Plant Protection Code for Large Cardamom

Policy on usage of Plant Protection Formulations in Large Cardamom Plantations in India

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FOREWORD

Cultivated in the sub Himalayan tracts in the North Eastern India, Large Cardamom (*Amomum subulatum*Roxb) is one of the main cash crops of the region and has extensively been used by the food and beverage sector. Large Cardamom is also used for its medicinal properties such as 'hypnotic, appetizer, astringent to bowels, tonic to heart and liver 'in the Ayurvedic and Unani systems of medicine.

Traditionally cultivated as an agro-forestry crop mainly in Sikkim and Darjeeling district of West Bengal, there has been a shift in the recent years. Large Cardamom has made its way in to the nontraditional areas such as Arunachal Pradesh, Manipur and Nagaland using traditional practices. With the expansion of area under cultivation, it is important to have concrete guidelines for cultivation of Large Cardamom, for obtaining optimum productivity in the most sustainable way while addressing the safety and quality concerns of consumers and other stakeholders.

'The Plant Protection Code (PPC) for Large Cardamom' aims to achieve sustainability in the cardamom ecosystem through Integrated Pest Management (IPM), application and promotion of bio-control agents, and judicious application of plant protection formulations which are in alignment with the rich bio diversity of the Sub Himalayan region. Care has also been taken to ensure that 'the Plant Protection Code for Large Cardamom' addresses the concerns on adverse impact of chemicals on the environment as well as human beings in line with the quality and safety standards put forth by national and international regulators.

I hope, this document will be highly beneficial for the Large Cardamom Industry in reaching further heights through sustainable operations.

(**D.Sathiyan IFS)**
Secretary, Spices Board

PREAMBLE

Following are the guiding principles for Plant Protection Code:

- Plant Protection Formulations (PPFs) are essential pre-requisiteof cultivationof large cardamom for achieving optimum productivity under prevailing conditions in India.

- Plant Protection Codes (PPCs) are aimedto achieve sustainability in agricultural system through an approach inclusive Integrated Pest Management (IPM), application and promotion of bio-control agents, and judicious application of synthetic chemicals in agriculture to gradually reduce the dependence on chemicals in India.

- However being Sikkim is declared as organic state during the year 2016, the usages of synthetic chemical is totally banned. Hence application of bio-control agents is followed by phyto-sanitation for the management of various pests and diseases,but in other North East states, synthetic chemicals can be used.

- PPCs should focus on scientific and responsible approaches of chemical management viz. proper selection, judicious usage, safe storage and proper disposal, occupational health and safety and green chemistry.

- PPCs is committed to reduce the anticipatedadverse impact of pesticides on human being and the environment to as lowest as possible. This can be achieved through a coordinated approach including effective governance, review and monitoring.

In this document the term "PPF" includes all Plant Protection Formulations covering insecticides, fungicides, bio-pesticides etc.

INTRODUCTION

Large cardamom (*Amomum subulatum*Roxb.), a member of the family, Zingiberaceae is the main cash crop cultivated in the sub-Himalayan state of Sikkim and Darjeeling/Kalimpong districts of West Bengal. It is also cultivated in other North Eastern Hill states like Arunachal Pradesh, Nagaland, Manipur, Meghalaya and Assam and in someparts of Uttarakhand.

The large cardamom plant is a perennial herb with subterranean rhizomesand leafy shoots. The climatic conditions of the spice growing regions of India are conducive for a large number of pests, diseases and weeds that needs to be managed below the economic injury levels to avoid huge crop loss. Theusage of chemical pesticides is banned in large cardamomcultivation in Sikkim since the state has beendeclared as organic in January 2016 by Govt. of India. But in other North Eastern states synthetic chemicals can be used as a component in the Integrated Pest Management for effective management of pest and diseases.

Thecrop lossdue to various pests, diseases and weeds is estimated to be approximately around 20-40% of total crop production. In the recent years, there have been continuous efforts to reduce the use of chemicals in agricultural system and to adopt integrated management practices for control of pests, diseases and weeds. The large-scale adoption of the recommended integrated pest management (IPM) approach from the very beginning of the pest season will be most crucial in adequate crop protection besidesensuring food safety.

Under IPM, PPFs are used ***only as a component***instead of as a sole approach. It is always emphasized that pesticides should be used in a judicious way rather than blanket sprays in thefields. Large cardamom is a cross pollinated crop which is pollinated mainly bybumble bees and hence any plant protection measures adopted should not deter the pollinators. A very effective pest monitoring system is required to put in place at the grass-root level to minimize the indiscriminate use of pesticides in areas where large cardamom is cultivated.

CHAPTER 1

PLANT PROTECTION FORMULATIONS USAGE POLICY

1. Spices Board India shall recommend only such Plant Protection Formulations (PPFs) - that have been cleared and registered by the Central Insecticides Board and Registration Committee, Government of India, with label claim on cardamom. Chemical Pesticides are not applicable in Sikkimregion being declared as an organic state.

1.1 Only Spices Board in India is authorized to undertake efficacy and residue trials of new PPFs on large cardamomthat have to be cleared by CIB for other crops.

1.2Indian Cardamom Research Institute, Regional Research Station, Spices Board is authorized to visitlarge cardamom gardens and to take the inventory of PPFs used in each garden for compliance with the approved list mentioned in this document.

1.3The Scientists of ICRI and development officersof Spices Board will ensure that only such PPFs as per Annexure 1 are used for the plant protection in large cardamom plantations. The decision with regard to purchase and application of the PPFs would be decided by the panel of experts, development officials and famers will also attend the meeting.

2. All the large cardamom plantations shall keep the records of usage of PPFs.

3. All large cardamom Plantations should follow IPM for sustainable production.

4. The PPFs should not be used near the water bodies, wildlife habitats and human dwelling to ensure that there is no contamination beyond the application area.

5. There should be designated areas for preparation of spray fluids with clear signage for the workers. These areas must be away from any natural water bodies, drinking water sources, children’s play areas, food stores, clinics and fish ponds.

6. The PPFs must be stored safely and correctly in facilities which are dry, well ventilated and should not be accessible to children and unauthorized people. The storage facility should be away from food and animal feed.

7. Storage areas should display information on hazardous chemicals in a way which is easily understandable for the workers (in a language they can understand or in pictorial formats), including information regarding their classification, the hazards they present and the safety precautions to be observed.

8. There should be provisions for training for plantation workers on safe and appropriate usage of PPFs.

9. The large cardamom plantation unit must regularly maintain and calibrate agrochemical application equipment and keep records of such equipment maintenance and calibration

10. The Plantation unit must have emergency facilities and procedures available in the vicinity of PPFs storage to deal with spillage of PPFs (i.e. sand or sawdust) and with operator

contamination (i.e. clean water). The procedure must indicate basic accident care instructions as well as contain the contact details of the ambulance, nearest hospital and the person trained in first aid.

11. During transportation of plantprotection products, the plantation unit should ensure prevention of spilling and other accidents.

12. Safe interval of application of PPFs should be ensured as per recommendations of the authorized institutes.

13. The spraying procedureand maintenance of spraying equipment should be done as per the advice of ICRI Spices Board.

Annexure: 1

List of approved Plant Protection Formulations for use in Cardamom plantations #

Type of PPFs	Sl. No.	Name of PPFs
Insectcides/Botanicals/ Microbial bio-agents	1	Neem based oil(Azadirachtin0.15% EC) NKAE (Neem Kernal Aqueous Extract) *Metarhiziumanisopliae* WP *Metarhiziumanisopliae* liquid formulation *Beauveria bassiana* WP *Beauveria bassiana*liquid formulation *Bacillus thuringiensis* var. kurstakiSerotype 3a, 3b, SA II WG Spinosad 45 SC
Fungicides/ Microbial bio-agents	2	Copper oxychloride 50% WP Bordeaux mixture 1% *Pseudomonas fluorescens*@ 3-5% *Bacillus subtilis* @3-5% *Trichoderma* spp. @ 1-2%

The above list is dynamic and may change from time to time based on the CIB approved list of pesticides for use in large cardamom and this may be seen from the website of Spices Board.

