

MANAGEMENT OF MAJOR COCONUT DISEASES IN INDONESIA

D. Sitepu
Research Institute for Spices and Medicinal Crops

S.N. Darwis
Coconut Research Institute

ABSTRACT

Important coconut diseases that now occur nationwide, are budrot, nutfall, stem bleeding and leaf spot diseases as well as diseases of unknown etiology in certain areas. Hybrid coconuts are unfortunately very susceptible to many kinds of diseases. Budrot and nutfall diseases have been causing a large number of coconut losses in the last eight years and are still destructive. The spread of such diseases can be minimized or prevented by adopting integrated control methods comprising of sanitation, quarantine enforcement, agricultural practices and fungicides application.

Stem bleeding and leaf spot diseases are common in Indonesia, however under certain conditions they may become very destructive, particularly to hybrid and dwarf coconuts. The control of these diseases has never been successful and fungicides are still the main choice. The diseases of unknown etiology, are still spreading and active in certain areas, the only control measure suggested is the quarantine procedure. The search of possible resistant varieties is expected to be the most promising solution of the problems.

Collaboration among the members of coconut growing countries in various aspects of research would give more efficient, successful and beneficial results in solving the disease problems in the future.

INTRODUCTION

Coconut (*Cocos nucifera* L.) is an important cash and food crop in Indonesia, and a majority of farmers will have at least some coconut palms to support their income. The government of Indonesia has given high priority to smallholding development, since the implementation of its first Five Year Plan in 1970. About 97% of the coconuts in Indonesia are produced by smallholders.

To accelerate the development and to increase the national production of coconut, the Government has introduced coconut hybrids into various areas of Indonesia since 1976. The use of the hybrids is now an important part of the national coconut development programme.

However, since the introduction of the hybrids, a number of diseases have become increasingly destructive in many plantations, and large numbers of hybrid palms have already been killed.

Although hybrids are high yielding coconuts, they are, unfortunately, very susceptible to certain diseases and losses have been reported from all parts of Indonesia. Although these diseases

have been known for a long time on local tall coconuts, the losses they caused were negligible. Consequently relatively little attention was given to them in the past.

Coconut plantations in Indonesia run the risk of being invaded by a number of devastating diseases, some of which are difficult if impossible to control economically. At least, three groups of coconut diseases are responsible for losses on hybrid coconuts, namely *Phytophthora* rots, stem bleeding and leaf spot diseases. Another group of diseases of still uncertain causes has affected coconut farmers in certain parts of the archipelago.

It appears that environmental conditions, high rainfall in particular, are associated with the occurrence of some of these diseases and with the severity of damage they cause. This shows the importance of a suitable environment for growing coconuts profitably and safely.

This paper is aimed at discussing the present status of some economically important diseases, the present research findings and future trends in improving the management of coconut diseases.

IMPORTANT DISEASES OF COCONUT IN INDONESIA

Many coconut diseases occur nationwide, their distribution is not confined to certain areas but are found wherever coconuts grow. These are leaf spots, stem bleeding, root rot and seedling budrot. Other diseases, and these are usually more dangerous and cause more serious problems, have only become a problem in certain areas, and attack predominantly certain coconut varieties. They seem to depend on local favourable environmental conditions. These are : budrot, premature nutfall, natuna wilt, and leaf yellowing diseases. Most of the latter are lethal diseases which commonly cause epidemics and death of coconut palms.

Budrot disease

Although this disease is considered endemic to Indonesia, it has been more recently responsible for the death of large numbers of coconut palms after the introduction of hybrids and dwarf varieties to certain places in Indonesia. Budrot is a very destructive disease and can cause great losses in a relatively short time.

Its incubation period is short and its causal agent, *Phytophthora palmivora*, is very aggressive under favourable environmental conditions (Brahmana & De Chenon, 1986; Bennett *et al.*, 1988).

