Integrated Disease Management in Coconut

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1. Introduction

It is known that intensive agriculture is possible only with organised plant protection measures as a factor contributory to high yields. The annual losses due to pests and diseases in many of the crops are some times as high as 20-30 percent of the total yield. The incidence of these pests and diseases depends on many factors viz; weather/climate, agro-ecology, variety of the crop, prevalence of parasite/predators/pathogen or antagonistic organisms, etc. and thus the damage may vary from year to year. Hence the importance of plant protection in minimising these losses as a measure for increasing the production need not be over emphasized.

Till very recent times the prime role in plant protection was taken by chemicals for eliminating the potential losses due to pests/diseases. This had heralded an era of use of a variety of synthetic organic pesticides. The current plant protection strategies are largely pesticides based. It is a recognised fact that pesticides viz; insecticides, fungicides and weedicides have a pride of place in increasing the agricultural production. The relatively high effectiveness, versatality, simplicity in use and availability of these pesticides led to a boom in their use for plant protection. However, gradually, people started realising the adverse effects of massive and often non judicious application of pesticides. Thus, reports of pesticides accumulation in the soil, water bodies and living organisms and the emergence of resistant populations of pests/pathogens, etc. started pouring in. In addition, there was a potential threat to public health and unforeseen consequences including genetic effects. Further, the exorbitant cost of pesticides and increasing labour charges for pesticide application discouraged farmers from using them.

Integrated disease management is defined as an approach which attempts to use all known viable methods in a compatible manner for reducing plant diseases/pathogens of a crop in a field so that their levels below the economic threshold is maintained and the least damage is done to the environment and ecosystem.

It is now globally recognised that the most effective and acceptable plant protection methods from the view point of preservation of the environment are the integrated methods. They provide not only for the destruction of the pathogens, but also for long term maintenance of the complex of harmful organisms at a safe level with minimum adverse consequence for the environment. Thus, this method will not only spare but even stimulate the activity of useful organisms.

The process involves one or several control procedures frequently; it does not try to eradicate a pathogen/pest completely, but to regulate it. This in fact is restoring the balance of nature.

Integrated disease management (IDM) aims at providing a sound scientific basis for the many measures adopted to protect the crops from harmful pests/diseases. It requires a close linkage of scientific research and practical plant protection.

2. The Need for IDM in Coconut

The influences of pests/diseases in coconut have ranged from major catastrophes to minor threats in many countries. The cadang-cadang disease of coconut in the Philippines, the lethal yellowing disease in Jamaica, Nigeria, etc, the root (wilt) disease in Kerala, the fatal wilt (Heart rot) in Trinidad, Cuba etc., the red-ring disease in Caribbean area, Mexico and the leaf scorch decline in Sri Lanka are some of the examples which have strewn calamity in the region where they occur. It is estimated that root(wilt) caused an annual loss of 968 million nuts (1985 survey). Thus, the incidence of a disease can be devastating on a large scale or in a small area or in an entire garden. The cultivators no doubt will attempt to suppress them, resulting in success or failure.

In a crop like coconut, the land is committed to the crop for a long period. Coupled with this, adoption of monocropping system provides the pathogen with a substrate that is continuous in both space and time. In addition to this, with the intention of increasing

production per unit area, many modern agricultural practices are being followed, which at times result in higher incidence of pests or diseases. In coconut, control measures of various kinds are known for tackling some of the major diseases. With a view to managing these diseases, the efficient methods are to be integrated in a manner to derive greater benefit.

Multiple cropping in coconut has been in vogue in Kerala for a long time. This has its attendant advantages and disadvantages. The incidence of pests or diseases might increase or decrease as per the situations. In such cases, also the integrated management is necessary so that the disease or pest is tackled or kept at a low level not only in the main crop, but also in the subsidiary crop in the cropping system. The management measures also call for a need to understand the compatibility of the various chemicals applied vis-a-vis the pests/diseases involved and also the bioagents used in the management system. When we are just entering the 21st century and when the planters, scientists and politicians opt for sustainable agriculture devoid of the use of hazardous chemicals to alleviate the environmental pollution, adoption of the integrated pests and disease management is all the more relevant.

