera polygoni</i> (DC.) Saw.	白粉病
Stem rot	<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>Thanatephorus cucumeris</i> (Frank) Donk.	腰折病
Gray mold	<i>Botrytis cinerea</i> Pers.	灰霉病
Nematode root knot	<i>Meloidogyne javanica</i> (Treub.) Chitwood <i>M. incognita</i> (Kofoid & white) 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

The acreage of cotton is around 2,000 hectares mainly distributed in the Yunlin, Chiayi and Tainan areas. It is planted in May to June and harvested in November to December. Commercial varieties are Rex, Austine and stoneville. Production has been fluctuating greatly on account of typhoon attacks. The 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 fuzz on the seed, most likely 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 plant growth, and lesions on mature leaves are angular in shape. The disease also infects the boll if weather conditions are favorable. Soaking cotton seeds in sulphuric acid or a dilution of Granosan (1:1,000) for one to three hours prior to planting may prevent the spread of the disease in the seedling stage. However, lesions on mature leaves are very common. 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 cotton boll through wounds either due to bollworm or wind. Lesions of the infected boll are dull-brown in color with an abundance of tiny dots (the pycnidia). In the advanced stage, a part of or even the whole boll is affected. The disease is commonly found in the fields where winds are strong or where bollworms have not been put under control.

Difolatan or Polyram Combi has been recommended by the Tainan FCES for control of the disease. In bollworm control, the fungicide may be mixed with the pesticide 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 微 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

SISAL DISEASES

About 9,000 hectares of sisal (*Agave rigida* var. *sisalana* Englem) is extensively grown in the southern part of Taiwan. The plant is a perennial with an economic life of 7-9 years. Sisal can be planted all the year round and its leaves can be harvested three years after planting. The average yield is about 1,000 kg per hectare.

Ahthracnose. Anthracnose is incited by *Colletotrichum agaves* Cav. or *Botryodiplodia* sp., either a single pathogen or a combination of both. Generally, the disease occurs during March to September. An outbreak may occur if there is a heavy shower after the dry season in April to May or after a continuous rain or a storm in July to August. Leaves that are injured or sun burnt are liable to be infected.

Removing and burning of the severely diseased leaves and earlier harvesting of the leaves before May will reduce loss from the disease. Application of 6-6 Bordeaux mixture or 0.1% Polyram Combi after a storm may also check the spread of the disease.

VEGETABLE DISEASES

Vegetables are cultivated in small plots on most of the farms of Taiwan. The total acreage is estimated at 130,000 hectares excluding that of potatoes and asparagus. In recent years, several important fungus 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 fungicides to some extent. However, virus disease remains an important problem today.

Virus disease. Mosaic is the most common virus disease of vegetables. It is prevalent on cucurbits, tomatoes, pepper, radish (Fig. 13) etc. Leaves of the affected plant are distorted and reduced in size resulting in markedly stunted growth.

Several virus components are believed to exist and they are readily transmitted by aphids. No control method has been practiced, except roguing of diseased plants at the early growing stage to reduce the inoculum.

Late blight of tomato. Late blight of tomato (*Phytophthora infestans* (Mont.) de Bary) is widely distributed in Taiwan especially in such areas as Tainan, Taichung and Taipei. The disease is rampant from December to April. When the weather is cold and wet, loss from the disease may reach well over 50% of the total yield. A crop may be completely wiped out in a severe case.

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

Powdery mildew of cucurbit. Powdery mildew of cucurbit (*Erysiphe cichoracerarum* DC.) is commonly found in the fields. The fungus mainly attacks the leaves, with powdery symptoms on the surface.

The disease can be controlled by spraying with Karathane (1:1,000).

Sprays are to be made at 10-day intervals until seven days before harvesting. Other chemicals such as Afugan and Benlate are also effective.

Purple blotch of onion. Purple blotch of onion (*Macrosporium porri* Ell.) is an important disease which occurs during the growth of the plant. The fungus attacks the leaves causing symptom blotches. In severe cases, the plant may die. The disease is controlled with Zineb (1:400-500). Sprays are made at 7-10 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 onion plants in Taiwan.

Rust can be satisfactorily controlled with Zineb (1:400). First spray is made when the disease is found. Subsequent sprays are made at 10-14 day intervals depending upon the severity of the disease. When the spray could be timed simultaneously with that for thrips control, 10 c.c. of 50% Malathion may be added to 80 kg. of the above diluted fungicide for a combination spray.

Downy mildew of crucifer. Downy mildew of crucifer is incited by *Peronospora brassicae* Gaum. The fungus attacks the leaves of the host. Lesions are irregular-shaped spots yellowish to light brown in color covering a layer of mold-like substance (Sporangiophores and sporangia).

