Bulletin of the Rubber Research Institute of Sri Lanka, (2006) **47**, 44-50

PESTICIDES USED IN RUBBER CULTIVATION AND PRECAUTIONS ON HANDLING

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SUMMARY

Pesticides used in rubber growing are hazardous having acute or chronic toxic effects on humans due to single or multiple exposures. Protective pesticides prevent establishment of pests or pathogens while eradicants kill or inhibit such organisms that are already established on rubber. The most effective systemics are taken up by plants and directed to the targets enabling use of low doses. They interrupt sterols or nucleic acid formation killing the pathogen. Preventing user's exposure to pesticides is important using protective wearing. Careful storage of pesticides is equally important to avoid accidental exposures by workers.

Key words: chemical control, diseases, *Hevea brasiliensis*, pests

INTRODUCTION

Use of pesticides evoked early days since our ancestors used to spread mud and dust over the skin to repel biting and ticking insects, resembling pigs, elephants and buffaloes similarly protecting their skin. In addition, use of extracts of pepper, tobacco, hot water, soapy water, vinegar, turpentine, fish oil etc were used as insecticides in the history. Thereafter, many effective substances have been developed and today, there are broad spectrum highly toxic insecticides, which persist on leaves for long periods.

Modern pesticides are notorious chemicals that kill or suppress the development of agricultural pests, pathogens or weeds. They are insecticides, herbicides, fungicides, bactericides, avicides, nematicides, molluscicides, rodenticides, defoliants, fumigants and repellents etc. They are harmful to the users and to the environment causing acute and/or chronic toxic effect to humans. The acute effect is more readily comprehensible to the user, shortly after contact with a single dose of a poison. The magnitude of the poisonous effect depends on the innate toxicity of the substances in pesticide and upon its method of application. A chronic effect exerts when a user has been repeatedly exposed to harmful substance, resulting lung cancer, brain damage, and necrosis of the liver or kidney (Hassall, 1990).

Pesticide groups according to the uptake and movement in plants

Pesticides which are available in the market can be systemic or contact types which have differences on uptake and mobility within plants. Systemics are absorbed to the plant through the upper layer and move across leaves to growing buds and affect the target. However, contact pesticides such as inorganic forms, directly affect the pathogen established on the surface of organs.

Systemic pesticides have eradicant properties inhibiting the progress of infections and also have therapeutic properties curing plant diseases. They are effective with very low concentrations and therefore, they shall not necessarily be applied on to the target, since, they are easily taken up and translocated within the plant. More often systemic pesticides are effective in controlling pests or diseases on young leaves, since, they move along with water and accumulate in tender leaves.

Pesticide groups according to their mode of action on targets

Simple inorganic to complex organic compounds which are available in the market are effective on rubber diseases. They are sulphur (inhibition of spore germination), copper-sulphate, Cupric-hydroxide, Copper-oxychloride, dithiocarbamates, mancozeb, maneb, etc. However, the most successful and effective fungicides inhibit the biosynthesis of sterols subsequently killing pathogens. Propiconazole, trideminol, hexaconazole, tebuconazole used in rubber plantations to control white root disease, and pink disease have this effect. There are tubulin biosynthesis inhibitors such as benzimidazoles (Benomyl, Carbendazim, Thiabendazole) which are effective against *Botriodiplodia theobromae* and *Fusarium solani* causing shoot die-back and root infections of young rubber plants. In addition, nucleic acid biosynthesis inhibitors are important fungicides. Metalaxyl is one of the members of this group and it has been used in rubber plantations to prevent *Phytophthora* infections on tapping panel. Inhibitors of chitin biosynthesis are very effective against organisms in which chitin is the major component of cell walls, *i.e.* Fungi belonging to Ascomycetes, Deuteromycetes and Basidiomycetes. However application of these chemicals to control *Phytophthora* has no effect since in cell walls of *Phytophthora*, cellulose is the major building material.

Why and how to protect the rubber plant?

