STRATEGIES IN PEST AND DISEASE MANAGEMENT IN COCONUT

P.K. Koshy, J.J. Solomon and C.P.R. Nair
CPCRI Regional Station, Kayangulam

The coconut palm which has been eulogised as 'Kalpavriksha' or the 'Tree of heaven' provides not only food, but also shelter, medicine and employment to millions of people in the tropic. India which ranks third in coconut production produces 12,355 million nuts from an area of 1.63 million ha.(1993-94). The productivity level at present recorded is 7572 nuts per ha. But within the country production as high as 18000 nuts per ha is also recorded. The low productivity observed in some states is attributed mainly to the loss due to pest and diseases. Hence there is an urgent need to bridge the gap between the yield potential and the yield realised. This paper elaborates the pest and disease problems of coconut in India and the strategies envisaged for the future.

A. DISEASES

Diseases account for substantial loss in coconut production. Among the maladies, root (wilt) disease, leaf rot, bud rot, Thanjavur wilt/Ganoderma disease, stem bleeding and Tatipaka are important as they contribute to significant decline in yield and in certain cases the death of the palm.

1. Root (wilt) disease

Root (wilt) disease reported over a century back in three isolated pockets in Kerala has since then spread and now occurs in 0.41 million ha, about 50 percent area under coconut in Kerala. The disease occurs in a contiguous manner in eight out of fourteen districts in Kerala and sporadically in the northern districts of the State and the bordering districts of Tamil Nadu. The disease intensity in the contiguous diseased tract ranged from 1.52 percent in Trivandrum district to 75.6 percent the highest being in Kottayam district. The annual loss due to the disease is estimated to be about 968 million nuts (Anon. 1985). The disease is non-lethal but debilitating and palms of all age groups are affected.

The etiology of the disease has now been conclusively established to be due to mycoplasma-like organisms (Phytoplasmas) (Solomon and Govindankutty, 1991). Lace bug, *Stephanitis typica* is the proven vector (Mathen *et al.,* 1990), the leaf hopper, *Sophonia greeni* and the plant hopper, *Proutista moesta* are the putative vectors (Rajan 1984, 1985). The perennial nature of the crop, presence of the pathogen in the vector once it is acquired and the possible transmission in brief duration of feeding by infective insects rules out the effective prevention of the spread of the diseases by the control of insects.

Since the organism is not amenable to culturing *in vitro* screening of chemicals for adopting control measures is not feasible. Diseased palms treated with tetracycline hydrochloride exhibited temporary remission of symptoms only and hence cannot be advocated as a control measure. However, palms in the early stage of disease respond to management practices. Strategies have been evolved for managing the disease in the mildly affected border areas and the severely affected contiguous area (Anon. 1986; Muralidharan *et al.,* 1991). The recommendation for the mildly affected area is to remove all disease affected palms irrespective of intensity of disease and yield so as to eliminate the source of infection. The strategy for the heavily diseased tract is adopting integrated management practices, removing all the palms in the advanced stage of disease and the juvenile diseased palms, replanting with healthy elite seedlings, application of balanced dose of fertilizers, basin management with green manure crops, adopting recommended plant protection measures, providing irrigation during summer months and also practising intercropping and mixed farming (Muralidharan *et al.,* 1991).

The permanent solution to the disease problem will, however, be only by generating planting materials that are resistant to the

disease. Field evaluation of 63 cultivars and 32 hybrid combinations in progress since 1972 indicates that none of the cultivars/ hybrids manifest resistance/tolerance to the disease. However the cultivar, Chowghat Green Dwarf (CGD) has been found to have field tolerance of over 90 percent to the disease (Anon. 1972). Intensive survey of heavily diseased tract - 'hot spot' area of Alleppey, Quilon, Kottayam and Pathanamthitta districts located about 140 high yielding West Coast Tall palms above 35 years age in gardens of 80 percent disease incidence. The selected palms are being used as mother palms for raising disease resistant progenies (Anon. 1996). Hybrids of selected WCT palms with CGD planted since 1990 have so far not contracted the disease. Mixed pollen from all the healthy palms is also used for pollination to develop a gene pool of field tolerant palms. Twentyfour exotic accessions collected in 1981 from South Pacific Ocean Islands have been planted in the World Coconut Germplasm Centre, Andamans with the main objective of producing *inter se* and selfed seednuts and also for making crosses using their pollen with disease-free palms in hot spots and evaluating the progenies for resistance to disease.