The disease may be controlled with Maneb or 75% Daconil or 38% Delan W.P. in 1:500 dilution. Sprays are made at 7-day intervals until seven days before harvesting. In general, the disease can be satisfactorily controlled by 3-4 sprays.

Anthracnose of cucurbit. The disease is incited by *Colletotrechum lagenarium* (Pass.) Ell. et. Halst. It causes brown circular spots on the leaves which become blighted entirely after the spots are enlarged. Lesions which appear on fruits may have black depressed spots, which result in malformation. When maturing fruits are infected, the lesions are circular in shape, somewhat water-soaked and sunken.

The disease can be controlled with Zineb (1:500) to be sprayed at intervals of 5-7 days.

Root-knot nematode. Root-knot nematode (*Meloidogyne* sp.) attacks many vegetables including carrot, tomatoes, cucurbit, etc. in Taiwan. It causes the roots or tubers to produce galls of different sizes. The affected plants have leaves paler in color than normal, and they will dwarf and wilt in hot weather. Yields are thus markedly reduced. Sandy soil is a favorable condition for the spread of the disease. It can be effectively controlled by injection of DBCP (Fumazone or Nemagon) into the cultivated soil.

A List of Vegetable Diseases in Taiwan

Disease	Cause	Chinese Name
1. Radish		
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	炭紋病
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 albo-maculans</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
Root knot nematode	<i>Meloidogyne incognita</i> (Kofoid & white) Chitwood	根瘤線蟲
Sclerotium rot	<i>Corticium rolfsii</i> (Sacc.) Curzi.	白絹病
Sclerotinia disease	<i>Sclerotinia sclerotiorum</i> (Leb.) DBY	菌核病
Soft rot	<i>Erwinia carotovora</i> (Jones) Holland	軟腐病
3. Onion		
Black mould	<i>Mycosphaerella schonoprasii</i> (Rabb.) Schrot	黑黴病
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	銹 病
Sclerotinia disease	<i>Sclerotinia allii</i> Saw.	小 菌 核 病

4. Chinese cabbage

Boron deficiency	<i>Physiological</i>	缺 硼 病
Club root	<i>Plasmodiophora brassicae</i> Wor.	根 瘤 病
Downy mildew	<i>Peronospora 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
Downy mildew	<i>Peronospora parasitica</i> (Pers.) ex Fr.	露 菌 病
Sclerotinia disease	<i>Sclerotinia Sclerotiorum</i> (Lib.) DBy	菌 核 病

6. Lettuce

Anthracnose	<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 sclerotiorum</i> (Lib.) DBy	菌 核 病

7. Spinach

Anthracnose	<i>Colletotrichum spinaceae</i> Ell. et Halst.	炭 疽 病
Downy mildew	<i>Peronospora spinaceae</i> Lauabert	露 菌 病
Sclerotinia disease	<i>Sclerotinia sclerotiorum</i> (Lib.) DBy	菌 核 病
White rust	<i>Albugo occidentalis</i> G.W. Wilson	白 銹 病

8. Cucurbit

Anthracnose	<i>Colletotrichum lagenarium</i> (Pass.) Ell. et Halst.	炭 疽 病
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 spp.</i>	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
Root knot nematode	<i>Meloidogyne incognita</i> (Kofoid & white) Chitwood	根 瘤 線 蟲
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 微 病
Mosaic	Virus	葉 紋 病
Powdery mildew	<i>Erysiphe cichoracearum</i> DC.	白 粉 病
Root knot nematode	<i>Meloidogyne incognita</i> (Kofoid & white) Chitwood	根 瘤 線 蟲
Sclerotinia disease	<i>Sclerotinia sclerotiorum</i> (Leb.) de Bary.	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
-------------------	-----------------------------------------------	-------

Anthracnose	<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

POTATO DISEASES

Formerly potato was cultivated on a small scale in central Taiwan only. In the last few years, its acreage has been increased to about 2,000 hectares. It is grown as a cash crop in winter. As the seed tubers are mostly imported from Japan, with Norin No. 1 as the main variety, some diseases have been brought along with the tubers. The major diseases on this crop now found in Taiwan are ring rot, late blight, and some virus diseases.

Ring rot. This is a bacterial disease incited by *Corynebacterium sepedonicum* (Spieck. and Kotth.) Skapt. and Burkh.. The first sign of the disease on the tuber is the creamy exudation from the vascular ring when a cross section is cut. The organism is transmitted mainly by knife used for cutting the seed tubers prior to planting. Disinfection of the knife with chemicals is a rather tedious task. However, the disease may be controlled through the use of resistant varieties. No control measure is practised by the growers at present.