Protecting leaves and above ground parts of the rubber is important especially in disease conducive climatic conditions, since, diseases reduce or weaken the plant's growth rate. What are the usually used protectant forms of pesticides in rubber cultivation? They are to protect or prevent possible leaf infections in young plants in nurseries and bark infections during the wet or epidemic periods. The application of Dithane or Captan for nurseries and "Brunolinum Plantarium", Mancozeb MZ, Metalaxyl or other related chemicals on tapping panels during the wet or epidemics are examples. Polyphenolic tar or systemic fungicides contained therein prevent the pathogen establishing on bark tissues. Pathogens such as *Oidium hevea*, grow externally on leaves and non-penetrating soluble or wettable sulphur may be effective

as protectants. Preparations such as Super guard, Kumulus, Sulphur, Thiovit, Haymite, Morisal, Survisal and Macksul can be prepared as 50% wettable powder.

Enhancing penetration and absorption of pesticides

Pesticides penetrate into leaves or aerial parts of the plant through the cuticular membrane or bark consisting suberin (on roots), cork material (on stem), wax, cutin and cellulos and plasmalemma subsequently entering the protoplasm and move downward along the phloem using metabolic energy. Using this mechanism, low doses of systemic fungicides may be applied on foliage to control the white root disease of young rubber plants. However, their translocation may be confined to certain tissues and hence, re-application may be required for a complete cure.

Movements of triazoles in plants have been confirmed by Mayer *et al.* (1970) and this has led the treatment against white root disease on rubber using tridemephon (Baylaton WP), triadimenol (Bayfidan EC), hexaconazol (Contaf or Folicur) and propiconazole (Tilt). Eradicants are used to cure established diseases or pests outbreaks. Application of fungicides to cure fungal infections such as *Colletotrichum* on young field plants would be an example. However, studies of the Department of Plant Pathology & Microbiology revealed that the downward movement of a systemic along lateral roots was poor (unpublished results) although an effect on the point and on the surrounding area towards upward direction was evident.

Since cork material or wax is water proof, when applying fungicides on stem or collar area of rubber tree, better results may be obtained if cork layer is carefully removed by scraping off the thick cork layer surrounding and just above the collar region. The permeability of pesticides or other water soluble materials through the cuticle matrix depends on the degree of imbibitions of the matrix due to availability or transpiration/ loss of water from the particular tissue. Due to high water loss during the day time, the cuticular matrix curtails passing through any substances. The uptake *via* roots is mediated by transpiration stream *via* xylem vessels and solutes entering the root may be diluted due to the mass flow of the stream. Hence, accumulation does not occur in such instances. Therefore, the pesticide should be applied during early hours of the day to ensure higher absorption and better distribution to targets.

Use of sulphur on rubber

Sulphur restricts the growth of the pathogen, thereby preventing infections. It also ails their respiration through its reduction products (H_2S) disrupting proteins and forming complex molecules with heavy metals within the mycelia. Sulphur has selectivity against the *Oidium hevea* causing the *Oidium* leaf fall disease of rubber which is attributed to their unique and exposed growth habit or to possible uptake by the lipid layer of conidia (Hewitt, 1998). Sulphur is also used against spider mites on rubber. The inhalation of sulphur dust would affect lungs if precautions are not taken when applying.

Use of copper compounds on rubber

Copper, at first, was used as copper sulphate to control *Tilletia grisea* in wheat. Thereafter, it was used as a mixture with lime to discourage the theft of grapes which was later found as "Bordeaux mixture" which is also effective against *C. gloeosporioides* and *Corticium salmonicolor* (Pink disease) infection on young rubber. Although it has been recommended as a cheap and effective fungicide to control rubber nursery diseases in wet periods, it is not in use due to availability of ready-made alternatives. In addition, copper hydroxide and copper-oxychloride are equally effective if applied singly or in combination with systemics. They are recommended for application against *C. gloeosporioides*, or *Phytophthora* infections on young rubber plants especially in nurseries.