2. Leaf rot disease

Leaf rot, a disease of fungal etiology, occurs superimposed on about 30 percent of root (wilt) affected palms (Anon. 1989). Besides the unwhole appearance the affected palms presents, it brings about a rapid decline in yield. Information on the loss due to leaf rot disease alone is not available as the disease generally does not occur independent of the root (wilt) disease. However. Menon and Nair (1948) estimated the annual loss at Rs. 5.6 million. *Colletotrichum gloeosporioides, Exserohilum nostratum* and *Gliocladium vermoeseni* are the principal fungi associated with the disease (Srinivasan and Gunasekaran, 1994). Sequential spraying with 1% Bordeaux mixture, 0.3% Dithane M-45 and 0.5% Fytolan in this order at quarterly intervals after removing and destroying all severely affected leaves is recommended as a control measure (Anon. 1986).

3. Bud rot disease

But rot disease caused by *Phytopthora palmivora* is reported from all the coconut growing countries. In India it is reported in coconut and palmyra palms. It is observed in all coconut growing states affecting mainly palms below 20 years. The disease is sporadic in nature and often tends to be fatal unless remedial measures are resorted to in time. The disease generally occurs during the south-west and north east monsoon period and can be classified as a rain favoured disease. Low temperatures below 24°C and high relative humidity above 94percent favours the incidence and severity of the disease (Joseph, 1978).

Infected palms could be cured if the affected palms are treated before the rotting reaches the shoot apex. Thorough cleaning to remove all the rotten tissues, dressing the wound with Bordeaux paste and providing a protective covering to the wound and treated portion till the emergence of normal shoot is found to be effective. Prophylactic spraying with 1% Bordeaux mixture before the onset of monsoon and spraying the apparently healthy palms adjacent to diseased palms and proper field sanitation prevents fresh incidence and spread (Joseph, 1978). Leaf axil filling with Sevidol 25gm in 200 ml. sand is recommended to prevent red palm weevil infestation of affected palms.

4. Thanjavur / Ganoderma Disease

The disease first noticed on the coastal area of Thanjavur district of Tamil Nadu in the 1950's is now prevalent in Andhra Pradesh, Karnataka, Maharashtra, Gujarat, Orissa and Kerala State (Nambiar and Rethinam 1986, Wilson *et al.*, 1987). The disease is lethal affecting palm between 10-30 years of age. The disease is caused by the fungus *Ganoderma*. Two species *Ganoderma lucidum* and *G applanatum* have been isolated from diseased palms (Anon 1967). The fungus has a wide host range infecting both monocots and dicots (Rajan 1987 Bhaskaran *et al.*, 1989).

The disease could be constrained by adopting integrated management practices involving cultural, chemical and biological methods (Nambiar and Rethinam, 1986; Bhaskaran *et al.*, 1989). The integrated management practices recommended are removal of dead palms and palms in the advance stages of disease with bole and destroying isolation of diseased palms from healthy palms by digging isolotion trenches of 1m deep and 30 cm wide, providing adequa

soil moisture through irrigation coupled with mulching, avoiding flood irrigation, overcrowding and cultural practices like ploughing to prevent spread of inoculum, providing good drainage facilities, application of normal dose of fertilizers along with 50 kg farmyard manure and 5 kg neem cake per palm per year, application of Tridemorph 2 ml/ 100 ml per palm at quarterly interval through root feeding or Aureofungin sol 2 g + 1g copper sulphate dissolved in 100 ml water and raising Ganoderma resistant crop like banana as intercrop. Swabbing the affected stem with 0.1% carbaryl is recommended if attack by *Xyleborus* or *Diocalandra* is noticed.