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

1. Latent mosaic: The disease is common in Taiwan. Most of the infected varieties do not show any symptoms, though they carry the virus. Virus particles are rod shaped and generally called PVX (Potato Virus X). No insect vectors are found in the field. The disease is readily transmitted by mechanical means.

2. Mild mosaic: The disease is less common in Taiwan. Symptoms on some susceptible varieties are leaf mottling and stunted growth; tubers are under sized. The virus is called PVA, and its particles are rod shaped. The disease is transmitted mechanically and by aphids.

3. Vein-banding mosaic: Symptoms on potatoes vary greatly among different varieties. Typical symptoms are light green interveinal areas with veins banded by dark green lines. Field identification is done by observing

the lower leaf surface against sunlight when the plant is grown about two months old. The virus is called PVY with rod-shaped particles. It is transmitted mechanically and by several species of aphids.

4. Rugose mosaic: This disease is also commonly found in the field. Infected plants show rugosity and leaf curl. Necrosis usually follows and finally the entire leaf will die, often clinging to the stem.

The causal viruses are PVX+PVY.

Leaf roll. Leaf roll is prevalent in potato fields. Leaves of infected plants roll upwards. Tubers are significantly smaller than those of healthy plants. When the diseased tubers are used as seed, great loss would result.

The causal virus particles are spherical. The disease is transmitted by aphids.

In recent years, a new causal virus named PVM has been found by the Bureau of Commodity Inspection and Quarantine. Disease symptoms are about the same as those of leaf roll, except that the leaves have crinkles.

Other virus diseases such as purple top are not so widespread, and are considered to be of minor importance.

Control measures recommended are roguing of the diseased plants and use of Malathion, etc. to control the aphids. A project to produce virus-free seed tubers by tip tissue culture has been carried out by the Academia Sinica.

Late blight. Late blight (*Phytophthora infestans* (Mont.) DBY.) is commonly found in the potato fields when the weather is foggy and cloudy. The disease can be controlled by the application of Captan (1:400) or Zineb (1:500).

ASPARAGUS DISEASES

The cultivated area of asparagus at present is between 9,000 and 10,000 hectares. The crop is a perennial with an economic life of 10 years. Seeds are sown twice a year, March to April and late August to mid-October. Transplanting is done 5 to 6 months after seeding when the seedlings are about 70 cm tall.

The major varieties are Mary Washington, UC 309, and UC 711. The latter two are especially good for producing green asparagus. The average yield is about 12,000 kg per hectare. Stem blight and *Cercospora* blight are the two important diseases which occur during the growth of asparagus. Rust, a serious disease in other countries, is not prevalent in Taiwan.

Stem blight. Stem blight is incited by *Phoma asparagi* Sacc.. The disease is mainly found on stems, particularly on older ones. Lesions are elliptical, dark brown in color, depressed in the center with many black dots found in the advanced stage (Fig. 14).

The disease is widely distributed in Taiwan. All recently cultivated varieties are susceptible. So far Difolatan is the only chemical that can control the disease to some extent.

Cercospore blight. The disease is incited by *Cercospora asparagi* Sacc.. Conidia of the fungus are wind borne. The fungus infects the stems, branches and bracts of the plant to produce small ash gray spots. Diseased branches become yellow and die in severe cases.

No control method has been recommended.

MUSHROOM DISEASES

In the past decade, mushroom has been cultivated as an important sideline product of the farms in Taiwan. The space devoted to mushroom cultivation each year is around 8,000,000 square meters.

Temperature is the main factor affecting the growth of mushroom. However, it has been found that the crop is adaptable to the natural conditions on this island. Generally, spawning is done in October and harvest in November to March of next year.

Rice straws are used to make compost for mushroom culture. The polyethylene mushroom houses widely adopted by farmers may eliminate a number of harmful diseases and insects by the heat generated from compost fermentation. The variety cultivated currently is *Agaricus compestris* L. et Fr. which is divided into white, cream and brown species. White mushroom is mainly used for canning. The average yield is 4.7 kg. per sq. m.

Diseases found in the cultivation houses vary with environmental factors that are conducive to their development. Wet bubble and truffle are two important diseases of mushroom, while dry bubble, bacterial blatch, virus and nematode occur sporadically.

Wet Bubble. The causal organism of wet bubble is *Mycogone pernicioso*. It grows white, felt-like mycelium that covers the caps and gills of mushroom with dark amber liquid exuded from the surface. Affected mushrooms are distorted and malformed with a putrid odor (Fig. 15).

Studies on the control of the disease is now underway.

