सत्यमेव जयते

INTEGRATED PEST MANAGEMENT PACKAGE FOR CHICKPEA

NCIPM

Government of India
Ministry of Agriculture, Department of Agriculture & Cooperation
Directorate of Plant Protection, Quarantine & Storage
CGO Complex, NH IV, Faridabad
Haryana- 121001

INTEGRATED PEST MANAGEMENT FOR CHICKPEA

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Cover picture : Healthy crop of Chickpea

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FOREWORD

Intensive agricultural practices relying heavily on chemical pesticides are a major cause of wide spread ecological imbalances resulting in serious problems of insecticide resistance, pest resurgence, pest replacement and pesticide residues. There is a growing awareness world over of the need for promoting environmentally sustainable agriculture practices.

Integrated Pest Management (IPM) is a globally accepted strategy for promoting sustainable agriculture. There is a conscious shift from the reliance on economic threshold level and chemical pesticides driven approaches in the past to more ecologically sustainable Agro-Eco System Analysis (AESA) based IPM strategies. These focus on the relationship among various components of an agro-ecosystem with special focus on pest-defender dynamics, innate abilities of plant to compensate for the damages caused by the pests and the influence of abiotic factors on pest buildup. In addition, Ecological Engineering for pest management - a new paradigm to enhance the natural enemies in an agro-ecosystem, is being considered as an important strategy.The ecological approach stresses the need for relying on bio intensive strategies prior to use of chemical pesticides.

Sincere efforts have been made by resource personnel to incorporate AESA based principles and field proven technologies for guidance of the extension officers to educate, motivate and guide the farmers to adopt AESA based IPM strategies, which are environmentally sustainable. I hope that these IPM packages will be relied upon by various Central and State government functionaries involved in extension and Scientists of SAUs and ICAR institutions in their endeavour to promote environmentally sustainable agriculture practices.

A K Srivastava

(Avinash K. Srivastava)

PREFACE

Pests are major biotic constraints to achieve self sufficiency in ensuring food security. Losses due to pest vary range 10-30% depending upon the genetic constituent of crop, its health and the governing environment. General national estimate of annual crop losses due to pest amounts to ₹ 260000 million per year. However, negligence of endemic areas can result in complete crop failures. In view of inefficacy of chemical pesticides and environmental problems thereof, Integrated Pest Management (IPM) has been accepted as a cardinal principle of Plant Protection in the overall Crop Protection Programme under the National Agricultural Policy of the Govt. of India. IPM being an eco-friendly approach, socially acceptable and economically viable has been widely accepted across the country. The IPM package encompasses various management strategies for pest and disease problems. Pest monitoring is also one of the important components of IPM to take proper decision to manage any pest problem. It can be done through Agro-Ecosystem Analysis (AESA), field scouting, light, pheromone, sticky/yellow pan traps. The economic threshold level (ETL) of important pests and diseases are also given in the package to activate appropriate control measures on standing crops.

The existing package and practices was developed way back in 2001-02 by DPPQ & S, Faridabad catering the need of extension personals in extending IPM tactics to farmers. Though these were useful, there is a need to update them in view of changing climate and its impact on pests and their protection measures.

A National Workshop on IPM for harmonization of Package of Practices was organized at the National Centre for Integrated Pest Management, New Delhi, during 25-26th Feb., 2013 with a view to provide technical knowledge to the extension functionaries and farmers in the States. The IPM package has been developed with the technical inputs from the experts from the PI (AICRIP), Indian Council of Agricultural Research (NCIPM), State Agricultural Universities, and DPPQ & S, Faridabad.

It will also be useful in reducing the pesticide residues in exportable agricultural commodities and would also help in the management of pests/diseases/weeds/nematodes, which may get inadvertently introduced in the country. These packages will be useful for the researchers, extension workers and farmers alike who are engaged in the agricultural practices.

Editors

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A. INTRODUCTION

India accounts for 68% of total global output of chickpea and incidentally it is one of the largest consumers. Chickpea is grown in about 8.68 million ha in India with tentative production of 5.35 million tonnes. In 2010-11, the estimated production was about 8.25 MT, a record in the last 50 year. Chickpea forms an integral part of vegetarian diet as a protein substitute in the Indian sub-continent. Besides being a very rich source of protein, it also maintains soil fertility through biological nitrogen fixation. Chickpea is mostly grown in soils poor in fertility and moisture retention capacity. The perennial and indeterminate growth habit, prolonged flowering, flower drop and pod shattering contribute to low yields. The crop is raised mostly by marginal and sub-marginal farmers and is grown unwillingly with no adequate fertilization and sufficient irrigation because of lack of support prices.