5. Stem Bleeding disease

The disease is reported from all the coconut growing countries. It is observed in palms in all soil types from coastal littoral sand to laterite. It can occur sporadically in isolated palms or gardens or endemically in certain areas.

The disease is caused by *Thielaviopsis paradoxe* (Nambiar *et al.*, 1986). High humidity and low temperature are the predisposing factors for disease development. Preliminary field observations indicate the west Coast tall variety to be most resistant to stem bleeding among the indigenous cultivars (Radhakrishnan and Potty, 1980).

The control measures suggested are chiseling and removing affected bark and dressing the wound with hot coal tar or Bordeaux paste (Ramanandan and Antony, 1976). Application of Calixin and Bavistin through root feeding thrice a year was found to be more efficient in disease management (Nambiar and Sastry, 1988). Cultural practices such as summer irrigation to retain soil moisture, providing good drainage in rainy season and application of recommended dose of organics and inorganic along with 5 kg neem cake per palm are the other measures suggested.

6. Tatipaka disease

Tatipaka disease first noticed in 1949 from Tatipaka in East Godavari district is now prevalent in East and West Godavaries, Srikakulam and Nellore districts. A survey conducted during 1985-1990 recorded 8179 palms to be diseased in "Konaseena" the Central delta region of the river Godavari (Rajamanar *et.al* 1991). The disease is non-lethal but debilitating, affecting palms in the age group of 25-40 years. The spread of the disease is not contiguous but random at a slow pace of 3.5% in five years. The affected palms bear atrophied nuts.

MLOs are implicated as the etiological agent of the disease. Since there are no known control measures available for plant MLO disease, and the affected palms are only limited in number, surveillance and eradication of the diseased palms is the practical solution for managing this disease.

Future lines of investigation

1. Root (wilt) disease

a) Since the disease is induced by MLOs and as there are no effective control measures for phytoplasma disease, breeding for disease resistance should receive priority. Survey of hot spots should be extended to all the eight districts where the disease occurs in a contiguous manner to locate more numbers of disease-free WCT and CGD palms. Progenies of crosses made between such selected palms may be planted in each district as nucleus stock, the procedure of which will cater to future planting material requirement of the districts.

b) Replanting in a phased manner with resistant material starting simultaneously from Trivandrum district in the south and Trichur district in the north proceeding towards the centre should be taken up so that over the years the entire diseased area may be replanted with the resistant material.

c) Research on molecular diagnostics for screening seedlings for resistance in the nursery should receive immediate attention.

2. Leaf rot disease

a) Leaf rot being the major contributing factor for the decline of root (wilt) diseased palms more effective control measures needs to be developed.

b) Use of biocontrol agents for tackling the principal fungi should be explored.

3. Bud rot disease

a) The disease being a rain favoured one, meteorological studies and disease forecasting system should be developed and the cultivators may be advised through media to protect the plant at the critical time with the appropriate chemicals.

4. Thanjavur wilt

a) The integrated management practices developed should be popularised for adoption.

b) The alternate hosts of the

pathogen especially the weeds in the coconut garden should be rogued.

c) The disease could be arrested by providing isolation trenches and adopting field sanitation.

5. Stem bleeding disease

a) Organic fertilizers and biochemicals which favour the multiplication of antagonists may be tried for managing the disease.

6. Tatipaka disease

a) Tatipaka disease being a localised problems occurring on limited number of palms survey and immediate removal of diseased palms will arrest further spread of the disease.

Epidemiological studies should be undertaken for all the diseases so that effective need based management strategies could be formulated.

Information on distribution, intensity and production loss available for the various diseases is meagre and outdated and it may be updated with fresh survey employing more refined techniques. The information generated will help the developmental agencies to plan appropriate strategies for managing the pest and disease problems and also to enhance the productivity.