3. Operation of IDM in Coconut

The basic aim of IDM is to minimise the losses caused by diseases in coconut and coconut based cropping systems. The tools employed for this purpose are many and interrelated. It is to be remembered that IDM is not an entity by itself; rather it is a part of an overall crop production system, with the aim of minimising inputs to maximise the net return.

Accordingly, a plant protection specialist should have a thorough knowledge of the crop management, pathogen, environment and the use of his knowledge on the array of control measures available.

The factors involved in developing and operating meaningful disease management programmes are many. These factors should be applied in such a way that they may reduce/delay the disease/pest and also decrease the rate of spread during the growing period of the crop. IDM will be most successful if executed in a comprehensive manner during all phases of crop production. The important factors to be kept in mind in the operation of IDM programmes are:

3.1 Identity of the disease

Correct diagnosis of the disease is absolutely important in arriving at the IDM schedules to be adopted. Mistaken identity of a disease may result in havoc and invite the results of management efforts. For example, attacks by mites in areca seedlings may be mistaken for drought effect or nitrogen deficiency; bud rot symptoms in coconut nursery at times may be mistaken for rhinoceros/ red palm weevil attack and vice versa. Symptoms due to nematodes are often confused for nutrient imbalances.

3.2 Basic biological-ecological studies

Knowledge of basic epidemiological factors of a disease is essential to gain an insight into the interaction of the disease with the ecosystem in which it thrives. This will help in getting information about the reasons for the build up of inoculum or spread of a disease. An understanding of these will be helpful in manipulating the factors responsible for the disease inoculum increase with a view to preventing the disease from becoming an epidemic. The knowledge on the epidemiology of *Ganoderma* is helpful in knowing the mode of infection, spread, etc. and how this can be tackled.

3.3 Crop loss assessment

Crop loss information is essential to determine the threshold for each disease so that it enables one to decide when to take up the control measures. The cost of control measures vis-a-vis the benefit from the intended control measures should also be worked out with a view to deciding the selection of the best management measures.

In coconut, surveys have been conducted in the case of root(wilt) disease in Kerala, crown choke disease in Assam, Tatipaka disease in Andhra Pradesh and Thanjavur wilt in Tamil Nadu, a few years ago.

3.4 Controlled use of pesticides

The pesticides should be used judiciously so that their use does not have any deleterious effect on the ecosystem or does not lead to the development or resistance to pesticides in the pathogen. The impact of pesticide on natural enemies should also be studied so that their natural multiplication in the ecosystem may not be curtailed. Development of resistance in pests due to indiscriminate use of pesticides has been reported in crops like cotton. Continuous use of Metalaxyl is reported to lead to the development of resistance in *Phytophthora* species. The health hazards, environmental pollution, suppression of beneficial organisms etc. also have been reported. The effect of various pesticides on other organisms (beneficial and harmful) are also to be studied. The compatibility of pesticidal formulations and beneficial microbial agents including entomophilic nematodes is to be well understood. Hence the selection of chemicals and their dose must be done with great care so that in an integrated system the use of chemicals should be judicious so

as not to upset the balance of nature drastically.

3.5 Information on the role of biocontrol agents

An indepth knowledge of the role of various microorganisms acting as antagonists to pathogens, is essential for their effective employment in the IDM programme.

In coconut, information is available on the use of antagonistic microorganisms like *Gliocladium virens, Trichoderma* spp., actinomycetes, etc. against the Stem bleeding/Thanjavur wilt diseases. Similarly, biocontrol agents are also known in the case of plant pathogenic nematodes. Various green plants or their extracts are known to have antimicrobial activities. Among the large number of plants tested, a few have been found to have fungicidal/ fungistatic property against *Phytophthora palmivora* or *Thielaviopsis paradoxa*. In pests and nematodes also similar information is available. *Glyricidia* leaves have been found to suppress population of *Radopholus similis* in coconut roots and soil. Leaf extracts of *Ricinus communis* caused the highest reduction in hatching the eggs of *Meloidogyne incognita*.