In present scenario there is tremendous scope for increasing the productivity of chickpea by reducing the production losses thereof caused by serious pests. The pests and extent of losses thereof differs among various agro-ecological zones. Among them diseases are the most serious constraint causing up to 100% losses during epidemic years. Environmental factors coupled with intensity are known to compound the occurrence and severity of the diseases. Very often the roots of plants are severely affected with nematode infestations, which not only helps pathogen to establish but also blocks nutrient transport to aerial parts of the plant. Currently, chickpea is severely affected by half a dozen major pests, a dozen of major diseases, a dozen of nematodes and weed. On an average 30-80% crop losses occur in pulses due to ravages of insect-pests valued at ₹ 4000 - 5000 crores. Single larva of the gram caterpillar *Helicoverpa* destroy 30-40 pods before its maturity. Annual damage due to *Helicoverpa* alone is around ₹ 150-200 millions. An annual loss due to insect-pests is estimated to be 15% in chickpea. While the losses due to diseases like *Ascochyta* blight and wilt are estimated around 600-750 thousand ton. Estimated loss (%) due to specific pests in Chickpea crops is as follows:

Gram pod borer	10-90%
Gram cutworm	5-30%
Termites	5-15%
Semilooper	0-10%
Wilt/Root rot	20-25%
Ascochyta blight	5-10%
Botrytis grey mould	5-10%

B. BIOTIC CONSTRAINTS

B.1 Major Pests of National Significance

(a) Gram pod borer (*Helicoverpa armigera* Hubner)

(b) Cut worm (*Agrotis ipsilon* Hufnagel)

(c) Termite (*Odontotermes obesus* Ramb. or *Microtermes obesi* Holmgren)

B.2 Major Insect Pests of Regional Significance

(a)	Black bean aphid (*Aphis fabae* Scopoli)	- Haryana
(b)	White grub (*Phyllophaga implicita* Horn)	- Gujarat, Rajasthan and Karnataka

(b)	Termite (*Odontotermes obesus* Ramb. or *Microtermes obesi* Holmgren)	- Rajasthan and Haryana
(d)	Semi looper (*Autographa nigrisigna* Walker)	- Eastern U.P
(e)	Cutworm (*Spodoptera exigua* Hubner)	- Bihar, Haryana, West Bengal and Assam
(f)	Tobacco caterpillar (*Spodoptera litura* Fabricius)	-Andhra Pradesh

B.3. Major Disease of National Signficance

(a)	Vascular wilt (*Fusarium oxyporum* f. sp. *ciceri* (Padwick) Matuo et K. Sato)	All zones
(b)	Dry root rot (*Rhizoctonia bataticola* Taub. Butler)	Central zone, Southern zone
(b)	Collar rot (*Sclerotium rolfsii* Sacc.)	Central zone
(d)	Ascochyta blight (*Ascochyta rabiei* Pass. Labr.)	Central and North-eastern Plateau Zone and Northern himalayan zone
(e)	Botrytis Grey mould (*Botrytis cinerea* Pers. Ex Fr.)	Tarai region

B.4. Major Disease of Regional Significance

(a)	Rust (*Uromyces ciceris- arietini* Grogn. Jacz. & Beyer)	Bihar, U.P. and Karnataka
(b)	*Stemphylium* blight (*Stemphylium sarciniforme* Cav. Wilts)	Eastern Uttar Pradesh, Bihar and Karnataka

B.5. Major weeds of National Significance

(a) Bathua (*Chenopodium album L.*)
(b) Yellow pea (*Lathyrus aphaea L.*)
(c) Common vetch (*Vicia sativa L.*)
(d) Barqua/ Basal (*Asphodelus foelida L.*)
(e) Choulai (*Amaranthus viridis L.*)
(f) Jute (*Corchorus capsularis Spinger*)

B.6. Major Nematode of National Significance

(a)	Root knot (*Meloidogyne incognita* Goldi)	Northern himalayan zone, North-eastern Plateau Zone and Southern zone
(b)	Reniform (*Rotylenchulus reniformis* Linford & Oliveiria)	North-eastern Plateau Zone, Central zone and Southern zone
(c)	Root lesion (*Pratylenchus thornei* Sher & Allen)	Central zone and Southern zone

B.7. Major Nematode of Regional Significance

Chickpea cyst nematode (*Heterodera ciceri* Vovlas)

B.8. Major Rodent of National Significance

Smaller bandicoot (*Bandicota bengalensis* Gray)