Use of complex organic substances on rubber

Dithiocarbomate fungicides probably had greater popularity and use than all other fungicides combined. Except for systemic action, they are employed collectively in broad spectrum preparations for foliar, soil and seed applications. These chemicals are metabolized to iso-thiocyanate radicals, which inactivate the sulphydril (-HS) groups of amino acids contained in pathogen's cells (Ware & Whiteacre, 2004). The most common member from this family used in rubber plantations is mancozeb, which comes under different trade names such as Dithane M 45, Biltox, mancozeb, manzate, Unithane or Vondozeb.

Phthalimides were very popular foliage protectant fungicides used as dusts and sprays. They were the safest of all pesticides available and recommended for routine application (Ware & Whiteacre, 2004). Captan and Folpet control a wide range of pathogens and in rubber nurseries Captan has been used to control common leaf diseases. They react with sulphydryl groups of enzymes in pathogens attacking amino groups as well as inhibiting pathogen's enzymes subsequently deactivating it's growth (Hewitt, 1998). However, users should take adequate precautions when handling organic-base fungicide since; there may be a chronic effect on human beings.

Triazoles are class of systemic fungicides having protective and curative effects against pathogenic fungi. They include bitertinol, propiconazole, trideminol, hexaconazole, penconazole, tebuconazole, tetraconazole *etc.* Triademefon and trideminol have also been effective against the white root disease of rubber which are readily absorbed by roots or leaves of rubber and translocated to distal parts exerting curative and eradicative as well as a protective action. Hexaconazole (Contaf) and tebuconazole (Folicur) are very effective systemic fungicides used to control white root disease on rubber. These fungicides contain strong volatile fractions and the users should wear protective clothes and suitable face masks to prevent inhalation of toxic organic vapours. This has to be taken very seriously since most of the filters of face masks used by workers are not up to the standards and proper types. The masks should be equipped with appropriate single or dual filter cartridges with colour bands as per norms, preventing organic vapour inhalation, but not the dust mask. The gloves

should also be the ideal type (chemical resistant. nitrile) without leaks and should be discarded after use. Reusing gloves can cause serious health hazards to users.

Pesticides used in rubber cultivation

Dimethoate is effective as contact and systemic insecticide against a wide range of sucking and leaf feeding insects. mites and flies. Carbofuran and chlorophyriphos are having insecticidal and nematicidal properties effective as a contact or stomach poison. It is applicable to soil, but broadcasting carbofuran may kill useful earthworms. Carbofuran does not persist in plant for a long period, but when applied to soil, plant may absorb the chemical over a several weeks providing control of sucking and many plant feeding arthropods. However, when applying in to planting holes of young rubber plants to prevent grub infestation, care should be taken not to add excessive amounts into holes, to prevent adverse effect on emerging young root system. It has a moderate toxicity level in contrast to the other similar substances. However, users of these two types should wear protective clothing and organic vapour masks.

Pesticide forms, additives and application

Pesticides are more often applied as aqueous solutions or suspensions and these spraying methods usually use large volumes as 10 litres per ha. However following advanced machinery and Ultra-Low-Volume techniques this amount may be reduced to less than 4 litres per ha. Pesticides are produced as wettable powder (WP) or emulsifiable concentrated (EC) liquids. WP's are solids including clay or diatomaceous earth as filers that disperse in water, while EC's are oil-based water soluble formulations. Particles in WP are 1-10 μm diameters and the active ingredient normally remains strongly adsorbed on the filler and therefore the handlers should be extremely careful not to inhale the dust by wearing suitable dust masks.

Supplements such as stickers are added to spraying formulations to increase the time of droplet retention on leaves to increase the efficiency of the pesticide. Casein, flour, oils, gelatine, gums, resins and synthetic polymers serve as stickers. Stabilizers enable the mixture to be heterogeneous in the tank. Spreading or wetting agents or humectants reduce the surface tension of the solution enabling better spread on waxy surface of leaves. Tween (a polyoxyethylene sorbitan monopalmitate) is one of the best structures among various sorbitol anhydrites. Penetration of woolly material produced by aphids. require more time to retain on the surface until the chemical penetrates the woolly material. Synergists or activators are added to formulations to activate some toxicants to be more poisonous.