In hybrid plantations, budrot can cause losses as high as 50% depending on local conditions and age of the palm trees. Nias Dwarf, the mother palm of KHINA 1 and KHINA 2 (the hybrids of Indonesia), is highly susceptible to budrot disease. In Pakuwon, West Java and in Paniki as well as in Tiniawangko, North Sulawesi the losses have been substantial since early 1980.

The distribution of budrot disease is wide and unpredictable. It has been reported from almost all hybrid gardens in Sumatera (Aceh, North Sumatera, Lampung), Java, Kalimantan and Sulawesi. The highest incidence is recorded in North Sulawesi and North Sumatera.

Epidemiological studies suggest that the severity of budrot disease is influenced by climate, high rain fall and humidity in particular. Gardens which are poorly cultivated, and have unfavorable conditions appear to suffer most. The pathogen P. palmivora seems to grow and develop faster under such conditions.

Premature nutfall disease

The casual agent of premature nutfall disease is the same as the causal agent of budrot, P. palmivora. Hybrid and dwarf varieties are again highly susceptible to the pathogen. The most susceptible age of the nuts is 4-7 months (Bennett et al., 1986).

Nutfall disease usually exists in gardens where budrot is present and active. It may cause nut losses up to 65% in certain years. This disease is particularly important when it occurs in seed gardens, because of the possible dispersal through seeds to new disease free areas.

As nutfall disease is considered identical to budrot, its epidemiology and distribution is also similar to budrot disease.

Stem bleeding disease

Stem bleeding disease, suspected to be caused by Thielaviopsis paradoxa, is particularly dangerous to hybrid PB-121, causing serious damage to the trunk and consequently to production both in quantity and quality (Bennett et al., 1986b; Kartika et al., 1984; Sitepu et al., 1988a). In an advanced stage of the disease, the palm has large quantities of the stem tissue.

Although stem bleeding can attack palms of all ages, the most susceptible age is from the start of bearing to up to 15 years old. Infected trees become susceptible to weather changes, pest damage and will be less responsive to fertilizer.

Stem bleeding has never been reported causing serious damage and loss to local tall palms in Indonesia. However, its presence in many plantations should be considered in future coconut replanting programmes in Indonesia.

Leaf spot diseases

Many fungal pathogens are reported to be responsible for this group of diseases, such as Helminthosporium palmarum, Pestalotiopsis palmarum, Sphaeropsis sp., Colletotrichum sp., Fusarium sp., Dreschlera sp. (Mathai et al., 1985; Mathai et al., Sumaryono and Triaharso, 1985; Sitepu et al., 1986; Mawikere and Sitepu, 1988; Sualang, 1988). The pathogens may, either alone or together, cause severe damage to seedlings and productive adult palms, depending on the environmental

conditions and the varieties. Evidence shows, that hybrids and some tall varieties are more susceptible to leaf spot diseases.

Disease of unknown etiology

There are at least three diseases of unknown etiology known in Indonesia, causing losses to coconut palms and nuts every year, namely : Natuna wilt, Ampas Tebu and Leaf yellowing. Of these, Natuna wilt appears to be the most destructive. Although their occurrence is still limited to certain areas they affect local growers and have drawn the attention of government and research workers. The diseases still spread and research should be continued in order to overcome these problems.

Natuna Wilt Disease

Since Natuna wilt was first recognized in 1976, the disease has killed more than one million productive palms in the Natuna Islands, Riau, Indonesia (Sitepu, 1983; 1988). Later, a disease with similar symptoms was discovered in several smallholdings in Central Kalimantan. In that area the disease has been noticed by growers as long as 10 years ago (Sitepu, et al., 1988b; Varghese and Sumaraganda, 1989)> Wilt diseases have also been noticed, recently, in Central Sulawesi (Sitepu and Mawikere, 1989), although at a low incidence.