B. PESTS

Coconut palm is prone to infestation by a variety of insect, mite and rodent pests. Pest incidence is observed in palms of all ages from nursery to adult palms. Kurien *et al.* (1979) listed 547 insect and mite species infesting coconut palm and copra. In India, for the management of major pests like rhinoceros beetle *(Oryctes rhinoceros* L.), red palm weevill (*Rhynchophorus ferrungineus* Fab.), leaf eating caterpillar (*Opisina arenosella* Wlk.) and root grub *(Leucopholis coneophora Burm.)* integrated pest management (IPM) technologies involving various proven methods of control have been developed. The present IPM strategies mainly comprise of mechanical, chemical, biological and field sanitation methods. Intensified research programmes on biological suppression of coconut pests have resulted in formulation of feasible biological control tools for two key pests of coconut viz. rhinoceros beetle and leaf eating caterpillar (Pillai, 1993).

The rhinoceros beetle is managed by an integrated approach which includes hooking out the beetles from crown of affected palms, treatment of breeding sites with carbaryl 0.01 per cent and prophylactic leaf axil filling of palms with suitable insecticide like Sevidol @ 25 g per palm mixed with 200 g of fine sand. The entomogenous fungus *Metarhizium anisopliae* and the pathogenic virus, Baculovirus of Oryctes are two successful microbial control agents currently being used in our country. The success on the introduction/re-release of the viral disease in several places has been well accepted.

For the red palm weevil a combined adoption of cultural, sanitational and chemical control methods has yielded encouraging results. Timely detection and proper curative treatment are the essential steps in the management of this pest.

In the case of leaf eating caterpillar during epidemic outbreaks an IPM strategy comprising mechanical, chemical and biological methods of control is employed with high success. Effective candidate parasitoids affecting larval, pupal and prepupal stages of the pest are widely employed throughout India for the biological suppression of the pest.

The IPM schedule for the root grub is based on mainly mechanical and cultural methods and insecticidal application coinciding with the pest activity.

Though integration of various methods of insect control has been successful in managing the pest problems in coconut on a whole, there is sufficient scope to refine and modernise the current technology by undertaking research on the modern approaches. A reorientation in the future programmes is therefore essential to make the present IPM technologies more sound, feasible, economic and ecofriendly. The pest management programmes proposed for the next two decades envisage the following aspects :-

1. Development of Integrated Pest Management Systems for key pests :

a) Chemical control strategies :

A rescheduling of the present recommendations is to be made to evolve an insecticidal control strategy that can fit well in a sustainable agricultural ecosystem. In this connection investigations are to be undertaken on the problem of pesticidal residues on coconut and coconut based intercrops/mixed crops and its en-

vironment. Hence establishment of an organised system to study the pesticidal residues in the products and the environment and sufficient infrastructure to educate the farmers on the hazards of the pesticides is very much needed.

b) Autocidal and Genetic methods of pest management :

This involves studies on chemosterilants and radiation and their effects on pest populations. Introduction of incompatability and deleterious genes in natural population of the pest species is a promising field that has to be explored.

c) Use of semiochemicals and pheromones in suppression of key pests like red palm weevil and leaf eating caterpillar.

d) Utilisation of botanical pesticides and exploring the insecticidal properties in the local flora will be a short cut approach in our efforts in building up a sustainable agroecosystem. The probable use of oil cakes in pest management and promoting use of botanical pesticides will have to be undertaken.

e) Attempt on location tolerance/resistance for major pests by screening the coconut germplasm at various centres. This may yield encouraging results in the case of leaf eating caterpillar because a variety having high waxy coating on the epidermis will be a resistant type for the pest.

f) Use of cultural practices and crop mixes in minimising pest incidence. In the case of red palm weevil, coreid bug etc. effect of crown cleaning and sanitation methods of management will be more effective in their management.

g) Need based investigations on management of vertebrate pests in coconut based farming system.

h) Early diagnosis of red palm weevil by electronic devices so that timely curative treatment shall be taken up against this tissue borer pest.

2. Basic studies on bio-ecology of pest.

Simultaneously with the above lines of research on the applied aspects, basic studies also may be undertaken to generate information on the impact of changing ecological conditions and crop management strategies on the bio-ecology of pests on coconut. This area will cover identification of emerging pest problems; working out economic threshold levels, life table studies on pest etc. In India coconut is now occupying sizable areas in the non-traditional belts like Ma dhya Pradesh, Bihar and North eastern States. To identify the pest problem in those areas survey will be undertaken with the collaboration of the respective State Agricultural Universities and other agencies.