CHAPTER 2

INTEGRATED PEST AND DISEASE MANAGEMENT IN LARGE CARDAMOM PLANTATIONS

The concept of IPM

Integrated Pest Management (IPM) is a system where all suitable methods and techniques are utilized in a compatible manner to maintain pest incidence at levels below those causing economic loss of crop. An effective IPM strategy needs knowledge of bio-ecology of pests and pathogens, economics of control measures and on the possible adverse effects of pesticides on non target living organisms and environment and human health.

There are various non-chemical strategies also have been established against various pests of large cardamom such as PGPRs, control measuresincludes cultural, biological, physical and mechanical and have been recommended for incorporation with chemical control measures in North East Statesexcept Sikkim since the state declared as organic state and usages of chemical plant protection formulations is banned. These approaches not only control pests effectively but also provide a way for judicious use of chemical pesticides, reduces the harmful effects of chemicals on the environment.To impart a successful IPM programme, it needs the knowledge on:

1. Identification of pests and diseases and time of occurrence
2. Life cycle and biology of the causal organism
3. Site of attack
4. Damage symptoms and sign of pest attack and damage
5. Mode of migration/dispersal
6. Alternate hosts

The concept of integrated pest management (IPM) in large cardamom plantations is in existence since 1985 both in North East region and this has resulted in minimizing the use of toxic agrochemicals.

Elements of IPM

1. Cultural practices:

The incidence of pests and diseases can be reduced to some extent by collecting and destroying the different pests and affected plant parts alsoremoval of weed are important activity which comes under phyto-sanitation need to be carried out as a part of cultural practices. Likewise for large cardamom optimum shade level maintenance is very much essential. Proper nutrition and irrigation management are also plays crucial role for healthy plantation.

1.1 Field sanitation:

Field sanitation an important aspects one need to carry out in order to reduce the incidence of insect pest and disease, in general 2-3 weeding recommended for minimizing the plantation free from weed along with weeding insect and disease affected large cardamom plants and parts also need to be removed from the plantation to reduce the incidence. Around 52 weed species been identified associated with large cardamom in Sikkim condition which may vary with the agro ecological zone where the crop been cultivated. These weeds acts as alternate host to many of the insect pest and diseases associated with large cardamom. *Chirkey* and *Foorkey* are the major viral diseases in large cardamom and removal of affected plants alongwith roots as on when noticed is very much important to eradicate the viral disease.

1.2 Shade management:

Large cardamom is shade loving plants; it grows well under shade of 50-70% which protect the plants from direct exposure to sunlight causing sun scorching of leaves and from frost injury during winter in high elevation plantations. Apart from it, shade tree too some extent protect the crop from hail storm which is the sever problem causing tearing of leaves in large cardamom cultivation in Sikkim during February to May leading to secondary infestation of diseases. Therefore, to avoid these problems to some extent judicious shade management is very important for good growth, timely flowering and for better yield. *Alnusnepalensis* (Utis in Nepali)/ (Taram in Nyishi) is the most common shade tree and Alnus-large cardamom is a most appropriate agro-forestry system for sustainable production in the region. The other species of shade trees are *Terminaliamyriocarpa* (Panisaj), *Bucklandiaspp.* (Pipli), *Macaranga denticulata* (Malato), *Edgeworthiagardneri* (Argeli), *Viburnum erubescens* (Asare), *Maesachisia* (Bilaune), *Symplocostheifolia* (Kharane), *Albizzia lebbeck* (Siris), *Erythrina indica* (Phaledo), *Schimawallichii* (Chilaune) etc.

In case of nursery seedling maintaining the pandals with agro shade net can help to eliminate the damage to some extent in nursery seedlings.

1.3Nutrition management:

Maintaining optimum soil fertility is one of the most important aspects for a good plantation. For producing about 100 kg dry large cardamom, the robust cultivars require (in kg) 10.33 N: 1.95 P: 26.24 K: 19.10 Ca and 11.9 Mg; whereas non robust cultivars like, *DzonguGolsey* removes only about 5.74:0.99:3.54of NPK and 9.18 Ca and5.86 Mg respectively. However, Sikkim being an organic state, the alternate organic fertilizers should be applied to compensate the nutrition requirements. The period of application and quality of organic inputs are very important. Sufficient moisture should be maintained and the organic inputs must be composted well before application.Application of well -decomposed cattle manure/compost/organic products @ 5 kg/plant at least twice a year i;e., in April-May and October- November is

recommended. Vermicompost, having favourable impact on soil physical properties and good source of nutrients, may also be applied @ 1 kg/clump in two equal doses in combination with FYM. Application of mustard cake @ 500 g / plant at least once in two years during April – May is beneficial.

Soils with pH ranging from 5-5.5 and towards neutral are ideal for the growth of large cardamom. Soil needs to be tested for its pH and for very acidic soils lime/dolomite application is warranted. The quantity of lime/dolomite for soil application has to be determined based on the soil tests only.

1.4Irrigation management

Large cardamom plants cannot thrive under water stressed or drought condition also in waterlogged condition. Yield performance is better in plantations where irrigation is given during dry winter. Moreover, blight disease incidence was more prevalent in plants weakened due to low water stress. Watering during November–March is essential to maintain sustainable yield in the plantation.

2. Host plant resistance:

Use of pest and disease tolerant varieties has been one of the most important ways to reduce theincidence of pests anddiseases. Large cardamom being a perennial crop, research on clonal selection and breeding for find out insect pest and disease tolerance/ resistant in progress. This approach is highly effective in bringing down the use of chemical insecticides/pesticides etc.

3. Physical and Mechanical Control:

Manual removaland soilsolarization in the nursery are some most common practices in approaches of physical control to control certain types of insect-pest populations in spices. For example, in case of leaf eating caterpillars and their pupae can be collected manually and destroyed. Soil solarization can be effectively employed to eliminate root knot nematodesin the nursery practices.

4.Biological/ Microbial control

ICRI has carried out studies on biological control of large cardamom root grub with Entomo Pathogenic Fungi (EPF) like *Metarhiziumanisopliae* and *Beauveria bassiana* and with Entomo Pathogenic Nematodes (EPN). It was found that soil drenching with *M. anisopliae* or *B. bassiana*at monthly intervals can also effectively manage the pest compared to EPN. One must keep in mind that the application of pesticides before or after 15 days of imposition bio-agent may not have the effect to reduce beneficial microbes.

5. Botanicals and Other Methods of Control:

Plant products such as Neem (Azadirachtin) oil or NSKE (Neem Seed Kernal Extract)mostly been used for its pesticidal properties are also found to be effective against several pests and pathogens.Growing a row of marigold in the border areas of large cardamom plantations reduces the root knot nematodes attack effectively.

6. Indigenous Technical Knowledge (ITK) for Pest Control in Large Cardamom

Since long back, farmers in Sikkim have been using various indigenous techniques to control a wide range of pests in large cardamom. It includes use of ash, juice of different medicinal plants, leaf extracts etc.

The ants pose a serious threat to plants in large cardamom cultivation by burrowing around plant base also act as vector for mealy bug, which suck cell sap. In such conditions, farmers use warm ash around plant base to control attack of ants. Use of tobacco leaf juice is very common practice for controlling white grub and soil insects. Monkeys have been causing a serious damage in large cardamom plantations, to keep the monkeys away and frighten them, farmers use to hang a bell and rang in between. Timur fruit grind have been used widely to control sucking pests in large cardamom. Application of rotten eggs in base of plants is a regular practice for controlling mammalian pests. The leaf extract of titepati, indreni and chillowneyare quite common to control chewing, sucking and soil borne pests of large cardamom.