The etiology of Natuna wilt is still unclear. Bacteria (Xanthomonas sp., Erwinia sp) as well as fungi Thielaviopsis sp., Botryodiplodia sp. are consistently present. The latest information from local extension survey in Riau (personal communication), confirmed that Natuna wilt is still active in The Natuna Island (Table 1). The report also suggests that the antibiotic oxytetracycline appears to suppress the pathogen of Natuna wilt. This preliminary information could mean that an MLO is the possible causal agent.

The epidemiology of Natuna wilt is also not well understood. It spreads and kills young and old palms alike and its pattern and time of spread is unpredictable.

Table 1. Estimated numbers of dead coconut palms caused by Natuna wilt in Natuna Islands (1981-1986)¹

Year	Dead palms	
1981	100,152	(1) Source : Ext.Service,(Disbun), Riau Prov., (2) an additional 20,000 were showing disease symptoms but were still alive
1982	112,000	
1983	114,000	
1984	90,000	
1985	60,000	
1986	50,000 ²	
In 6 years	526,000	

Leaf yellowing disease

The first report on leaf yellowing of coconut in Indonesia came from South Sulawesi (Sitepu et al., 1978) where the disease spread and caused damage to many smallholdings. However so far only limited information is available, such as disease symptoms, distributions, environmental correlations and the effect of the disease on the productivity of the palms. The etiology of the disease is still unknown.

Recently leaf yellowing disease of coconut was reported from Central Sulawesi, in the Subdistrict Poso (Sitepu and Mawikere, 1989) where it attacks a large area of smallholdings. The disease strikes young and adult palms, tall and hybrid varieties, and occurs in various soil types and environments. It spreads without any specific patterns. Reduction of yields varies from place to place depending on the age, cultivation practices, environment and variety of palms. Usually the yield is reduced by 60% over a 10 year period, starting from when visual symptoms are first clearly observed. However some trees stop producing completely.

The typical symptom of the disease is an intensive yellowing of leaves, starting from the tips of the leaflets and the older fronds. Eventually all leaves, except the youngest fronds, become yellow. In some cases the tips of the affected leaves suffer from necrosis. In the advanced stage, the fronds and leaflets become smaller, until the whole crown is reduced and stunted. The palm produces smaller, fewer or no nuts at all. The nuts appear normal, but according to local growers the affected palms produce a small amount of copra per nut which is then of poor quality.

In some plantations, about 75% of the palms show symptoms and the number of palms affected increases each year. The disease is most prevalent in the Kecamatan Tojo, Kabupaten Poso.

Ampas Tebu Disease

Ampas Tebu disease was first reported in 1985 attacking local tall palms in Bengkulu, Sumatera. The leaves of the affected palms dry and eventually wilt. In the advanced stage of the disease the palms might die. Two different theories about its nature have been put forward : physiological conditions (Brahmana and de Chenon, 1985) and the presence of a pathogen agent (Bennett, 1985; personal communication). Ampas Tebu disease seems to occur in various soil types and there is evidence that it spreads.

RESEARCH ON THE CONTROL OF COCONUT DISEASES IN INDONESIA

Research activities on the protection of coconuts from diseases have increased during the last 15 years. These were aimed at improving palm productivity, minimize constraints in cultivation and to provide smallholders with acceptable crop protection technology.

The Coconut Research Institute (Balitka in Manado, North Sulawesi) is responsible for coconut research in Indonesia and concentrates on the smallholdings sector. Balitka in coordination with the Extension Service (Directorate General of Estate Crops, DGE) has an important function in disseminating research results to smallholders and other users. Its mission is made easier through the operation of various research substations which are located in North Sulawesi, West Java, West Kalimantan, East Kalimantan, Sumatera and Maluku.

Balitka has adequate research facilities such as laboratories, green houses, nursery sites, experimental gardens, outside stations and equipment. Balitka deals mainly with coconuts but also conducts research on other palms. Its research is divided into 7 sections namely: agronomy, plant breeding, agro-industry, entomology, plant pathology including weed science, agro-ecology and agro-economy.