3.6 Use of quarantine procedures

This is obviously an important component in the IDM programme. It requires coordination at national and international levels. In coconut, sporadic cases of incidence of root(wilt) disease has been recorded in north Kerala in Iritty/Irikkur areas in Kannur district. The seedlings have been transported from southern Kerala decades ago by some enterprising settlers. This has resulted in the accidental introduction of RWD.

3.7 Physical factors

Basic information on factors like atmospheric humidity, soil moisture, soil and ambient temperature etc. is essential for understanding the effect of these factors on the incidence of diseases. Quantification of environmental influences on diseases will enable us to develop precise methods of predicting the disease development.

For a monocyclic pathogen the effect of environment on the multiplication and increase in population is realised just once during the season. However, this is realised more frequently for a polycyclic pathogen. Consequently, when other things are equal, the magnitude of environmental effect on disease development within a single season is greater for disease induced by polycyclic pathogens (Eg. Phytophthora diseases) than for those induced by monocyclic pathogens.

3.8 Cultural manipulation

Cultural practices, which include all manipulations necessary in crop production, can be modified to help suppress the rate of epidemic development. They also help to repel pests or vectors. Such cultural practices include modification of crop canopy, alteration of irrigation mode, frequency, its modification in the application of various nutrients, manipulation of light intensity, etc. In the case of *Ganoderma* wilt, digging trenches around the diseased palms helps in isolating such palms to avoid contact between roots of healthy and diseased palms. At the same time, intercultural operations are discouraged since they may result in root injury which favours entry of the pathogen. It may also favour dispersal of the fungal inoculum. Similarly flood irrigation is discouraged since fungal propagules could be distributed through flowing water.

When plants are deprived of required nutrients, they become weak, exhibiting symptoms. For eg. boron deficiency causing crown choke symptoms in coconut. Often nutrient deficient plants are susceptible to certain diseases. Coconut palms deficient in K a more susceptible to leaf sp caused by *Pestalotia palmarum* Addition of organic amendment like neem cake, etc. has bee found to be very useful in enhan ing microflora in the soil antag nistic to stem bleeding Ganoderma wilt and Basal ste rot pathogens.

Raising banana as an intercro in coconut garden is reported t help in checking the basal stem r disease in Tamil Nadu. It has bee found that banana rhizome roots, etc. contain certain inhib tive principles against *Ganode ma*, the causative agent of bas stem rot(Thanjavur wilt.)

3.9 Phytosanitation

It is the process that reduce excludes or eliminates the initia pest population/primary funga inoculum by the distruction of in fected plant parts, the impact it has on IDM is great. Cuttin and burning two to three severel infested lower whorls of leaves i the case of leaf eating caterpilla or eradication of root(wilt) di eased palms from mildly affecte tracts, Destruction of coconu stumps showing *Ganoderm* brackets etc. are beneficial in a resting their further spread. Re moval of palms which are dea due to bud rot disease, and th destruction of the crown by burn ing will not only help in reducin the primary inoculum o *Phytophthora*, but also will elimi nate breeding of pests like re palm weevil/rhinoceros beetle.

3.10 Development of resistant/tolerant lines

Use of resistant/tolerant plan species is one of the most attractive approaches of long term nature. Thei use involves no action from the par of the farmer during the growing pe riod as far as the incidence of pests diseases is concerned. Avoid the use of chemical pesticides, and it does not disturb the environment and is gen erally compatible with other manage

ment techniques. Magnitude of resistance can range from small to very large.