6. Traps: Different traps are followed for collection of insects

6.1 **Yellow/blue pan water/ sticky traps:** Set up yellow pan water/sticky traps 15 cm above the canopy for monitoring aphids and blue pan water/sticky trap for thrips @ 4-5 traps/acre. Locally available empty tins can be painted yellow/blue and coated with grease/Vaseline/castor oil on outer surface may also be used.

6.2 **Light traps:** Set up light traps @ 1 trap/acre 15 cm above the crop canopy for monitoring and mass trapping insects. Light traps with exit option for natural enemies of smaller size should be installed and operate around the dusk time (6 pm to 10 pm) to trap adult white grub during April- May.

6.3 **Fish meal traps:** Fish meal trap found promising to trap the Dipteran insects. It must be installed during Oct-Nov or towards the end of the monsoon. Six to seven traps are required per acre. Traps are to be cleaned and re-installed once in 45-60 days till May.

7. **Ecological engineering for pest management**

Ecological engineering for pest management has recently emerged as a paradigm for considering pest management approaches that rely on the use of cultural techniques to effect habitat manipulating and to enhance biological control. Ecological engineering for pestmanagement is based on informed ecological knowledge rather than high technology approaches such as synthetic pesticides and genetically engineered crops.

7.1**Ecological Engineering for pest management – Below ground**

There is a growing realization that the soil borne, seed and seedling borne diseases can be managed with microbial interventions, besides choosing appropriate plant varieties. The following activities increase the beneficial microbial population and enhance soil fertility.

- Keep soils covered year-round with living vegetation and/or crop residue.

- Add organic matter in the form of farm yard manure (FYM), vermicompost, crop residue which enhance below ground biodiversity of beneficial microbes and insects.
- Application of balanced dose of nutrients using biofertilizers based on soil test report.
- Application of biofertilizers with special focus on mycorrhiza and plant growth promoting rhizobia (PGPR)
- Application of *Trichoderma harzianum/ viride*and *Pseudomonas fluorescens* for treatment of seed/seedling/planting materials in the nurseries and field application (if commercial products are used, check for label claim. However, biopesticides produced by farmers for own consumption in their fields, registration is not required).

7.2**Ecological Engineering for Pest Management – Above Ground:**

Natural enemies play a very significant role in control of foliar insect pests. Natural enemy diversity contributes significantly to management of insect pests of above ground so, natural enemies conservation an important aspects under ecological engineering. Natural enemies require

- Food in the form of pollen and nectar
- Shelter, overwintering sites and moderate microclimate, etc.
- Alternate hosts when primary hosts are not present.

In order to attract natural enemies following activities should be practiced:

- Raise the flowering plants / compatible cash crops along the field border by arranging shorter plants towards main crop and taller plants towards the border to attract natural enemies as well as to avoid immigrating pest population
- Grow flowering plants on the internal bunds inside the field
- Not to uproot weed plants those are growing naturally such as *Tridaxprocumbens, Ageratum* sp, *Alternanthera* sp etc. which act as nectar source for natural enemies,
- Not to apply broad spectrum chemical pesticides, when the P: D ratio is favourable. The plant compensation ability should also be considered before applying chemical pesticides.
- Reduce tillage intensity so that hibernating natural enemies can be saved.
- Select and plant appropriate companion plants which could be trap crops and pest repellent crops. The trap crops and pest repellent crops will also recruit natural enemies as their flowers provide nectar and the plants provide suitable microclimate.

Due to enhancement of biodiversity by the flowering plants, parasitoids and predators (natural enemies) number also will increase due to availability of nectar, pollen and insects etc. Major parasitoid found in large cardamom ecosystem are *Cotesiaflavipes, Dolichogenedea* sp.,*Medina*sp.and*Bactromyra* (F.Tachinidae) sp., while the major predators are a wide variety of spiders, syrphid fly, ladybird beetles, long horned grasshoppers, *Chrysoperla*, earwigs, etc.

INSECT PEST MANAGEMENT IN LARGE CARDAMOM

There are as many as 23 insect pests are found to be causing damage at different degree on large cardamom. Among the insect pests that found to be cause more damage to large cardamom are viz., leaf caterpillar (*Artonachorista*Jordon), stem borer (*Glyphipterix*spp.) Shootfly, (*Merochloropsdimorphus* Cherian), White grub (*Holotrichia sp.*) and capsule borer(*Jamidesalecto*). Apart from these, aphids are found infesting large cardamom but they mostly act as vector responsible for transmitting viral diseases *viz*., *chirkey* and *foorkey*.

The bumble bees, *Bombus breviceps* and *B. haemorrhoidalis* have been recorded as important pollinators of large cardamom in all the altitudes. Consideration should be given towards conservation of pollinators while adopting pest management approaches. Decline of bumble bee population throughout the world is a cause of concern now. Bumble bee, act as pollinator for large cardamom are nesting in soil, so care should be taken during farm operations to keep the nests in the soil undisturbed to conserve the pollinators in their natural habitat. Maintenance of natural vegetation as well as micro-climate of the bumble bee nests in the plantation bears significant importance. Flowering plants need to be grown in the plantation throughout the year to maintain continuous supply of their food.

1. LEAF EATING CATERPILLAR:

Leaf caterpillar *Artonachorista* Jordon (Lepidoptera: Zygaenidae)is a major defoliator of large cardamom plants causing noticeable damage to the crop. The adult is a moth, black and its size ranges from 10–15 mm. The male moth can easily be distinguished from female with its bushy antennae, white bands on the abdomen and smaller size.

Period of occurrence

Although the leaf caterpillars remain in the field throughout the year but the infestationis mostly observed from June to July and October–March.

Nature of damage

The leaf caterpillars are highly host specific and monophagous. Caterpillars are gregarious in nature (60-200 caterpillars/leaf) and feed on chlorophyll content underneath the leaf leaving transparent epidermis and veins (skeletonization). The damaged portion of the leaf becomes brownish and the infested leaf can easily be identified from a distance. The mature larvae completely defoliate the plant leaving only the midrib of the leaves. Removal of chlorophyll and defoliation of the plant by the caterpillar affects the yield indirectly.

Management

Cultural, biological and botanical approachescan be adopted to manage this insect pest.

- During June-July and October-December, the infested leaf can easily be collected along with the larvae and destroyed

- Application of Neem Kernal Aqueous Extract (NKAE) @ 5% + 1% surfactant can deter the pest from feeding. The NKAE has to be applied on both sides of the leaves at 15 days interval during September to November and last week of May to July.
- Application of Spinosad 45 % SC @0.3 ml/l three times in cropping year February – March, June- July and October- November found to be most effective to manage this pest.
- Application of Neem based oil(Azadirachtin0.15% EC) 1500ppm @ 3ml/l three times in cropping year February – March, June- July and October- November also provides control.
- Entomopathogenic fungi viz. *Beauveria bassiana* @ 5.0 ml/l/*Metarhiziumanisopliae*@ 5.0ml/l/ *Bacillus thuringiensis* var. kurstaki WG @ 2.0g/l three times in cropping year February – March, June- July and October- November also provide control of this pest.