C. IPM Approach

There are over seventy two (72) definitions of IPM, issued by governments, research organizations, NGOs, and universities (Bajwa and Kogan, 2002). Some assume that IPM will eliminate the use of crop protection products, specially the chemical pesticides, which is most unlikely. Extreme views equating IPM with "pest free" farming will become increasingly marginalised and more balanced views will prevail. There is no reason not to support IPM as defined by the FAO International Code of Conduct on the Distribution and Use of Pesticides (Article 2): *Integrated Pest Management (IPM) means a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in a compatible manner as possible and maintains the pest populations at levels below those causing economically unacceptable damage or loss* (FAO, 1967). Thus, IPM is the best combination of cultural, biological and chemical measures that provides the most cost-effective, environmentally sound and socially acceptable method of managing diseases, insects, weeds and other pests.

IPM is a knowledge-intensive sustainable approach for managing pests by combining compatible cultural, biological, chemical, and physical tools in a way that minimizes economic, health, and environmental risks with the help of pest scouts. IPM relies heavily on knowledge of pests and crop interaction to choose the best combination of locally available pest management tools (Fig. 1). Therefore, IPM is not a single product that can be stored on shelves like pesticide, and it does not rely on single method to solve all our pest problems. Pests also co-evolve and adapt very quickly to single control tactics through natural selection, and that multiple methods used simultaneously, or an "integrated" approach, is the most effective for long-term, sustainable management programs.

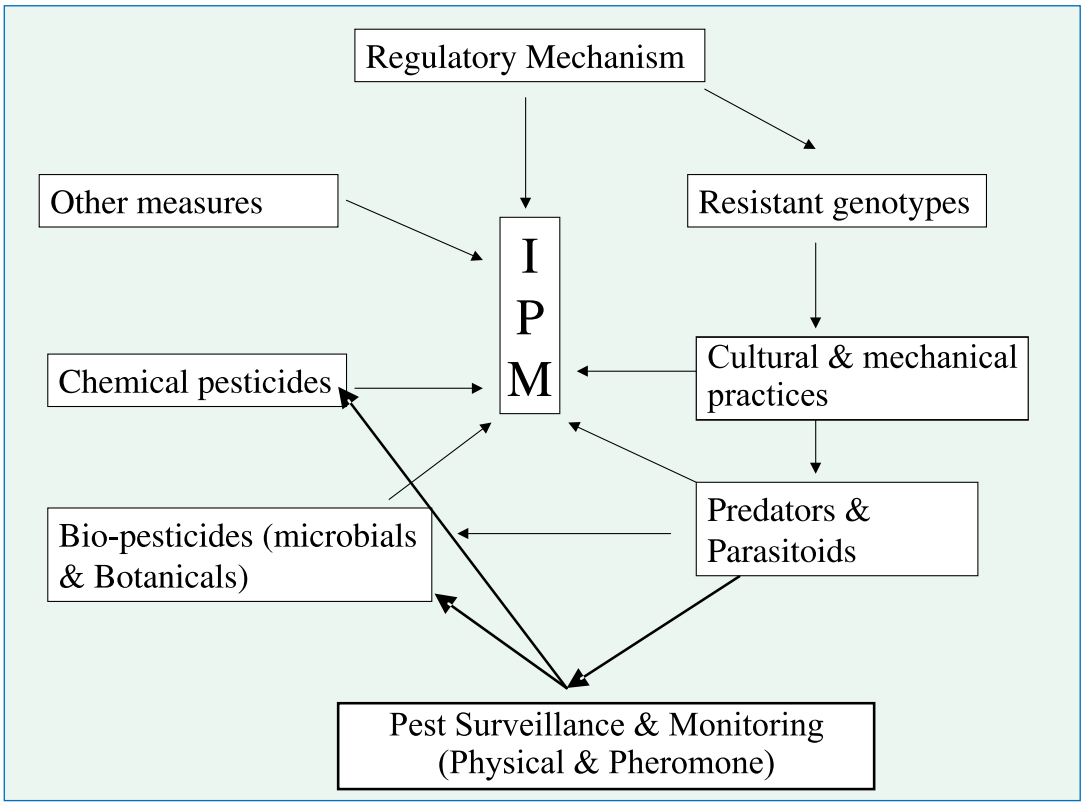


Fig 1. Diagrammatic representation of IPM components.