Truffle or Calves' brains. The causal organism of the disease is *Diehliomyces microsporus*. It is characterized by the development of cottony, cream mycelia in the manure at casing time. The parasitic fungus forms wrinkled bodies quite resembling those of the abnormal mushroom. As the fungus matures, it turns reddish-brown and then decay at the stage when the fungus begins to release ascospores. A chlorine-like odor may be

detected in serious cases.

No satisfactory control method has been found. However, to avoid the spread of the disease, lime is recommended to be applied in grooves dug around the affected portion of the mushroom bed as a means of isolation. Hands of worker should be washed with soap water.

DISEASES OF MISCELLANEOUS CROPS

A number of crops in Taiwan are either newly introduced or cultivated in relatively small areas. Information about their diseases are far from sufficient. The major diseases of miscellaneous crops found so far and their control methods are listed as follows:

Crop	Major Disease	Control Method
Sesame	Witches' broom	Under testing
Pepper Mint	Powdery mildew	Spray with Karathane
Coffee	Rust	Spray with Zineb
Ginger	Pythium root rot	Under testing
Pear	{ Scab	Spray with Difolatan
	{ Rust	Spray with Folpet
Papaya	Anthracnose	Under testing
Mango	Anthracnose	Under testing
Peach	Leaf curl	Spray with Difolatan
Grape	{ Anthracnose	Under testing
	{ Southern blight	
	{ Leaf spot	
	{ Powdery mildew	
Sunflower	Powdery mildew (Fig.16)	Under testing

LITERATURE CITED

- (1) Atkins P. & F.C. Atkins.
Major diseases of the cultivated white mushroom
Agaricus bisporus var. *albidus*
Mushroom Growers' Association
Agriculture House, Knightbridge, London, S.W.I.,
W.S. Maney & Son Ltd, Hudson Rd. Leeds, LS 9 DL. England,
1971.
- (2) Carter, W. and K. Ho.
Study of the Value of Pineapple Plants as Sources of the Mealybug
Wilt Factor.
Phytopathology Nov. 1956.
- (3) Chen, Z. C.
Effect of Dipping Treatment with Some Fungicides upon the Mycelial
Growth of Damping-off Fungi (Chinese with English Summary).
Laboratory of Forest Pathology. The Experimental Forest of National
Taiwan University. Contribution No. 2, January, 1959.
- (4) Chien, T. H. and S.H. Ou.
On Insect & Disease Control for Crops in Taiwan (Chinese),
Taiwan Agriculture and Forestry Monthly Vol. IV No. 12, 1940.
- (5) Chu, H.T. and K.C. Ling.
Survey on Pineapple Disease in Taiwan (Chinese).
Report of 1957-58 Sugarcane Experiments. Taiwan Sugar Experiment
Station. 1958.
- (6) Chiu, R.J., J. H. Jean, M.H. Chen and T.C. Lo.
Transmission of Transitory Yellowing Virus of Rice by Two Leafhoppers.
Phytopathology. Vol. 58, No. 6, June, 1968.
- (7) Chiu, R.J., H. Jean and M. H. Chen.
Transmission of Yellow Dwarf of Rice by two Leafhoppers in Taiwan.
Plant Prot. Bull. Vol. 8, No. 4, Dec. 1966.
- (8) Chen, C. C.
Some Experiments on the Control of Black-rot of Sweet-potato.
Taiwan Agriculture and Forestry Monthly Vol. 4, No. 12, Dec. 1950.
- (9) Cheng, Y.W. and K.L. Chan.
The Breeding of Rust Resistance Soybean "TAINUNG 3".