Insecticides/ Botanicals	**Doses in 100 lt. of water**	**Spray interval**
Neem Kernal Aqueous Extract	500 ml	30 Days
Spinosad 45% SC	30ml	3 months interval
Neem based oil (Azadirachtin0.15% EC) 1500ppm	300ml	3 months interval
B. bassiana (1 x 10^8CFU/ml)	500 ml	3 months interval
M. anisopliae(1 x 10^8CFU/ml)	500 ml	3 months interval
B. thuringiensis var. kurstaki WG	200g	3 months interval

2. SHOOT FLY

Two species of shoot fly already identified so far in damaging large cardamom. These two are *Merochloropsdimorphus* Cherian (Diptera: Chloropidae) and *Bradysia* sp. (Diptera: Sciaridae), However, *M. dimorphus* is most prevalent in large cardamom growing tract of Sikkim and Darjeeling. The adult fly *M. dimorphus*is 5–6 mm in size and brownish yellow in colour.In the main field, more damage is recorded at higher altitudes than in the lower altitude.

Period of occurrence

Although the shoot fly is found throughout the year but severe incidence of the pest noticed during February to August. Higher incidence is recorded in new plantations within 3 years of planting.

Nature of damage

The tip of the shoot becomes brown and later whole shoot dries up causing ‘dead heart’ symptom.Low to moderate damage by shoot fly is recorded in large cardamom plantation in

Sikkim and West Bengal. Single, pale glossy white larva bores the young shoot and feeds on the central core of pseudostem from the top to the bottom resulting in its death. In general, young shoots up to one foot length are infested by shootfly and incidence was as high as 56 per cent of new shoots.

Management: For managing this pest cultural, biological and botanical approaches can be adopted

- Infested young shoots should be removed at ground level and destroyed.
- Adult shootfly can be trapped using fish meal bait and then destroyed
- Application of neem seed kernel extract 5 ml L^{-1}during new shoot emergence at monthly interval reduces the pest problem.
- Application of Spinosad 45 % SC @0.3 ml/l three times February – March, June- July and October- November found to be most effective to manage this pest.
- Application of Neem based oil(Azadirachtin0.15% EC) 1500ppm @ 3ml/l three times February – March, June- July and October- November also provides control.
- Entomopathogenic fungi viz. *Beauveria bassiana* @ 5.0 ml/l/ *Metarhiziumanisopliae* @ 5.0ml/l/ *Bacillus thuringiensis* var. kurstaki WG@2g/l three times in cropping year February – March, June- July and October- November also provide control of this pest.

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M. anisopliae(1 x 10^8CFU/ml)	500 ml	3 months interval
B. *thuringiensis* var. kurstaki WG	200g	months interval

3.STEM BORER:

Glyphepterix sp. (Glyphiperidae:Lepidoptera) is also associated to large cardamom in all the cardamom growing tract.

Period of occurrence:

Stem borer is incidence noticed throughout the year. But in four periods, December-January, March-April, May-June and September-October their abundance is more.

Nature and extent of damage:

The larvae feed on the central portion of the shoot and passage of food material to growing tip is blocked. The central leaf of the plant gets dried up and this symptom is known as dead heart. Infestation of this pest is also indicated by the presence of entry holes plugged with excreta.

Management: For managing this pest cultural, biological and botanical approaches can be adopted.

- Infested shoots to be removed at ground level and destroyed.
- Spraying of 3000 ppm neem oil @ 3.0 ml/ lit of water during July-October (at 21 day intervals) is effective.
- Application of Spinosad 45 % SC @0.3 ml/l three times February – March, June- July and October- November found to be most effective to manage this pest.
- Entomopathogenic fungi viz. *Beauveria bassiana* @ 5.0 ml/l/ *Metarhiziumanisopliae* @ 5.0ml/l/ *Bacillus thuringiensis* var. kurstaki WG@2g/l three times in cropping year February – March, June- July and October- November also provide control of this pest.

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B. thuringiensis var. kurstaki WG	200g	3 months interval

4.WHITE GRUBS*:*

In Sikkim, four species of white grubs(*Holotrichia* spp., Coleoptera: Melolothidae) are reported. Among these *H. seticolis*is identified as major one, while another species named as *H.sikkimensis.* is also found to cause damage.The young grubs are white translucent whereas mature grubs are pale in colour and 'C' or semi-circular shaped. Adults are dark brown dorsally, yellowish ventrally, forewing thick (elytra), hind wings membranous, crepuscular to nocturnal in habit. As large cardamom being preferably cultivated in under natural forest ecosystem the incidence of white grub more or less available in all the plantations.

Period of occurrence

The adults emerge in large numbers on receipt of summer showers during April-May. Larval stage of this pest is causing damage to the crop. The grubs are active in their second and third instar larval stages and remains very active during rainy seasons (July-October) and feed on organic matter until they come in contact with living roots of plants.

Nature and extent of damage:

White grub is a polyphagous and it feeds on the feeder roots and newly formed rhizomes. The infested plant shows yellowing of leaves and withering symptoms. In severe infestation, pseudostem may be cut at the basal region by third and fourth instars larval stage.

Management

For managing this pest,

- community wise collection and killing of adult beetle during dusk to night period (6.00 – 7.30 pm) in the month of May to early July from their preferred host tree
- Placelight traps @ 1 trap/ha during May to early July also reduces the adult beetle too some extent.
- Drenching of root zone with neem seed kernel extract 5 ml L^{-1} water at monthly interval reduces the pest problem.
- Soil drench with *Metarrhiziumanisopliae*(1 x 10^8CFUg^{-1}) @10.0 g L^{-1}/ NKAE 5% + 1.0 % surfactant /*Beauveria bassiana*(1x 10^9CFUg^{-1})@ 10.0 g L^{-1} of water at monthly intervals can also effectively manage the pest.

Insecticides/ Botanicals	Doses in 100 lt. of water	Spray interval
Neem Kernal Aqueous Extract	500 ml	30 Days
B. bassiana (1 x 10^8CFU/g)	1000g	30 days
M. anisopliae(1 x 10^9 CFU/g)	1000 g	30 days

5. APHIDS:Aphids

In large cardamom, aphids cause more damage as a vector of viral diseases rather than as a pest. The aphids are associated with the transmission of viral diseases (*Foorkey* and *Chirke*) of large cardamom. The major species associated with large cardamom are:

1. *Pentalonia nigronervosa* f. caladii (Goot) (Hemiptera: Aphididae)
2. *Micromyzus kalimpongensis* (Hemiptera: Aphididae)
3. *Rophalosiphum maidis* (Fitch) (Hemiptera: Aphididae)
4. *Rophalosiphum padi* (Lin.) (Hemiptera: Aphididae).

Period of occurrence

The aphid population is recorded high during summer months at lower altitudes.

Nature of damage

P. nigronervosa f. *caladii* and *M. Kalimpongensis*are known to be as vectors of *foorkey*' or virus yellow disease. The aphids colonize at the base (rhizome) of the clump and if population is more, they move to aerial portion of the clump. They remain mostly to exposed rhizomes and dried leaf sheaths and they suck the sap from the pseudostem.

Maize aphids, *Rophalosiphummaidis*and*R. Padi*are used to be on the lower surface of the leaves of large cardamom, congregating near the mid-rib and veins. These aphids are known to be the vector of another viral disease, mosaic streak or '*chirke*'.

Management: For managing aphids in large cardamom,

- The removal and destruction of diseased plants is helpful in control of further spread of disease and in reduction of aphid population
- It is necessary to keep vigil on infestation of these aphids on their most important alternate hosts like Banana and Canna for *P. Nigronervosa*and maize for *R. maidis* and *R. padi*. If infestation is noticed, alternate hosts also to be removed and destroy to minimize the chances of spread of these pests.
- Spraying of Neem oil (Azadirachtin 0.15%EC) 1500 ppm @ 3 ml L^{-1} formulations at 15 -20 days interval provide effective control.