The entomology and plant pathology sections are presently receiving technical assistance from UNDP/FAO project entitled: Integrated Coconut Pest Control. The aim of the project is to provide advanced training to the staff as well as additional equipment. Also a plant pathology expert, provided by the World Bank, was attached to Balitka for the same purpose for two years. The number of workers in the Plant Pathology section is still not sufficient to attend to the various coconut disease problems in Indonesia.

The current activities carried out at the Plant Pathology section can be summarized as follows:

Budrot and nutfall diseases

- Control of budrot and nutfall diseases by using systemic fungicides, phosphorus acid, and non-systemic fungicides.
- Studies on the epidemiology of budrot and nutfall diseases.
- Pathogenicity of Phytophthora isolates, collected from different gardens in Indonesia.
- Field resistance trial using 18 varieties in Paniki EG., North Sulawesi.
- Trials on integrated control measures

Stem Bleeding disease

- Studies on the etiology and pathogenicity of the disease
- Epidemiology of stem bleeding disease
- Integrated control of stembleeding

Leaf spot diseases

- Integrated control of leaf spot diseases
- Research on variety resistance to leaf spot
- Pathogenicity of leaf spot pathogens (Colletotrichum sp., Pestalotia sp., Helminthosporium sp., Dreschelera sp., Sphaeropsis sp., etc.)

THE PROSPECT OF RESISTANT VARIETIES

Resistant varieties against certain diseases are likely to be the most promising and profitable way of controlling coconut diseases. Therefore research activities on resistance should receive priority. Evidence, that some varieties escape from infection of certain diseases helps scientists to identify possible resistant varieties of coconut palms. Other methods of control measures have proved to be insufficient, expensive and difficult to practice. Some progress has already been made in searching for resistance to various important coconut diseases. However, much work remain to be done.

When Lethal Yellowing disease destroyed palms in Jamaica and Florida, USA, the only hope was to plant resistant varieties. Trials on screening varieties provided evidence that at least four Dwarf varieties showed resistance to Lethal Yellowing, namely Malaysian Dwarf, Ceylon Dwarf, Indian Dwarf, and Raja Dwarf (Ohler, 1984), while the most susceptible varieties were Indian Tall, Jamaican Tall, and Rangiroa Dwarf. The case of Lethal Yellowing has so far been the greatest in finding resistance against a coconut disease.

Zelazny et al. (1982) reported that a few attempts on testing coconut varieties against Cadang-cadang disease in the Philippines are under progress. But the results were still inconclusive. Besides artificial inoculation of different varieties, a large field trial was under way, which was hoped would reveal resistance against the disease. Bennett et al. (1988) found evidence that resistance to nutfall disease existed when detached nuts were artificially inoculated in the laboratory. Results of twenty four coconut varieties tested against nutfall in Mapanget, North Sulawesi, showed that the nuts from KHINA-1 hybrid were less susceptible than those from PB-121 hybrid, and that Nias Yellow Dwarf nuts were extremely susceptible. The Tall varieties in general had a low level of susceptibility against the nutfall in the trial. Amongst the most promising dwarf varieties as mother palms are the Raja and Jombang Dwarf (Table 2).

Phytophthora rots are reported to be very infectious to many coconut varieties. These diseases become very destructive when certain environmental factors support the development of epidemics, especially among susceptible varieties. The susceptibility of coconut Dwarf x Tall hybrids to these diseases is believed to be inherited from their mother (dwarf) palms which appear to be more susceptible than the pollen source. Some local Tall varieties can also become infected but to a lesser degree. It is interesting to note that, Nias Dwarfs have never been reported suffering from Phytophthora rots in their area of origin Nias Island, North Sumatera. This implies that in studying resistant characteristics, environmental conditions as stated by Darwis (in Bennett et al., 1988) should be considered.