IPM is neither organic nor it relies solely on biological control to achieve the desired sustainable outcome. It does often try to assist and augment the efficacy of natural enemies by limiting the impact of pesticide on their populations and provide clean and safe niche. It seeks to conserve balance between the crop and the natural environment. The World Bank policy (OP 4.04 - Natural Habitats) also promotes the conservation of natural habitats, and enhancement of the environment for long-term sustainable development. In the IPM concept, use of pesticides involves a trade-off between pest control and the risks of adverse effects on non-target organisms, such as natural enemies, pollinators, wildlife, and plants, contamination of soil and water.

C.1 PEST MONITORING

The objective of pest monitoring is to detect the initial development of pests and also assess the potential of management by natural enemies under field conditions.

C.1.1 Rapid Roving Survey (RRS)

a) At the beginning of the crop season, survey routes are required to be identified in the pest and disease endemic areas to undertake Rapid Roving Surveys (RRS). During the survey the observations are to be made at every 5-10 km distance in the pro-selected route at 7-10 day intervals depending upon pest and disease situation. Record the seedling mortality by creating dead plants per meter row. Same sampling procedure may be adopted for assessing pod borer infestation. Recoding the incidence of pest, disease and defender population at each spot on 5 plants at random and 12 spots per ha.

b) Root-knot nematode produces diagnostic symptoms of "gall" formation on roots, reniform produces "dirty roots systems" and cyst nematode produces "pearly root disease". This can be seen with a hand lens. Stain roots with Trypan blue stain, egg sacs of nematodes turn deep blue, root remains unstained.

c) The working index for rodent pests is 25 live burrows/ha.

C.1.2 Field Scouting

Based on the observations of RRS the farmers at village level are to be mobilised to undertake field scouting. During field scouting, farmers may record pest, disease and defenders population once in 7-10 days in their own fields as per Agro Eco-System. The State Departments of Agriculture should make all possible efforts using different media, mode and publicity to inform the farmers for the need of field scouting in the specific crop areas having indication of pest or disease build up.

C.2 Agro Eco System Analysis (AESA)

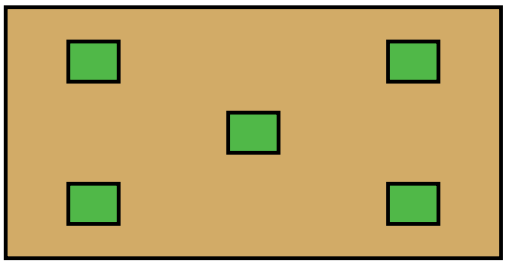
IPM has been evolving over the decades to address the deleterious impacts of synthetic chemical pesticides on environment ultimately affecting the interests of the farmers. In modern IPM (FAO, 2002) emphasis is given to Agro Eco System Analysis (AESA) where farmers take decisions based on larger range of field observations. The health of a plant is determined by its environment which includes physical factors (i.e. sun, rain, wind and soil nutrients) and biological factors (i.e. pests, diseases and weeds). All these factors can play a role in the balance which exists between herbivore insects and their natural enemies. Understanding the intricate interactions in an ecosystem can play a critical role in pest management.

It is an approach, which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factors and their interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practice. The basic components of AESA are:

1. Plant health at different stages.
2. Built-in-compensation abilities of the plants.
3. Pest and defender population dynamics.
4. Soil conditions.
5. Climatic factors.
6. Farmers past experience.

C.2.1 AESA Methodology

Field observations on insect pests and diseases are to be initiated after 20 days of sowing. In each field select five spots randomly as shown in the figure (four in the corner, at least 5 feet inside the border and one in the centre). At each spot select/ 10 plants randomly for recording observations (Total 20 plants/field).



Data recording

Farmers sho uld record data in a notebook and drawing on a chart

- Keep records of what has happened
- Help us making an analysis and draw conclusions

Data to be recorded

- Plant growth (weekly)
  - Length of plant
  - Number of seedling mortality (Collar rot/ wilt/ insect damage)
- Crop situation (e.g. for AESA)
  - Plant health: Observe the crop stage and deficiency symptoms etc
  - Pests, diseases, weeds: Count insect pests at different places on the plant, and identify any visible disease symptoms and severity. Observe weeds in the field and their intensity. For termites, count number of affected plants.
  - Natural enemies: Count parasitoids and predators
  - Soil condition
  - Irrigation
  - Weather conditions
- Input costs
  - Seeds
  - Fertilizer
  - Pesticides
  - Labour
- Harvest
  - Yield (kg/ ha)
  - Price of produce (₹ /kg)