Chemical substances having volatile toxic effect against pests or pathogenic fungi are known as fumigants and the vaporized active ingredient is applied to the target site. The advantage of using this technique is that the vapour form of pesticides easily penetrates to target sites such as soil or other media constituting a homogeneous gaseous phase. Therefore to increase the effect. this application should perform in an enclosed place. One example is methyl bromide that had been used in

agriculture to control some root diseases and pest infestations. In the field, the fumigant had been applied deep into ploughed soil by aggregates and the vapour trapped by using a thick polythen sheet. Tea growers earlier used to fumigate nursery soils with methyl bromide against soil borne pests such as nematodes and subsequently since its ban, an alternative called "Metham-Sodium" or "Vapam®" has been introduced. It has been used world-wide to control numerous soil-borne fungal diseases, nematodes, germinating weed seeds and insects. Once it is added to the moist soil, methyl-isothiocyanate (MITC) is formed (Nufarm Metham User Guide) and released into the soil. This MITC vapour is effective against the above organisms. Efforts have been made to explore the possibility of using this fumigant to eradicate the white root disease pathogen on old rubber logs to minimize the disease incidence. However, again the health hazard should be noted as MITC is a toxic vapour and can enter human body through inhalation, skin or oral exposure.

Pesticide powders are usually made by evaporating the solvent of the concentrated pesticide solution. As the particle sizes are produced at an average range of 3-30 or up to 50 μm diameter to be highly effective, they are also an inhalation hazard. It has been noticed that not more than 10-20 % of the applied material normally adheres to dry foliage, although retention is much improved if the dust is applied when the foliage is damped with dew (Hassall, 1990). Therefore those who are handling them should be careful to wear suitable face masks. Granules are a convenient and efficient form of pesticides which are produced to minimize the wastage of the active ingredient and avoid the possible phytotoxicity.

Strategies on using pesticides to prevent building up resistance by target organisms

Although these pesticides are highly effective, building up resistance by pathogens against them is one of the most important phenomenons to be discussed, since, the continuous use of a pesticide against a single pathogen or pest leads to building up of resistance by the target organisms. Resistance to fungicides may occur as a result of genetic changes in the fungal mycelium although non-genetic changes may also give same results. Therefore, to minimize such instances, it is recommended to use pesticides alternatively in prolonged use. In rubber nurseries, it is also recommended to alternatively use phthalimides including a copper base one to control leaf diseases. In evolution, nothing can be regarded as impossible provided conducive environmental circumstances. The asexual or epidemic growth stage of most plant pathogens are haploid, and therefore, mutations are expressed easily. However, in Oomycetes, such as *Phytophthora* spp., this may be exceptional.

Precautions on application

Precisely, those who handle pesticides should be suitably trained for the particular task to minimize risks of self contamination and risks on others. Irrespective of the competence of the handler, proper clothing should be worn till the operation is over. In Sri Lanka, very few storage depots are available in some rubber and tea estates, but how far they are safe enough to the environment are not known.

When spraying herbicides, most of users do not wear protective clothing and proper face masks, but instead only use dust masks, which are not suitable at all for the purpose itself. If not wearing gum-boots, bare skin get contacted with the chemical sprayed onto weeds. To avoid skin contamination with sprayed chemicals, the worker should be educated to adopt the ideal way of applying the chemical without spraying on to the path in front of the user. Disposal of empty containers is an important aspect that should draw more attention by the users. Empty containers should be rinsed thoroughly with water and added to the tank before disposal of the container. All the other normal precautions are equally important when handling noxious chemicals and it is always a good thing to think about the other living beings and the environment before using toxicants.

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