In the case of coconut, screening for resistance has been initiated in recent years against major diseases and pests in various countries. A comprehensive breeding programme for evolving root(wilt) resistant/tolerant lines is being implemented in CPCRI. It was observed that in the disease endemic areas (hot spots) in southern districts of Kerala, disease free palms could be located in the midst of highly disease-affected palms. Such disease free palms which are more than 35 years old and high yielding (> 80 nuts per year) have been identified. Thus a few WCT and CGD palms which fulfill these qualities have been selected as the base material for the breeding programme.

4. IDM in Coconut and Coconut Based Cropping Systems

Coconut is conventionally grown as a monocrop. However, in recent years, emphasis is given to coconut based cropping/farming systems with a view to obtaining increased income from unit area. In the coconut based cropping/farming systems, different species of crops are grown in a field simultaneously in a sound scientific manner where the different components of agriculture interact favourably at micro and macro-levels in a human-animal-plant ecosystem. Continuous monoculture of genetically similar plants has met with great hazards in the past. In the multicrop system, the component crops have different genetic bases and as such the opportunities for different pathogens/pests to grow and multiply are also different and limited. Now let us examine the various factors involved in disease incidence under coconut based integrated cropping/farming system:

4.1 One pathogen :many resistant crops

Normally, no single pathogen becomes alarmingly serious under the system. This is because of the fact that there is little scope for the pathogen to spread extensively as it would do in a monoculture system, since there are so many non-susceptible crops around. Let us consider a multicropping system under the main crop coconut with coffee, pepper, banana, pineapple, tree spices, etc. as component crops in the interspaces. If coffee is affected by the coffee rust disease, the spread of the disease will be quite slow due to the numerous resistant crop species in between coffee plants as compared to that in a coffee estate where a continuous spread of the susceptible species exists. Similarly, banana acts as a barrier to the spread of *Ganoderma* wilt in a coconut garden mix-cropped with banana, since banana root extract inhibits the growth of *G.lucidum*.

4.2 One pathogen: many susceptible crops

Sometimes it happens that in the multicropping system two or more crops may be susceptible to a pathogenic organism. Thus in a multicropping system involving coconut, cocoa and pepper, *Phytophthorara capsici* infecting black pepper can also infect cocoa. In the case of nematodes like *Radopholus similis* it is seen that the nematode infects coconut/arecanut, pepper and banana in the cropping system. Thus, one has to be very careful in selecting the combinations of crops in the cropping system.

4.3 Shade and humidity

When inter or mixed crops are grown amongst perennials in an unscientific way, they do not receive enough sunlight. Apart from the fact that this might have an adverse effect on the growth of plants, it encourages, in general, disease incidence and spread. High humidity, under such situation adds to the problem. Thus excess shade in black pepper is known to encourage incidence of pollu disease caused by *Colletotrichum necator* and also pollu beetle (*Longitarsus nigripennis*). Hence pepper should be trained on coconut only when it is above 25 years of age so that enough light falls on the vines.

4.4 Irrigation and soil moisture

Integrated farming involves more intensive use of land. Some of the component crops will be receiving irrigation. The resultant build up of moisture affects microbial activity in soil, including that of pathogens.

4.5 Crop residue

In integrated systems, crop residues are formed in a staggered manner and the whole area is rarely fallow at any given time. Crop residues, besides adding organic matter to the soil, enhance the multiplication of some beneficial micro-organisms. Thus in coconut-cocoa system, the litter thrown by cocoa leaves is found to favour the growth of the nitrogen fixers and the beneficial *Arbuscular mycorrhizal* fungi (AMF)

In root (wilt) affected areas, mixed cropping involving coconut and cocoa has been found to give not only higher yields but also helped in slowing down the decline of the palms.

Crop residues can also be detrimental. It is often noticed that when ginger is grown continuously for some years in a location, severe incidence of soft rot disease occurs. Thus one has to be careful in selecting the component crops in the system.

4.6 Beneficial microorganisms

It has already been stated that activity of soil micro-organisms is more in a multicropping system. This includes beneficial micro-or-

ganisms like antagonists, AMF, etc. AMF, in addition to helping in the uptake of nutrients like Phosphorous, has also been reported in a few cases to help in the control of soil borne diseases. Preliminary investigations show that healthy coconut roots had more AMF colonization than stem bleeding affected palms.