Based on previous preliminary resistant tests, Balitka in Manado is now preparing a large field trial in which 18 coconut varieties will be exposed to various pests and diseases. In particular we hope the trial will give more information on resistance to Phytophthora rots.

Table 2. Susceptibility of coconuts to nutfall disease, caused by P. palmivora

Coconut variety			
High susceptibility	Medium high susceptibility	Medium susceptibility	Low susceptibility
Nias Yellow Dwarf	Paslaten Tall	Jombang Dwarf	Tenga Tall
Nias Green Dwarf	Takome Tall	Raja Dwarf	Bali Tall
Bali Yellow Dwarf	KHINA-2	Palu Tall	Banyuwangi Tall
Tebingtinggi Dwarf	KHINA-3	Jepara Tall	KB2
	KB-4	Sawarna Tall	KB3
		KHINA-1	
		MAWA (PB-121)	
		NIWA	

A similar case seems to be the PB-121 hybrids, which are also highly susceptible to Phytophthora rots. The Malaysian Dwarf mother has been often associated to susceptibility more than its farther, local tall palms from West Africa plantations.

Stem bleeding only became an important disease when new hybrids, particularly PB-121, were introduced into various areas. In Indonesia for example stem bleeding causes severe damage to PB-121 hybrids and affects yields as well (Kartika. et al., 1984; Anon., 1985; Sitepu and Lolong, 1985; Sitepu et al. 1988a).

The very low incidence of stem bleeding among various local Tall varieties may imply wide spread natural resistance or tolerance. In Indonesia, stem bleeding is only found important in PB-121 plantations. However, more studies need to be conducted before definite conclusion can be made about the low incidence of stem bleeding in local Tall varieties of Indonesia. The great susceptibility of PB-121 against stem bleeding disease may be influenced by the following aspects:

- The hybrids are planted intensively. i.e. they are regularly cultivated and fertilized, in contrast, local varieties, especially Tall coconuts, are almost never fertilized or cultivated.
- The hybrid is also more susceptible to various other kinds of diseases.
- It is also more susceptible to drought. Both weather condition and pests damages may be prerequisites for infections by stem bleeding.

Several research workers have suggested that the problem of stem bleeding is more influenced by environmental conditions and agricultural practices than by a difference in coconut varieties (Goonewardene, 1985; Menon and Pandalai, 1960; Kartika et al., 1976;

Thampan, 1981; Sitepu et al., 1988a).

The Coconut Research Institute has made significant progress in identifying resistance to leaf spot diseases in Indonesia. There are a number of promising varieties as far as leaf spot is concerned. Both, local Tall and Dwarf show variation in resistance to leaf spots. The degree of resistance in hybrid seems to be influenced by either one or both of their parents.

Mawikere and Sitepu (1988) reported that leaf diseases caused mainly by Spaeropsis sp. and Pestalotia palmarum attacked various coconut palms at different degrees of infestation, revealing that resistance may occur in many varieties of coconut, particularly in Tall coconuts. Among 17 varieties (10 Talls, 3 Hybrids, 4 Dwarfs) surveyed, 8 varieties (4 Talls, 2 Dwarfs, 2 Hybrids). e.g.: KHINA-1, KHINA 3, Nias Yellow Dwarf, Salak Dwarf, Markham Tall, Tenga Tall, Mapanget-32 Tall, and Banyuwangi Tall are considered to have low susceptibility against leaf spot diseases.

Local environmental conditions are also thought to influence leaf spots infections. Mawikere and Sitepu (1988), found that the incidence of leaf spots in North Sumatera was much lower than in West Java.

PROPOSED RESEARCH PROGRAMMES

Research programmes of the Balitka for coconut diseases are based on various considerations such as existing problems, national goals, staff potentials, research facilities and the availability of research budgets. Therefore activities are scaled into various high and low priority as well as short and long term programmes, which are summerized in a national programme of the Research Institute. The objectives are to continue research activities on the control measures of the main coconut diseases throughout the country.