To cater the needs of extension and development departments as a whole, establishment of computerised information retrieval system on pests is to be done. This will enable to undertake forecast of pest outbreaks and surveillance of crop loss studies very effectively.

3. Strengthening bio-control programmes

Though currently biological suppression of two major pests viz. rhinoceros beetle and leaf eating caterpillar has been developed and widely practised, further refinement of the technology will be possible through the use of following aspects.

a) Microbial control agents for management of red palm weevil.

Red palm weevil being a tissue borer can be well managed if a potential pathogen could be located. The reports on a nuclear viral infection of the pest by Dangar and Banerjee (1993) and Gopinathan (1993) are suggestive of taking up in depth studies on this aspect.

b) Use of entomophilic nematodes for biological pest suppression of coleopteran pests like red weevil, rhinoceros beetle and root grubs.

c) Use of biocontrol agents for management of vectors of root (wilt) disease and egg pa rasitoids against leaf eating caterpillar.

d) Attempt to improve the strains of biocontrol agents to tide over adverse climatic conditions. This will be more applicable in the case of microbial pathogens currently being used against rhinoceros beetle.

e) Large scale production and wide use of biocontrol agents.

f) Attempt on biological control of newly emerging pests like coreid bug, mealy bugs and scale insects.

4. Training and Demonstration activities

Large scale adoption and popularisation of the IPM technologies already developed are to be taken up in various agrocli-

matic zones including the non-traditional areas. Both short term as well as long term projects are needed for this. An area wise operation that will ensure the active involvement of entire farmers in the operational area is highly imperative. For this purpose action plan will be worked out in collaboration with various funding and implementing agencies. Probably a net work of national demonstration programme will be more feasible and fruitful.

For the immediate five years the thrust areas identified are the following :-

a) Use of newer pesticidal formulations including bio-pesticides and better application technologies to make pesticidal application more ecofriendly to fit in a sustainable agricultural system.

b) Use of pheromones and attractants in pest management, particularly coleopteran pests like red palm weevil and root grubs.

c) Assessment of pesticide residues in coconut products after application at recommended doses.

d) Large scale demonstrations on the use of promising biocontrol agents in the IPM schedule especially against rhinoceros beetle and leaf eating caterpillar.

e) Exploring the probable use of new types of bioagents like entomophilic nematodes for pests like red palm weevil and rhinoceros beetle.

f) Developing an early detection device for the red palm weevil.

The above programmes will be undertaken with the financial and technical collaboration of national and international agencies. For the implementation and area wise operation the involvement of regional agencies from both governmental and non-governmental agencies like KVK will be sought.

C. NEMATODES

Nematode fauna reported on coconut consists of 78 species belonging to 56 genera. In India the more serious nematode on coconut is the burrowing nematode *Radopholus similis* (Cobb, 1893; Thorne 1949). Infestation by *R. similis* on coconut results in general yellowing of foliage, reduction in growth and vigour, delay in flowering and reduction in yield that can be attributed to lack of nutrition and drought effect experienced as a result of loss in root system. In a perennial crop like coconut having a massive root system chemical control of the nematodes by nematicides is not practical. Therefore, integrated nematode management programme utilising organic amendments, biocontrol agents like fungi or bacteria and cultural practices have been proved to be feasible.

The nematological programme for the next two decades therefore shall be oriented towards developing an effective integrated nematode management schedule using biocontrol agents, organic farming and adjustment in crop environment through modified crop combinations and cultural practices.

The thrust areas includes :-

1) Screening of coconut germplasm for juvenile susceptibility and adult resistance.

2) Demonstration on the management of burrowing nematode through bio-control agents and soil amendments.

3) Popularisation of green manure crops suitable for coconut gardens with a view to promote antagonistic soil nematode fauna that can combat plant parasitic nematodes.

The probable association of aerial nematodes in the incidence of leaf rot disease of coconut palms requires a thorough investigation. Hence identifications of the nematodes associated with the malady, their exact role in the disease complex and proper management strategies will form a topic for immediate interest in nematological programmes.

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