- Journal of Taiwan Agricultural Research Vol. 17, No. 2, June, 1968.
- (10) Chen, M. J. and E. Shikata.
Electron Microscopy of Virus-like Particles Associated with Transitory Yellowing Virus-infected Rice Plants in Taiwan.
Plant Prot. Bull. Vol. 10, No. 2, June, 1968.
- (11) Chen, C.C. and T.G. Chou.
Statistical Evaluation of the Effectiveness of Granosan Solution Repeatedly Used for Rice-Grain Disinfection.
Plant Prot. Bull. Vol. 10, No. 3, Sep. 1968.
- (12) Chien, C. C., T.F. Hwang and C. C. Chen.
Studies on the Sclerotial Diseases of Rice Plant in Taiwan.
2. Relations of Sclerotial diseases to rice growth stages and their development to rice Productivity.
Plant Prot. Bull. Vol. 5, No. 3, Sept. 1963.
- (13) Chang, Y. C.
Whitefly-vectors and Plant Viruses.
Agri. Sci. Vol. 16, No. 5-6, May, 1968.
- (14) Chen, C.C.
Compatative Transmission of Rice Yellow Dwarf by Three *Nephotettix* Leafhoppers in Taiwan.
Plant Prot. Bull. Vol. 12, No. 4, Dec. 1970.
- (15) Chen, C.C.
Ecological Studies of Green Rice Leafhoppers in Taiwan (IV).
Ecological Studies of *Nephotettix Impicticeps*.
Plant Prot. Bull. Vol. 12, No. 2, June, 1970.
- (16) Chang, S.C.
Genetic studies of resistance to downy mildew in corn by means of chromosomal translocation.
Report of the Corn Research Center Tainan Dais. No. 7, Sept. 1969.
- (17) Chang, S.C. and T.H. Wu.
Effects of temperature and humidity on the formation and germination of spores of *Sclerospora sacchari*.
Report of the Corn Research Center Tainan Dais. No. 7, Sept. 1969.
- (18) Chang, S. C. and T. H. Wu.
Protection of corn from downy mildew infection by fungicide.
Report of the corn Research Center Tainan Dais. No. 7, Sept. 1969.
- (19) Chang, S.C. and C.K. Cheng.
Studies on the seed transmission of corn downy mildew (2).

- Report of the Corn Research Center Tainan Dais. No. 7, Sept. 1969.
- (20) Chang, S.C. and T.H. Wu.
Studies on the sporulation of downy mildew of corn.
Report of the Corn Research Center Tainan Dais. No. 8, Sept. 1970.
- (21) Chang, S.C. and Y.Z. Wu.
The influence of fertilization and irrigation on the incidence of downy mildew of corn.
Report of the Corn Research Center Tainan Dais. No. 8, Sept. 1970.
- (22) Chang, S.C. and W. Y. Lai.
Note on a corn disease newly found in Tatwan.
Report of the Corn Research Center Tainan Dais. No. 8, sept. 1970.
- (23) Chang, S. C. and T. H. Wu.
Reaction of corn varieties introduced from indonesia to downy mildew of corn in Taiwan.
Report of the Corn Research Center Tainan Dais. No. 8, Sept. 1970.
- (24) Chen, C.C. and T.G. Chou.
Statistical Evaluation of the Effectiveness of Granosan Solution Repeatedly Used for Rice-Grain Disinfection.
Plant Prot. Bull. Vol. 10, No. 3, Sept. 1968.
- (25) Calavan, E. C., R.M. Burns, C. J. Barrett, D.W. Christiansen and R. L. Blue.
Tristeza in Lemon on Citrus Macrophylla Rootstock.
California Citrograph. Vol. 53, No. 4: 108, 119, 122, Feb. 1968.
- (26) Carpenter, J. B. and E.C. Calavan.
Effects of Stubborn Virus on Young Valencia Orange Trees
Proc. first International Citrus Symposium, Vol. 3, 1969.
- (27) Calavan, E. C. and J.B. Carpenter.
Stubborn Disease of Citrus Trees Retards Growth, Impairs Quality and Decreases Yields
California Citrograph. Jan., 1965.
- (28) Dickson, J. G.
Diseases of Field Crops 1956.
- (29) Hashioka, Y.
Studies on the Mechanism of Prevalence of the Rice Blast Diseases in Tropics.
Technical Bulletin No. 8, Taiwan Agricultural Research Institute, 1950.
- (30) Han, Y. S.
Survey on Soybean Diseases in Taiwan (Chinese).