Budrot and Nutfall diseases

- To continue studies on the epidemiology.
- To improve control methods for small holders.
- To search for resistant varieties through laboratory and field trials.
- To continue to search for effective and economical fungicides which are suitable for smallholders.
- To study appropriate farming systems which could prevent epidemics in areas such as North Sulawesi and North Sumatera.
- To develop integrated control methods applicable to smallholdings.

Stem bleeding disease

- To continue studies on the etiology and epidemiology of stem bleeding disease.
- To continue study on the ecology of T. paradoxa and other possible pathogens causing stem bleeding of coconut.
- To search for varieties resistant against stem bleeding disease.

- To improve integrated control practices presently recommended to the smallholding sector.
- To study losses of coconut yield and palms caused by the disease.

Leaf spot disease

- To continue isolations and inventory of pathogens of leaf spot diseases.
- To continue studies on resistant varieties both in the laboratory and the field.
- To improve integrated control methods.
- To study effect of leaf spots on the growth and yield of the palms.
- To continue trials on effective and economical chemical control.
- To continue ecological studies on the leaf spot outbreaks, specially on climatic factors.

Diseases of unknown etiology

- To screen for resistant varieties (field trials) in the areas where diseases are common.
- To continue studies on the etiology of each disease existing in Indonesia.
- To study the epidemiology and economic impact of each disease.
- To obtain more information on the distribution of these diseases.
- To study the methods of controlling the diseases.

In order to make the control of coconut diseases more efficient, successful and beneficial in the future to all coconut growing countries, collaboration among the countries needs to be strengthened, under the coordination of APCC. The following aspects should receive special attention :

- Exchange of information.
- Coordination of research on specific regional problems (e.g. diseases of unknown etiology).
- Exchange of workers (researchers, extension officers, crop protection officers and leading farmers) to promote the exchange of experience in plant protection implementation.
- A regional survey on coconut diseases and the problems they cause, with emphasis on diseases of unclear causes, to clarify their relationship and the risk to the region as a whole.
- Technical meetings and training courses in integrated disease management once in every two years.
- Biological control of some coconut diseases.

REFERENCES

- Anonymous. 1985. Monitoring coconut stembleeding disease on the PB-121 hybrid. CRI. Annual report 1984/1985: 34.

- Bennett, C.P.A., O. Roboth, G. Sitepu and A. Lolong. 1986a. Pathogenecity of Phytophthora palmivora (Butler) Butler causing premature nutfall disease of coconut (Cocos nucifera L.) Indonesian Journ. of Crop Science Vol. 2(2): 59-70.
- Bennett, C.P.A., M.L.A. Hosang and H.H. Assa. 1986b. Observation of pests and diseases of the coconut in the Northern Islands of Maluku. CRI., Manado: 54-59.
- Bennett, C.P.A., H.F. Mangindaan and S.Kharie. 1988. Screening varietal resistance of coconut to premature nutfall disease caused by Phytophthora palmivora (Butler) Butler. In Proceeding of coconut Pest and Diseases Seminar. 28-31 March 1988 (In Press)
- Brahmana, J., R.D. de Chenon. 1985. Laporan kunjungan ke propinsi Bengkulu. PPK. Bandar Kuala, Sum Utara. Doc. 33/V/1985:36 hal (Unpublished).
- Kartika, D., F.X. Soebagio, P.D. Turner and C.J. Breure. 1984. Severe stem bleeding and frond fructure of MAWA Hybrid Coconut in North Sumatera. Paper 51, Intern. Conf. on Cacao and Coconut. Malaysia: 14 pp.
- Mathai, G., A.V. Mathew and U.M. Kunju. 1985. Reaction of Coconut cultivars (Cocos nucifera) to root (wilt) and leaf rot diseases. Indian Phytoph. 38: 561 - 562.
- Mawikere, J. dan Sitepu. 1988. Tingkat ketahanan beberapa kultivar kelapa terhadap penyakit bercak daun. Dalam Prosiding Seminar Hama dan Penyakit Kelapa 28 -31 Maret 1988. Balitka - UNDP/FAO, Manado (In Press).
- Menon, K.P.V. and Pandalai. 1958. The coconut Palm. A Monograph. Indian Control Coc. Com. Ernakulam : 203-232.
- Ohler, J.G. 1984. Coconut, tree of life. FAO Plant Production. FAO Rome, Italy Paper No. 57; 446 pp.
- Sitepu, D., Nildar, H. R.V.J. Sudhono, Hadad, E.A. 1978. Penelitian faktor-faktor penyakit gejala daun kuning pada kelapa di Sul. Selatan. LPTI Bogor: 170 Hal (Unpublished).
- Sitepu, D. 1983. Coconut wilt in Natuna Island of Indonesia. Exotic Plant Quar. Pests and Procedures for Introduction of Plant Materials: 81-85.
- Sitepu, D. dan A. Lolong. 1985. Pengelolaan penyakit stem bleeding terhadap kelapa. Dalam, Prosiding Seminar Proteksi Tan. Kelapa Seri Pengembangan No.3: 1988. Puslitbangtri. Edit.: M. Soehardjan D. Sitepu, Darwis, SN: 145-155.