Insecticides/ Botanicals	Doses in 100 lt. of water	Spray interval
Neem oil (Azadirachtin) 3000ppm	300ml	21 days interval

DISEASE MANAGEMENT

Leaf Blight

Colletotrichum blight has devastated the large cardamom plantations and is the cause of concern for severe crop loss and decline in plant population in the recent past. The disease appears generally with the advent of the pre-monsoon showers in April-May and progresses rapidly during the rainy season. However, in some areas the incidence starts during winter months (January-March). Lesions on leaf and sheath carry black dots and are rough in its texture. These dots are identified as perithecia of the pathogen. Leaf sheath covering the pseudostem show blackish brown discoloration which extends up to rhizomes and subsequently turn into greyish or blackish patches with brown margins. Gradually, the pseudostem becomes brittle and breaks in the middle or at the collar regions. In most cases, the lesions on the pseudostem become necrotic as a result the entire leaves dry out giving a burnt appearance. Later, the pseudostem lodges at the point of necrotic lesion. As a whole, the entire plantation looks dried up.

Management:

- No cultivar is found to be resistant to the disease. A holistic approach is required for disease management as the problem is related to environmental, soil and plant health.
- Diseased leaves, tillers and other plant parts which are cut during harvesting season should never be spread in the plantation. Strictly adopt phytosanitary measures like removal of diseased plants/plant parts and bury them away from the plantations. The infected material may serve as inoculum for the next season and hence to be composted for destructing the pathogenic propagules. Addition of EM (effective microorganism) solution or cow dung slurry in the composting pit will enhance the composting process.
- Destroy alternate host plants like marigold, *Amomum dealbatum* (cherumpa), canna, wild colocasia, ornamental basil etc.
- Regulate shade trees to provide not more than 50 per cent shade.

Chemical control (chemicals approved by NPOP for restricted usage in organic cultivation):

- Pretreatment of suckers with Copper Oxychloride @ 0.3% (300g in 100 litres water) for 30 minutes before planting in nursery/field.
- Application of 1% Bordeaux mixture after harvest and also as prophylactic sprays before onset of monsoon (April/May) and after monsoon (September/October).
- Foliar spray and soil drench with Copper Oxychloride 50WP @ 0.3% (300g in 100 litres water) during monsoon at 20-25 days interval.

Biological control

- Pre-treatment of suckers with bioagents like *Pseudomonas fluorescens* or *Bacillus subtilis* @ 5 litres in 100 litres water.
- Application of bioagents like *Pseudomonas fluorescens* or *Bacillus subtilis* as foliar spray and as soil drench after harvest, before onset of monsoon and during monsoon months. Mix 3-5 litres of bioagents in 100 litres of water and apply @ 3-4 litres/clump.
- Apply *Trichoderma* mixed with FYM (1-2 kg/100kg) and neem cake (1kg/100kg) in soil @ 2kg/clump. This will reduce soil inoculum of pathogen.

General

Copper fungicides may be applied only when the disease pressure is high. Once disease pressure comes down, bioagents can be applied. It should be noted that after using Bordeaux mixture/COC, bioagents should be applied only after 15 days interval and never mix bioagents with copper fungicides.

Care must be given to provide adequate plant health. In highly acidic soils, liming has to be done to attain optimum soil pH. Apply recommended dosage of manure every year. Insufficient/lack of irrigation during winter leads to weakening and collapse of the plants. Plants grown in moisture deficient stress are more susceptible to blight disease and hence, irrigation during winter months is essential. Severely infected gardens and traditional plots may be temporarily (3-4 years) converted to other crops (crop rotation). Wherever possible, planting in new ideal locations is to be adopted.

Control Measures

Fungicide/Bioagents	Dosage in 100 liters of water	Spray interval (days)/method of application

Copper oxychloride 50 WP	300g	20-25
Bordeaux Mixture	1.0%	Prophylactic sprays before onset of monsoon (April/May) and after monsoon (September/October)
Pseudomonas fluorescens	3- 5%	20-25
Bacillus subtilis	3- 5%	20-25
Trichoderma spp.	1-2%	Mixed with FYM (1-2 kg/100kg) and neem cake (1kg/100kg). apply in soil @ 2kg/clump

***Phoma* leaf spot disease**

Leaf spot caused by *Phoma* sp. was found to be of serious concern in the seedling nurseries in Arunachal Pradesh and field plants in Sikkim. Numerous water-soaked lesions, round in shape appear on the lamina which coalesce and become yellowish to dark brown and dry out. Rapid spread during continuous rain and consequent damage indicates its potential to devastate. In Sikkim, the disease was found to occur during late winter and peak rainy periods.

Management

- Field phyto-sanitation by removal and destruction of disease affected plants or plant parts
- Provide adequate drainage.
- Spray 1% Bordeaux mixture at 20-25 days interval during rainy days based on disease severity. Or
- Spray *Pseudomonas fluorescens* or *Bacillus subtilis* as @ 3Litre/100 Litre water

Control Measures

Fungicides/Bioagents	Dosages in 100 liters of water	Spray interval (days)
Bordeaux Mixture	1.0%	20-25
Pseudomonas fluorescens	3.0 %	20-25
Bacillus subtilis	3.0 %	20-25

Leaf streak disease

It is caused by *Pestalotiopsisroyenae* and results in considerable damage to foliage in cultivar *Golsey*. It is prevalent round the year. The disease symptom appears as numerous translucent streaks on young leaves along the veins. The infection starts from emerging folded leaves and this result in spread of the disease to the adjacent folds. When these leaves open, many translucent streaks are noticed on the leaf blade.

Management

- Removal and destruction of severely affected plant parts
- Three rounds of 0.2 per cent Copper oxychloride (i.e, 200 g in100 lit water) or 1% Bordeaux mixture at 15 days interval can control disease.

Control Measures

Fungicides	Dosages in 100 liters of water	Spray interval (days)
Copper oxychloride 50WP	0.2%	15-25
Bordeaux Mixture	1.0%	15-25

Leaf Rust

It is caused by pathogenic fungi *Phakosporaelettariae*. Leaf rust is often seen on lower leaves as numerous whitish to brown powdery pustules (uredosori) on the under surface of the leaves. The uredosori are seen surrounded by chlorotic haloes and on the upper side of the leaves the symptom appear as yellow necrotic patches. In severe cases, the uredosori are found covering the entire leaf blade and cause premature drying of leaves. The disease mainly affects older leaves. It is prevalent throughout the year, but higher incidence is noticed during rainy months. Severe incidence is noticed in young nursery seedlings.

Management

- One or two rounds of 1% Bordeaux mixture at 15 days interval can control the disease.

Control Measures

Fungicides	Dosages in 100 liters of water	Spray interval (days)
Bordeaux Mixture	1.0%	15-25

Wilt/dry rot disease

Wilting of plants can be due to various biotic and abiotic factors. The wilt/dry rot disease due to pathogenic fungus *Furisumoxysporum*Schlecht has been reported in the large cardamom nurseries and plantations of Sikkim.

In case of wilt symptoms, initially, yellowing of lower leaves from base upwards is noticed. The yellowing may start from the margin and eventually spreads to the entire lamina. Later the leaves wilt, becomes dry and turns brownish/black. The entire leaves may collapse at the petiole leaving the pseuodstem standing. Loosening of leaf sheath and splitting at the base of pseudostem is also noticed.

Dry rot symptoms can be seen by longitudinally opening the rhizome which reveals the discoloured /rotten area. The inner whorls of the pseudostem just above the affected rhizome become brown and shrivelled. Almost the whole rhizome may be invaded. The roots show blackening and the bark peel off easily. The central core of pseudostem turns brownish and decay. Finally, the whole clump dries up

In nurseries, the wilt incidence was observed during February-March while in plantations, it was noticed during October to June.

Management

As it is an emerging problem, exclusive studies on management of *Fusarium* wilt/dry rot in large cardamom is under progress. Factors like acidic nature of soil, poor fertility status and poor plantation management predisposes the incidence of soil borne diseases including *Fusarium*.