- Agricultural Pest News. China Society of Phytopathology and Entomology. Dec. 1958.
- (31) Hu, C.C.
Four Common Tea Diseases in Taiwan (Chinese).
"Harvest" Farm Magazine, Vol. XI No. 1961.
- (32) Hsieh, S. C. and C.C. Chien.
Recent Status of Rice Breeding for Blast Resistance in Taiwan, With Special Regard to Races of the Blast Fungus.
The Proc. of the Symposium; "Rice Diseases and Their Control by Growing Resistant Varieties and Other Measures". Tokyo, 1967.
- (33) Hsieh, S. C., C.C. Chien and S.C. Hwang.
Genic Analysis in Rice. II. Inheritance of Resistance of Rice Seedlings to Blast Disease, *Piricularia Oryzae*.
Journal of the Agricultural Research. Vol. 10, No. 2, June, 1961.
- (34) Hung, C. H., C.C. Chien and S. Y. Lin.
Study on the Physiological Races of *Piricularia oryzae* Cav.
Journal of the Agricultural Research. Vol. 10, No. 1, March, 1961.
- (35) Hsu, J. C.
Study on Pythium Root Rot of Sugarcane.
Report of The Taiwan Sugar Experiment Station No. 32. May, 1963.
- (36) Hsu C.M. et al.
Study on soybean rust (in Chinese).
Agricultural Sci. Vol. 16, No. 5-6, May, 1968.
- (37) Huang, Y. T.
Studies on Virus Diseases of Sweet-potato in Taiwan.
Report No. 24, Dec., 1970.
- (38) Jan, C. R. and L.C. Wu.
Chemical Control of Soybean Rust.
Memoirs of the College of Agriculture National Taiwan University.
Taipei, Taiwan, China. Vol. 12, No. 1. 1971.
- (39) Kuo, T. T., T.C. Huang and T.Y. Chow.
A Filamentous Bacteriophage from *Xanthomonas oryzae*.
Virology, Vol. 39, No. 3, Nov. 1969.
- (40) Kuo, T. T., T.C. Huang, R.Y. Wu and C. M. Yang.
Characterization of Three Bacteriophages of *Xanthomonas oryzae*.
(U. et .I.) Dowson.
Botanical Bull. of Academia Sinica. Vol. VIII, Special Number, 1967.
- (41) Kuo, T., T. Huang and M. Teng.

- 5-Methylcytosine Replacing Cytosine in the Deoxyribonucleic Acid of a Bacteriophage for *Xanthomonas oryzae*.
J. Mol. Biol. 34, 1968.
- (42) Kuo, T. T., C. M. Yang, Y. Y. Yang and S. P. Y. Hsieh.
The Distribution of Strains of *Xanthomonas oryzae* and its Phages in Taiwan.
Plant Prot. Bull. Vol. 10, No. 3, Sept. 1968.
- (43) Kuo, T. T., T.C. Huang and S.E. Yang.
Factors Influencing the Assay of The Bacteriophage of *Xanthomonas oryzae* by Plaque Count.
Botanical Bull. of Academia Sinica. Vol. VIII. No. 1, 1967.
- (44) Kuo, T.T. and S.E. Yang.
Physiology of "Bakanae" Disease I, Effect of Gibberellic Acid on the Metabolic Changes in Germinating Rice Seeds.
Botanical Bull. of Academia Sinica. Vol. VIII, No. 2, 1967.
- (45) Lambert L.F.
Practical and Scientific mushroom culture 3rd ed.
Coatesville PA. U.S.A. 1946.
- (46) Lee, S.T.
Studies on Some Naturally Occurring Strains of Potato Virus Y in Taiwan.
Plant Prot. Bull. Vol. 12, No. 2, June, 1970.
- (47) Lin, B. C., C.C. Li and T.T. Kuo.
Bacterial Leaf Blight of Rice.
I. Serological Relationships Between Virulent Strain and Weakly Virulent Strain of *Xanthomonas oryzae*.
Botanical Bull. of Academia Sinica. Vol. X, No. 2, July, 1969.
- (48) Lin L. T. et al.
Soft rot of ginger.
Plant Protection Bull. The Plant Protection Soc. of ROC. June 1971.
- (49) Lin, S.S.
Study on Sugarcane Mosaic.
Report of the Taiwan Sugar Experiment Station No. 47, Dec. 1968.
- (50) Lin, S. C. et. al.
Study on White Leaf Disease of Sugar cane.
I. The Pathogen.
Report of the Taiwan Sugar Experiment Station No. 47, Dec. 1968.
- (51) Lin, Y.C. and L.C. Wu.

Some Observations on Nuclear Behavior of the Mushroom Cultivated
in Taiwan.

Chinese Journal of Microbiology 1, 1968.

(52) Lin Y.Y.

Studies on the Rice Root Parasitic Nematodes in Taiwan.

Jour. of Agri. and Forestry. Vol. 19, Oct. 1970.

(53) Ling, K.C.

Virus Diseases of the Rice Plant.

IRRI August. 1968.

(54) Liu, H. P. & Li, H. W.

Studies on the Sugarcane Mosaic Virus in Taiwan.

Report of the Taiwan Sugar Experiment Station No. 10, June 1953.

(55) Lo, T.T.

A Brief Report on the Sugar Cane Diseases in Taiwan.

Taiwan Sugar Vol. II. No. 2, Nov. 1955.

(56) Lo, T.T.

Leaf Scorch New Sugar Cane Diseases Discovered in Taiwan.

Taiwan Sugar. Vol. I, No. 6, 1954.

(57) Matsumoto, T.

Tobacco Diseases in Formosa.

Memoirs of the Faculty of Agriculture, National Taiwan University

Vol. I, No. 1, 1946.

(58) Matsumoto, T.