5. Points for Consideration While Practicing IDM

5.1 To maintain vigilance on the movement of pests and pathogens from one State to another, a scheme for inter-state surveillance should be started. Quarantine procedures should be strictly adhered to prevent introduction and spread of pests and diseases from one State or Country to another.

5.2 Interstate and international information exchange system on pests and diseases surveillance, crop losses, etc. to be made efficient and be reviewed and updated from time to time.

5.3 Planting materials supplied to the farmers must be free from pests/diseases/nematodes. Proper care should be taken to supply healthy seedlings from healthy nurseries. Otherwise, alongwith the seedlings, the disease/pest will be transported from one locality to another. Prevention is better than cure is the dictum.

5.4 In developing integrated disease management, cropping systems in a locality should be given adequate consideration. In other words, location specific strategies should be developed based on the cropping system.

5.5 Biological control centres should be set up in more centres in different parts of the country to intensify studies on biocontrol of pests/diseases/nematodes. At least one laboratory should be established in each district to multiply the biocontrol agents and supply to the needy farmers. These labs should function under the umbrella of CPCRI which promotes coconut research. Studies on location specific efficient antagonists against diseases may be taken up and intensified.

5.6 More low cost technologies involving non-chemical methods or environmental friendly methods should be developed so as to make them adoptable by small and marginal farmers.

5.7 Research on delivery system of chemicals in the control of diseases of palms need to be intensified. New plant protection equipments for pesticide application to coconut may be developed. So efficient and practical methods of applying systemic pesticides in coconut may also be developed.

5.8 To ensure quality pesticides, a cell should be established in each district. It should be the responsibility of the cell to monitor the quality of various plant protection chemicals (pp) distributed/sold to the growers.

5.9 While developing newer pp chemicals, information should be available not only on their effect on various pests/diseases causing organisms, but also on the beneficial fauna/flora like parasites, predators, antagonistic organisms, AMF etc. It is also essential to have information on the effect of new chemicals on various pests/diseases/nematodes.

5.10 Because of the growing concern for the environmental protection/conservation and also for human health, it is necessary to reduce/rationalise the use of chemical pesticides. The use of biocontrol agents, and products of plant origin in the IPM programme has given good results in many cases. It is important that wherever the use of pesticide is unavoidable, constant monitoring of pesticide residue should be taken up both in the plant tissues and in the ecosystem. Pesticide Residue Testing Centres should be established on a priority basis for crops like coconut.

5.11 In all pest and disease surveillance programmes implemented in the States, an active collaboration of plant protection scientists in ICAR institutes, Agricultural Universities, State Agriculture Departments and Development Board is necessary.

5.12 Extension workers should be invited for technical seminars organised by ICAR Institutes, Agricultural Universities etc. so that they are kept abreast of the latest development in integrated pest/disease management and also can provide feed back information.

6. Conclusion

Crop losses due to diseases of coconut occur in various proportions in different parts of India. In recent years the pattern of the cropping system in coconut has also undergone changes. The incidence of disease in different cropping systems may differ due to various factors. Different methods of control of diseases are available. Each may have its own advantages or disadvantages. The defects/difficulties in implementing biocontrol programmes should not discourage the worker since natural biocontrol with antagonistic microorganisms is ever in progress in nature. Hence one should strive to get more and more efficient biocontrol agents, screen them against various diseases so that the efficient ones can be used in successful IDM programmes. Side by side breeding for resistance/tolerance to various diseases should also get priority. Thus, not withstanding the limitations of one kind or another individual method of control, an integrated approach amalgamating all or a few efficient suitable methods will be the most effective and practical way of keeping the diseases of coconut below the economic threshold level. When we are at the portals of a new century of great expectations of sustainable agriculture, the integrated management of disease problems is all the more relevant.