- Correction of acidic soil by applying lime.
- Diseased materials to be properly disposed
- Provide adequate shade in the plantation.
- Maintain plantation by providing irrigation and apply recommended organic manures
- Apply *Trichoderma* mixed with FYM (1-2 kg/100kg) and neem cake (1kg/100kg) in soil @ 2kg/clump. This will reduce soil inoculum of pathogen.

Control Measures

Fungicide/Bioagents	**Dosage in 100 liters of water**	**Spray interval (days)/method of application**
Trichoderma spp.	1-2%	Mixed with FYM (1-2 kg/100kg) and neem cake (1kg/100kg). apply in soil @ 2kg/clump

Viral diseases of large cardamom

Aspect	**Chirke disease**	**Foorkey disease**
Identification by symptoms	Mosaic appearance on leaves. The symptom is more prominent on young emerged leaves where discrete pale green to yellow longitudinal stripes running parallel to each other can be seen.	Stunted and bushy growth of newly emerging tillers with small pale green leaves. Sometimes produce broadened pan like leaves.
Causal agent	It is caused by virus. Primary spread by infected planting materials. Transmitted through sap and aphid, *Rophalosiphummaidis.* Knife used for farm operations and harvesting can carry sap of infected plant to healthy ones. In most situations this is the major mode of spread.	It is caused by virus. Primary spread by infected planting materials. Transmitted through aphids, *Pentalonianigronervosa*and *Micromyzuskalimpongensis*.
Survival of infected plants	Plants continue to survive for few more years gradually reducing the yield.	Rapid reduction in yield.
Transmission through seeds & seedlings	Not transmitted through seeds, hence seedlings are disease free.	Not transmitted through seeds, hence seedlings are disease free.

Resistance / tolerance	No resistant cultivars / sources known	No resistant cultivars / sources known

Management of viral diseases

Viral diseases of plants are cancerous in nature and are difficult to cure. Early identification of the diseased plants and reducing the spread are the easy ways to tackle the problem. Hence, from an environmentally safe and economically viable perspective the following measures would be adopted for effective management of the diseases.

1. Monitor the plantation every month particularly during rainy season and carefully identify the diseased plants.
2. The diseased plants may be uprooted and destroyed as and when they are seen. They should be taken to an isolated place, chopped into small pieces and buried in pits for quick decomposition. As an alternative, mass uprooting and burning of infected plants at the village / area level could be taken up for eradication of the disease.
3. Never collect planting materials from an infected garden or apparently healthy plants from severely infected gardens.
4. Establish nursery about 500 m away from main plantation in order to avoid aphid colonization
5. Maintain clean clumps by removing old tillers with loosened leaf sheath so that aphids will not colonize.
6. During plantation monitoring, especially prior to harvesting, the plantation must be inspected carefully for identification of diseased plants. These plants may be uprooted and destroyed on priority. The knife and other implements used for the purpose should not be used on healthy plants since disease could be transmitted through sap. Dip the implements in hot water for half an hour for killing the inoculum before going to the healthy plants for harvesting or cleaning.

CHAPTER 3

HAZARD CATEGORIZATION OF PESTICIDES

Pesticides are poisonous substances and they are to be handled with extreme care. On the basis of 'acute toxicity', pesticides are grouped into four 'hazard categories'. The hazard categorization of the pesticide should be indicated in the label on the pesticide container. The

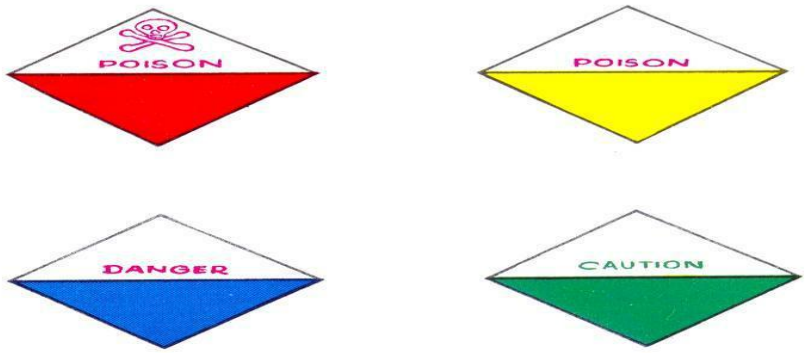
label shows a square (set at an angle of 45°) divided into two triangles. The lower triangle will be coloured according to the hazard category and the upper triangle will show the symbols of toxicity (Plate I). Following table gives the details of hazard categorization of pesticides in India (Table 1).

Table 1. Hazard categorization of PPFs

Classification of pesticides	**Colour of the lower triangle**	**Symbol and signal word* on upper triangle**
Extremely toxic	Bright Red	Skull and cross bones 'POISON' in red
Highly toxic	Bright Yellow	'POISON' in red
Moderately toxic	Bright Blue	DANGER
Slightly toxic	Bright Green	CAUTION

*Signal words in Indian languages may also be given in addition to those in English

Plate I: Hazard categorisation of pesticides



SAFETY PRECAUTIONS

The responsibility for the safe and effective use of pesticides rests with the government, industry, extension agencies, farmers and workers themselves (**GIFAP. 1983). The improper use of pesticides is a major cause of concern in all the developing countries and this highlights the need for educating the people engaged in the storage, handling and

application of these poisonous chemicals. It is the responsibility of all concerned with the use of pesticides to ensure that the workers involved in the application are properly educated and trained.(** Groupment International des AssociationeNationales des Fabricants de Produitsagrochimiques.)

CHAPTER 4

DO'S AND DON'TS IN LARGE CARDAMOMPEST MANAGEMENT

- Monitor the incidence of pests by assessing their populations in the field.
- Mark the areas from where the pest attack starts
- Start appropriate control measures in the beginning of the season
- Integrate cultural control methods with biological and cultural control measures.
- Use bio-formulations (botanical formulations and entomopathogens) wherever possible
- Do not allow the growth of weeds in ravines, along drains, foot-paths and vacant patches. Since these weeds may be alternate host of these large cardamom pests
- Do not allow cattle inside the large cardamom field

Guidelines for safe and effective use of pesticides

- Read carefully the label on the bio pesticide container
- Use the bio pesticide only when it is essential
- Use only the recommended bio pesticide from authorized supplier
- Apply bio pesticides at the correct dosage and by the recommended method
- Never blow out clogged nozzles with mouth
- Do not use leaking sprayers. Avoid contamination of skin, mouth and eyes.
- Do not inhale the bio pesticide while mixing
- Never spray against the wind
- Do not wash pesticide containers near wells or running streams
- Keep clean water, soaps and towels ready for use.
- Keep the bio pesticides locked in store room and out of reach of children and other unauthorized persons
- Dispose the containers safely after thoroughly emptying and washing. They may be buried in a place away from wells or water sources.

CHAPTER 5

SAFE DISPOSAL OF BIO PESTICIDE CONTAINERS

1. Unwanted bio pesticides and containers are serious hazards in the large cardamom if not disposed of properly due to be contaminations.
2. Pesticide containers should not be used for any other purposes like storage tanks, live stock feeding trough etc.
3. Pesticide containers can never be properly cleaned or decontaminated at garden level.
4. It is hazardous to leave the empty containers as such. These should be appropriately disposed off.
5. Combustible containers can be burnt unless the container label warns against burning. Containers made of paper, cardboard & plant materials can be disposed off by burning.
6. Non combustible containers should be broken or deformed by punching holes at several places to prevent reuse. They have to be disposed off by burying them in the soil.
7. The excess or left over pesticide spray fluid should also be disposed off in the designated pesticide disposal area.
8. The bio pesticide waste disposal area in the garden should be on a relatively higher ground, flat or gently sloping, away from any water source. The soil should be deep.