Plant Diseases and Their Control in Taiwan, (Chinese)

Bank of Taiwan Quarterly 6(1), 1950.

(59) Matsumoto, T., P.C. Chen and S. M. Yang.

Downy Mildew of Sugar Cane in Taiwan (VI).

Further Studies on the Relation of Environments to Sporulation.

I. Effect of humidity on sporulation.

II. Effect of light on sporulation.

III. Effect of nutrition applied to hosts.

Report of the Taiwan Sugar Experiment Station No. 33, Jan. 1964.

(60) Matsumoto, T., P.C. Chen and S. M. Yang.

Downy Mildew of Sugar Cane in Taiwan (V).

Comparative Studies on *Sclerospora Sacchari* and *Sclerospora Miscanthi*.

I. Two types of *Sclerospora sacchari* naturally occurring on sugarcane
in comparison with *Sclerospora miscanthi*.

II. Comparison of oospores of two *Sclerosporas*.

III. Production of conidia and their morphological characters.

Report of the Taiwan Sugar Experiment Station No. 28, May, 1962.

- (61) Matsumoto, T. et al.
Study on White Leaf of Sugarcane - The Insect Vector, *Epitettix hiroglyphicus* (in Chinese).
Plant Prot. Bull. Vol. 10, No. 4, Dec. 1968.
- (62) Murayama, D.
On the witches' broom diseases of sweet potato and leguminous plants in the Ryukyu Islands.
Memoirs of the Faculty of Agriculture Hokkaido University. Vol. 6, No.1 Sapporo, Japan 1966.
- (63) Murayama, D.
Immunological Studies of Potato Virus Diseases.
Dept. of Plant Pathology Faculty of Agriculture, Hokkaido University, Japan Dec. 1959.
- (64) Ou, S.H.
A Brief Report on Coffee in Taiwan.
Mimeographed sheets, JCRR Taipei, Taiwan, 1952.
- (65) R.I.C.E.
Rice Production Manual.
College of Agri. University of the Philippines 1967.
- (66) Sun, S. K. and Chien, H.S.
Banana Bunchy Top Disease.
Journal of the Agricultural Association of China. New Series No. 12, 1954.
- (67) Schwarz, R. E.
Results of A Greening Survey on Sweet Orange in the Major Citrus-Growing Areas of the Republic of South Africa.
S. Afr. J. Agric. Sci. 10, 1967.
- (68) Schwarz, R.E.
A Fluorescent Substance Present in Tissues of Greening-Affected Sweet Orange.
S. Afr. J. Agric. Sci. 8, 1965.
- (69) Schwarz, R.E.
Thin Layer Chromatographical Studies on Phenolic Markers of the Greening Virus in Various Citrus.
S. Afr. J. Agric. Sci. 11, 1968.
- (70) Schwarz R. E., A.P. D. McClean and H. D. Catling.

- The Spread of Greening Disease By Citrus Psylla in South Africa.
Phytophylactica 2, 1970.
- (71) Schwarz, R. E. and S. P. Van Vuuren.
Heat-induced Seed Abortion in Valencia Fruits.
Agroplanta 2, 1970.
- (72) Schwarz, R. E.
An Insect-transmissible Virus, Trapped on Sweet Orange Seedlings in
Orchards Where Greening Disease is Common.
S. Afr. J. Agric. Sci. 7, 1964.
- (73) Schwarz, R. E.
Comparative Indexing of the Annual and Seasonal Incidence of Greening
in Sweet orange fruits by External Symptoms and by the Albedo
Fluorescence Test.
Phytophylactica 2, 1970.
- (74) Schwarz, R. E. and S. P. Van Vuuren
Centrifugal Extraction of Phenolic Markers for Indexing Citrus Green-
ing And Avocado Sun-Blotch Diseases.
Phytophylactica 2, 1970.
- (75) Schwarz, R. E.
Seasonal Graft-transmissibility and Quantification of Gentisoyl Glu-
coside Marker of Citrus Greening in the Bark of Infected Trees.
Phytophylactica 2, 1970.
- (76) Taiwan Agricultural Yearbook 1970. Department of Agriculture &
Forestry.
Provincial Government of Taiwan, June 1970.
- (77) Tsai, Y.P. and C. H. You.
Study on the Diseases of Cotton
Seedling Diseases and Seed Treatment of Cotton
Jour. of the Agri. Res. Vol. 11, No. 2, June, 1962.
- (78) Tu C. C. and Y.H. Cheng
Cotton Damping-off *Thanatephorus cucumeris* (*Rhizoctomia solani*)
Fungicide and Nematicide Tests Results of 1969.
Vol. 25 The American Phytopathological Society.
- (79) Tu C.C., Y. H. Cheng and F. L. Kuo
Tomato Nematodes and southern blight (*Meloidogyne* spp., *Trichodorus*
spp., *Helicotylenchus* spp., *Pratylenchus* spp., *Rotylenchulus* spp.,
and *Corticium rolfsii*)
Fungicide and Nematicide Tests Results of 1970.