- Sitepu, D. 1988. Penyakit kelapa yang belum jelas penyebabnya, dampak dan statusnya. Dalam Prosiding Seminar Hama dan Penyakit Kelapa 28 - 31 Maret 1988. Balitka - UNDP/FAO, Manado (In Press).
- Sitepu, D., J. Mawikere, C.P.A. Bennett. 1988a. Pengaruh stem bleeding terhadap produksi kelapa. Dalam Prosiding Seminar Hama dan Penyakit Kelapa 28-31 Maret 1988. Balitka - UNDP/FAO, Manado (In Press).
- Sitepu, D., H.F. Mangindaan, J. Mawikere 1988b. Outbreak of coconut wilt disease in Central Kalimantan In Integrated Coconut Pest Control Project. Annual Report. AARD-UNDP/FAO., CRI., Manado: 51-52.
- Sitepu, D. and J. Mawikere. 1989. Diseases of unknown etiology in Central Sulawesi. Report, Balitka-UNDP/FAO., Manado.
- Sitepu, D., O. Roboth, M. Darwis, B. Pattang. 1986. Resistensi beberapa kultivar kelapa yang telah dirilis terhadap penyakit bercak daun. Dalam, Laporan Tahun 1985/1986. Terbitan khusus no. I/VIII/86. Balitka, Puslitbangtri, Manado: 12-16.
- Sualang, D.S. 1988b. Intensitas serangan penyakit bercak daun Pestalotia palmarum Cooke pada beberapa kultivar tanaman kelapa di Balitka, Mapanget. Tesis S₁, F.P. Unsrat, Manado: 44 hal.
- Sumardiyono, Y.B. dan Triharso. 1985. Pengelolaan penyakit daun pada tanaman kelapa. Dalam Prosiding Seminar Proteksi Tan. Kelapa. Seri Pengembangan no. 3: 1988. Puslitbangtri. Edit.: M. Soehardjan, D. Sitepu, Darwis, SN: 177-183.
- Thampan, P.K. 1981. Handbook on Coconut Palm. Oxford & IBH. Publishing Co. N. Delhi: 181-182.
- Varghese, G., T. Sukmaraganda. 1989. Report on visit to coconut problem areas in Sampit, C. Kalimantan. NECP., Ditlin - Perkeb., Ditjenbun, Jakarta: 18 pp. (Unpublished).
- Zelazny, B., J.W. Randles, G. Boccardo and J.S. Imperial. 1982. The viroid nature of cadang-cadang disease of coconut palm. Scientia Filipinas, Vol. 2: 46-63.