CHAPTER 6

TRANSPORTATION OF PLANT PROTECTION FORMULATIONS

Pesticides are toxic materials and accidents can occur at any time. The person undertaking transportation of the materials is responsible for taking preventive measures to reduce hazards during transportation.

Several precautions need to be taken to ensure safe transportation. Safety of the labourers loading and unloading the material, and safety of transporter, is equally important.

The following guideline should be helpful in the safe handling and transportation of pesticides:

1. The safest means of transporting pesticides by road is an open-type truck. Closed trucks do not offer good ventilation, and materials which give off noxious fumes can be hazardous.
2. Ensure that the good are protected against rain during transportation.
3. Load and unload the materials with care.
4. Do not throw pesticide packages, or allow them to drop from a height.
5. Do not use hooks in loading bags.
6. Never place pesticide packages under heavy loads of other items.
7. Whenever possible, do not load pesticides in passenger vehicles.
8. Do not carry foodstuff, animal feed etc., on the same truck as pesticides.
9. Do not transport livestock or domestic animals with pesticides.
10. Avoid puncturing paper containers when handling them.
11. Load only tightly closed and sealed containers.
12. When loading, check that the outside of the package is not contaminated with pesticide.
13. Load the pesticides on the vehicles in such a way that it does not roll or side from place to place.
14. Do not transport herbicides with other pesticides and fertilizers.
15. Do not allow children to ride on the vehicle.
16. Place boxes with the right side up.
17. Load one container or package at a time.
18. Do not permit handling labour to smoke or prepare and chew tobacco during loading and unloading.

19. Load carefully within the weight limitation of the vehicle. Ensure that containers do not fall on the vehicle.
20. Inform the truck driver of the potential hazards of the pesticide.
21. When transporting any hazardous substance, it is desirable that the carrier should have a Transport Emergency Card (TREMCARD) inside the vehicle.
22. Material Safety Data Sheet (MSDS) should be made available.
23. Do not leave a loaded vehicle unattended. Such vehicles may attract the attention of inquisitive children or livestock.
24. Always send a detailed inventory of the material loaded in the truck with the driver.
25. After unloading the truck inspect the body of the vehicle, the tarpaulin used to cover the material and other parts of the truck for evidence of leaks or spills. If found, treat spill properly.
26. Before loading check the truck body for protruding nails, metal strips or other sharp objects which could puncture containers. Hammer them flat if found.
27. Do not permit passengers to ride in the back of the truck, or sleep on top of the loaded truck.
28. Clean vehicle after unloading.

CHAPTER 7

STORAGE OF PLANT PROTECTION FORMULATIONS

The farmer/consumer normally handles much smaller quantities compared to the retailers. However, the fundamental principles of good storage practice remain the same.

1) Never store bio pesticides in living quarters, or in the kitchen.
2) Always keep bio pesticides in their original containers. Do not transfer to food or water containers.
3) Store away from children and fires.
4) Store in a locked cupboard or box meant exclusively for pesticides. There should be designated in-charge for keys to storage for PPFSs.
5) Store in shaded area.
6) Keep storage quantity to a minimum and maintain the temperature.
7) Buy only when needed and consume quickly.
8) Store in a ventilated area.
9) Do not store animal feed or other food stuff with bio pesticides.
10) Inform all family members of the location of the store and warm them.
11) Inspect periodically for signs of damage or leaks. The storage areas shouldhave sand pits and the floor should be concrete.
12) Use the oldest stock first.

CHAPTER 8

APPLICATION OF PLANT PROTECTION FORMULATIONS

Spraying equipment and tips for successful spraying:

Spraying is an important operation in large cardamom agro practices and considerable manpower and financial inputs are involved in the operation. The main difference in application of all these materials lies in the variable requirement of droplet sizes, accompanying spray pressure and targeting the spray towards different parts of the plant body.

Knapsack sprayers & backpack sprayers (Hand sprayers):

Hand sprayers are generally high volume sprayers used for spraying of bio pesticides in large cardamom plantation.

Knapsack sprayer for pesticide, fungicide and nutrient spraying:

For spraying bio pesticide, fungicide, the spraying machine needs to be fitted with Hollow cone nozzle, which normally discharges 450cc fluid per minute under an operating pressure of 40 psi. Recommended nozzles: NMD 60/450, NMD 80/450, HCN 100/700, BAN 75/450. For efficient operation of hand sprayers, continuous pumping is necessary.

CHAPTER 9

SPRAYING INSTRUCTIONS AND PROPER MAINTENANCE OF SPRAYING EQUIPMENTS

1) Read carefully the label on the bio pesticide containers
2) Wear personal protective equipment as recommended.
3) Spray crops with the wind and gradient. In other words, spray with the wind coming from the back.
4) Ensure that there are no animals, people, food or animal feed downwind, i.e. in the direction in which the wind is blowing.
5) Check sprayer and equipment for leaks. Leaking spray equipment can seriously contaminate the person. Avoid contamination of the skin, mouth and eyes.
6) Do not walk with running sprayer on roads, pathways.
7) Apply at the correct dosage and by the recommended method.
8) Never blow out clogged nozzles with mouth.
9) Do not wash pesticide containers near a well or running stream.

Before spraying

- Identify the pest and ascertain the damage done. Use only recommended pesticide which is least, if the pest populations exceed the economic injury Level.
- Read instructions manual of the pesticide and equipment.
- Check the spraying equipment and accessories which are to be used.
- Ascertain that all components are clean, especially filling and suction strainer, sprayer tank, cut- off device and nozzle.
- Test the sprayer and ascertain whether it pumps the required output at rated pressure.
- Check the nozzle spray pattern and discharge rate.
- Calibrate the sprayer, by set spraying speed and nozzle swath by adjusting spray height and nozzle spacing.

During Spraying

1. Take only sufficient pesticide for the day's application from the store to the site.
2. Do not transfer pesticides from original container and packing into the containers.
3. Recheck the use instructions of pesticide and equipment.
4. Wear appropriate clothing. Avoid contamination of the skin especially eyes and mouth.

5. Liquid for formulation should be poured carefully to avoid splashing.
6. Do not spray in high wind, high temperature and rain.
7. Never eat, drink or some when mixing or applying pesticides.
8. Never blow our clogged nozzles or hoes with your mouth.
9. Follow correct spray technique. Spray plant crop thoroughly by operating sprayer at correct speed and correct pressure.

Maintenance

1. Checking and preparation should commence well before the beginning of the season. Sprayer should be well maintained during the spraying season.
2. Clean both inside and outside of sprayer after each day's work, even if the same chemical is being used the next day.
3. Sprayer should be lubricated thoroughly and regularly, especially all moving parts, before starting the work.
4. While inspect the parts of sprayer, worn out, broken and damaged parts should be replaced.
5. Filters and nozzles should be cleaned thoroughly It is of paramount importance

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CHAPTER 10

QUALITY OF WATER FOR SPRAYING

The quality of water used to mix with agricultural chemicals can reduce the effectiveness of the Chemical applications.

Poor quality water can reduce spray efficacy. Use cleanest water possible for spray applications. Test water for turbidity, hardness, pH and EC

Poor quality water can:

- Reduce activity of agricultural chemicals
- Block spray lines or nozzles, reducing chemical application uniformity
- Increase wear of nozzles also causing reduced chemical application uniformity
- Increase wear on spray rigs.
- Water quality is variable and is dependent on the source of the water (e.g. rainwater, farm dams, river, bore, town reservoir). Water quality can also vary throughout the year and after periods of high rainfall or drought. Use the cleanest water possible when preparing agricultural chemicals for application. Where clean rain water is not available use the following guidelines to minimise spray failure due to poor quality water. Note that some agricultural chemicals are more sensitive than others to poor water quality; check the specific instructions on pesticide labels.