Vol. 26 The American Phthopathological Society.

- (80) Tu C. C. and Y. H. Cheng
Interaction of *Meloidogyne javanica* and *Macrophomina phaseoli* in
Kenaf root rot.
Jour. of Nematology, Vol. 3, No.1 Jan. 1971.
- (81) U.S.D.A.
Diseases of soybean and Methods of Control, Circular No. 931, 1954.
- (82) Walker, J.C.
Plant Pathology 1968.
- (83) Wang, H.C.
Banana Diseases Found in Taiwan.
Journal of Agriculture & Forestry Vol. VIII, Dec. 1959, Taiwan
Provincial College of Agriculture.
- (84) Wang H. F. and Y.C. Ma
A comparison of yield of different varieties of cassava.
Jour. of the Agri. Association of China New series XXXV Sept. 1961.
- (85) Wang, M.C.
A Preliminary Report on the Survey of Sweet Potato Diseases in
Taiwan (Unpublished)
- (86) Wang, C.S.
Study on affect of ratoon stunting disease of Sugarcane in relation to
the environmental factors. (In Chinese)
Report of the Taiwan Sugar Experiment Station. No. 47, Dec, 1968.
- (87) Wu, W.C.
Studies on the Colonial Variants of *Xanthomonas citri* (Hasse) Dowson
Plant Prot. Bull. Vol. 2, No. 4 1960.
- (88) Yang, I.L.
Studies on Witches' Broom of Sweet Potato in Taiwan (1)
Chiayi Agri. Expt. Sta. TARI. April 1969.
- (89) Yang I. L.
Studies on the varietal resistance to bunchy top disease of banana
Journal of Taiwan Agri. Res. Vol. 19, No.1, March 1970.
- (90) Yang I.L. and S.M. Hour
Studies on the Phoma blight of asparagus in Taiwan
(1) Varietal susceptibility and disease incidence.
- (91) Yang I.L., S.M. Hour and Y.L. Chen
Studies on the stem blight of asparagus caused by *Phoma asparagi*
(11) Physiological characteristics and chemical control
Jour. of Taiwan Agri. Res. Vol. 19, No. 4 Dec. 1970.

Symptoms of some major diseases



← Fig. 1 Bacterial blight of rice

↓ Fig. 2 Transitory yellowing of rice
Diseased (left); Healthy (right)



↑ Fig. 3 Witches' broom of sweet potato
Diseased (left); Healthy (right)

Fig. 4 Downy mildew of corn →





Fig. 5 Leaf blight of corn
(*Helminthosporium turcicum*)



Fig. 6 White leaf disease of sugar
cane



Fig. 7 Leaf scorch of sugar cane



Fig. 8 Bunchy top of banana



← Fig. 9 Li-ku-bin of citrus

↓ Fig. 10 Black spot of citrus



← Fig. 11 Heart rot of pineapple

↓ Fig. 12 Leaf curl of tobacco





Fig. 13 Mosaic of radish

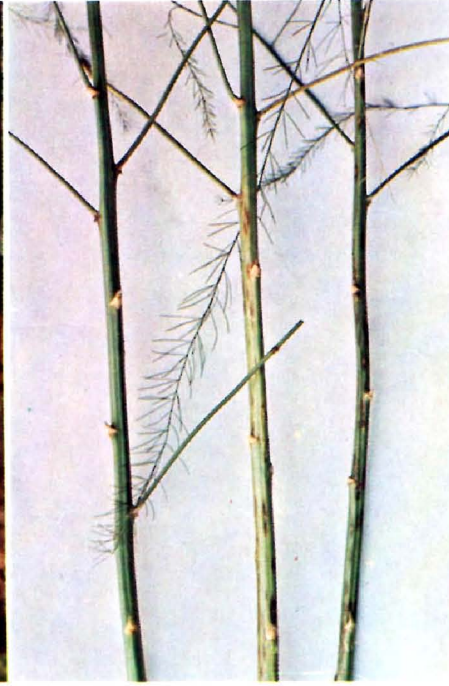


Fig. 14 Stem blight of asparagus
(One healthy plant at left)



Fig. 15 Wet bubble of mushroom



Fig. 16 Powdery mildew of sunflower

行政院農委會圖書室



0014581