Guideline to minimize spray failure

Turbidity

Dam or river water often contains suspended particles of clay, silt and fine organic matter, giving the water a “muddy” appearance. Transfer muddy water to a settling tank where heavier particles will sink to bottom. Use a “flocculent” such as Alum (aluminium sulphate) to settle out the very light particles. However DO NOT use water treated with Alum to spray amine formulation chemicals. Filter the water before filling the spray tank. Alum is most effective at pH 6.8 - 7.5 and should not be used if water pH is less than 5.5.

Hardness

Water hardness is caused by high levels of calcium and/or magnesium and is common for bore water. Chemicals with amine formulations, which include the herbicides: glyphosate, 2,4-D amine, and dicamba are adversely affected by hard water. Hard water can cause some chemicals to precipitate and can affect the properties of surfactants, emulsifiers and wetting agents. Precipitates can block nozzles and pre-filters and cause additional wear of spray rigs.

To “soften” hard water use softening agents, adjust pH and use water that is neither very hot nor very cold temperatures. Add Ammonium sulphate to hard water in spray tank before adding amine formulation herbicides. This will improve efficacy

pH

The pH of water indicates its acidity or alkalinity and is measured on a scale of 1 to 14. A neutral pH is 7. Most water has a pH between 6.5 and 8. Water above 8 is alkaline and water below 6.5 is acidic. pH >8.5 or <6, can affect spray mixes. pH >8 can cause deposits in pipes and blockage of equipment. pH <6, can cause corrosion of metal pipes and fittings. Alkaline water (>pH 8) can break down some chemicals through a process called alkali hydrolysis. In the case of some herbicides this actually improves efficacy, but it is likely to reduce the efficacy of many other agricultural chemicals. The longer a mixed chemical is left in the tank prior to spraying, the greater the breakdown; it is not recommended to leave spray mixes overnight. Acidic water can affect the stability and physical properties of some chemical formulations. Critical pH levels at which chemical efficacy is compromised should be included on pesticide labels. Water pH can be changed by adding an acid or alkaline to the water tank. Using an acid such as sulphuric or phosphoric acid will lower pH while addition of an alkaline such as potassium hydroxide will increase pH. This has to be done precisely using calculated amounts depending on the pH change required. Do not guess.

Salinity

Salinity is the concentration of all soluble salts in water. The amount of mineral salts dissolved in water is measured by its electrical conductivity (EC). The type of local rock and soil can influence the saltiness of water, but high EC is usually caused by runoff containing fertilizer salts getting into the water source. Salty water can cause blockages and corrode the metal parts of spray rigs. High salt levels, particularly chloride, can lead to burning of crop foliage. Sensitivity to salts varies between crops. It is important to know the concentration of chloride that will cause foliar damage to crops grown. Most agricultural chemicals are not adversely affected by low to moderate salt levels. Salty water can be mixed with fresh water to reduce EC levels to more suitable levels for spraying.

Organic matter

Water containing a lot of organic matter (e.g. algae or leaves) can block nozzles and pre-filters. High levels of algae can also increase the alkalinity of water and will reduce the efficacy of some agricultural chemicals. Filter water before filling spray tanks. The best filters to remove organic matter are media filters with 1 mm crushed basalt. Disc filters with 60-micron openings can also be used.

Iron

Iron-loving bacteria can grow in water where the concentration of iron is 0.3 to 1.5 mg/L (0.3 to 1.5 parts per million, ppm). This can cause blockages in equipment such as pressure gauges. Iron is soluble in water where there is little or no oxygen, as can occur in deep bores and dams. Iron concentrations above 1.5 mg/L (1.5 ppm) can cause iron deposits in water, pipes and equipment.

Aeration oxidises iron, which makes it form solid particles that can be filtered or settled out of solution. Procedures used include aeration, settling, chlorination and use of potassium permanganate.

Temperature

Very cold water can cause some chemicals to gel and reduces the solubility of wettable granule formulations. Hot water can reduce the stability of chemical mixtures. Water temperatures extremes can increase accentuate the effects of other water quality factors. Avoid mixing sprays during extreme weather. On a hot day let the hose flow for time enough to become cool.

CHAPTER 11

SAFETY MEASURES FOR SPRAYING SQUAD

The following type of protective equipment can be used:

Overalls:

Usually in most of the conditions a light cotton overall is the best and it must cover as much of the body as possible. A high collar with the upper-most button closed offers good protection of most of the body areas while thelong sleeves with cuff-buttons, trouser buttons which are laceable at the bottom offer good protection. Pockets and any such parts/areas which are supposed to accumulate pesticides dust/ residue must be avoided.

In no case should a pesticide be applied or mixed without adequate protective gear. There must always a separate set of clothes for above said purpose, this should be chosen in such a way that it covers body as much as possible.

Aprons:

Water proof aprons made of rubber or plastic are very effective while mixing bio-pesticides and/or spraying them in uncertain wind conditions and it should reach from the top of the chest to below the knees. However the locally available apron is a large sized plastic bag with three holes cut on its seamed bottom for the head and two hands can also be used butsuch apron does not protect the sleeves and shoulder but offers good protection to the body.

Gloves:

Gloves are one of the most important accessories which is helpfulto avoid dermal exposure while mixing or spraying bio pesticides. The gloves used should have a length upto 2-3" below the elbow and should be worn outside the shirt sleeves so that any liquid does not wet the shirt.

Rubber gloves are clean and easily available but other durable gloves like cloth-backed PVC gloves which are also quite effective. Continued use of gloves may cause stiffness and slight loss of dexterity so such works which include use of gloves should be done patiently and with due gap of time. Gloves should be cleaned regularly and changed after recommended period or if damage if seen.

Shoes:

The large gum bootsoffer the best protection. However even ordinary shoesoffer good protection. Shoes should be regularly inspected for damage and possibleleaks.Using shoes greatly reduces chances of dermal exposure.

Head Protection:

Hair presents an excellent place for dust or liquid mist to accumulate. It is also difficult to wash. It is therefore important to protect this area, A rain coat cap or hat with a wide brim offers a reasonable amount of protection.

In many areas turbans are used. This long piece of cloth can be effectively used to cover the head, It is preferable to identify one such turban for pesticide application and decontaminate it like other pieces of clothing.A cotton balaclava cap is cheap and offers a reasonable degree of protection.Pesticides should never be handled without proper head gear.

Goggles:

Goggles, face shields and spectacles primarily protect the eyes and the face. Apart from protecting against splashes and spills, tight fitting goggles offer good protection against irritating fumes on the eyes. Goggles, however do not protect the face. A properly fitting set of goggles will be found uncomfortable.

A cheap and fairly efficient method of protection against mists, small droplets and splashes reaching the eye is achieved by wearing ordinary spectacles, These are quite comfortable to use and can be used for prolonged use, goggles will be found uncomfortable.

A face shield is a piece of transparent acetate or acrylic sheet which covers the whole face. It is good to prevent a spill or splash from reaching the face. However, it does not protect against fumes irritating the eyes.

CHAPTER 12

MEASURES TO KEEP THE RESIDUES IN LARGE CARDAMOM BELOW THE MAXIMUM LIMIT

1. There should be regular monitoring for early detection of pests/diseases
2. Adopt integrated pest management techniques
3. Use only recommended safer pesticides/botanicals and bioagents
4. Avoid repeated spraying of same pesticides
5. Sufficient waiting period should be allowed between spraying and harvesting
6. Blanket sprays must be avoided as far as possible.
7. Resort to spot treatment
8. Pesticides should be used as per recommendations.
9. Check pesticide formulations for active ingredient and impurities
10. Regular monitoring should be done for inputs used in the fields.

Hygienic conditions must be maintained both in field andduring processing

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