C.2.2 Important instructions while taking observations

- While walking in the field, manually collect insects in plastic bags. Use a sweep net to collect additional insects. Collect plant parts with disease symptoms.
- Find a shady place to sit as a group in a small circle for drawing and discussion.
- If needed, kill the insects with some chloroform (if available) on a piece of cotton.
- Each group will first identify the pests, defenders and diseases collected.
- Each group will then analyze the field situation in detail and present their observations and analysis in a drawing (the AESA drawing as shown in MODEL AESA CHART.
- Each drawing will show a plant representing the field situation. The weathercondition, water level, disease symptoms, etc. will be shown in the drawing. Pest insects will be drawn on one side. Defenders (beneficial insects) will be drawn on another side.
- Write the number next to each insect. Indicate the plant part where the pests and defenders were found. Try to show the interaction between pests and defenders.
- Each group will discuss the situation and make a crop management recommendation.
- The small groups then join each other and a member of each group will now present their analysis in front of all participants.
- The facilitator will facilitate the discussion by asking guiding questions and makes sure that all participants (also shy or illiterate persons) are actively involved in this process.
- Formulate a common conclusion. The whole group should support the decision on what field management is required in the AESA plot.
- Make sure that the required activities (based on the decision) will be carried out.
- Keep the drawing for comparison purpose in the following weeks.

C.2.3 Description of parasitoids and predators in chickpea ecosystem

Chickpea insect pests have many natural enemies. Predators hunt and consume all or part of their prey and usually need to eat more than one victim. In contrast, parasitoids live on or in the body of their host and need only a single host for sustenance. These natural biological control agents are friends of the farmers and are responsible for controlling the population build-up of insect pests.

Egg parasitoids

***Telenomus* spp.**

Black and barely half the size of Tetrastichus. Has 5-segmented tarsus, pointed abdomen and with rib-like structure in the basal abdominal segment. Several wasps lay eggs on a single egg mass, but only one can develop within each egg. A female parasitizes 20-40 eggs and lives 2-4 days or longer.

Larval Parasitoids

Campoletis chlorideae

Adult female lays on an average 13 and 42 eggs after single mating and throughout its life span, respectively. The sex ratio of male: female in mated progeny is 1: 3.15. Adult longevity can be increased by providing honey. Field release of 1-2 day old parasitoids (15,000 adults/ha; sex ratio 1: 3) in field showed encouraging results.

***Bracon hebetor* Say** (Hymenoptera: Braconidae)

Bracon hebetor is a minute Braconidae wasp that is an internal parasite to the caterpillar stage of lepidoptera. The gut enzymes from the *Bracon hebetor* wasp quickly destroy the blood proteins in the moth larvae; thus it is an effective biocontrol agent. At 30 °C (86 °F), the life cycle of the wasp is about ten to thirteen days from initial parasitism to final emergence of the adult. The adult female parasite lives about 23 days during which it produces about 100 eggs. It deposits 1 to 8 eggs in individual paralyzed late instar moth larvae.

Egg-larval *Parasitoids*

A parthenogenetic egg-larval parasitoid, *Chelonus blackburnii* has a fairly wide host range. *C. blackburnii* is introduced from Hawaii. It could also be multiplied successfully on *Spodoptera exigua*.

Predators

Chrysoperla carnea

The green lacewings, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) is a cosmopolitan predator found in a wide range of agricultural habitats. They are important for the management of bollworms and aphids in cotton and tobacco and several sucking pests in fruit crops. They are capable of bringing down the population of the pest drastically. In India, 65 species of chrysopids belonging to 21 genera have been recorded from various crop ecosystems.

Assassin bugs: Reduviidae (Hemiptera)

Adults range from 10-30 mm in length and have distinct heads with prominent eyes; their abdomens have a slight waist. The head is elongated with a long curved 'snout' (proboscis). The proboscis is curved only in predatory bugs. Colour is variable, but usually includes brown, orange and/or black. The front legs are enlarged to grasp prey and the back legs are long and slender. The nymphs resemble adults but do not have wings. The eggs are barrel-shaped and laid upright in clusters or rows on the leaves or stems of plants. Eggs hatch within two weeks and the wingless nymphs pass through five growth stages before reaching adulthood. As adults, assassin bugs may live for a further 6-10 months and lay up to 300 eggs in rafts of 30-60 eggs.

Ladybird Beetle

Ladybird Beetle common name for any of numerous related species of brightly colored beetles found in temperate and tropical regions throughout the world. The ladybird beetle is less than 1.2 cm (less than 0.5 in) in maximum length. It has a nearly hemispherical body, rounded above and flat below, a small head, and short legs. Ladybird beetles are often red or orange above spotted with black, white, or yellow. Some species are black, with or without spots. The larvae are also brilliantly colored, often blue, with stripes of orange or black.

Spider

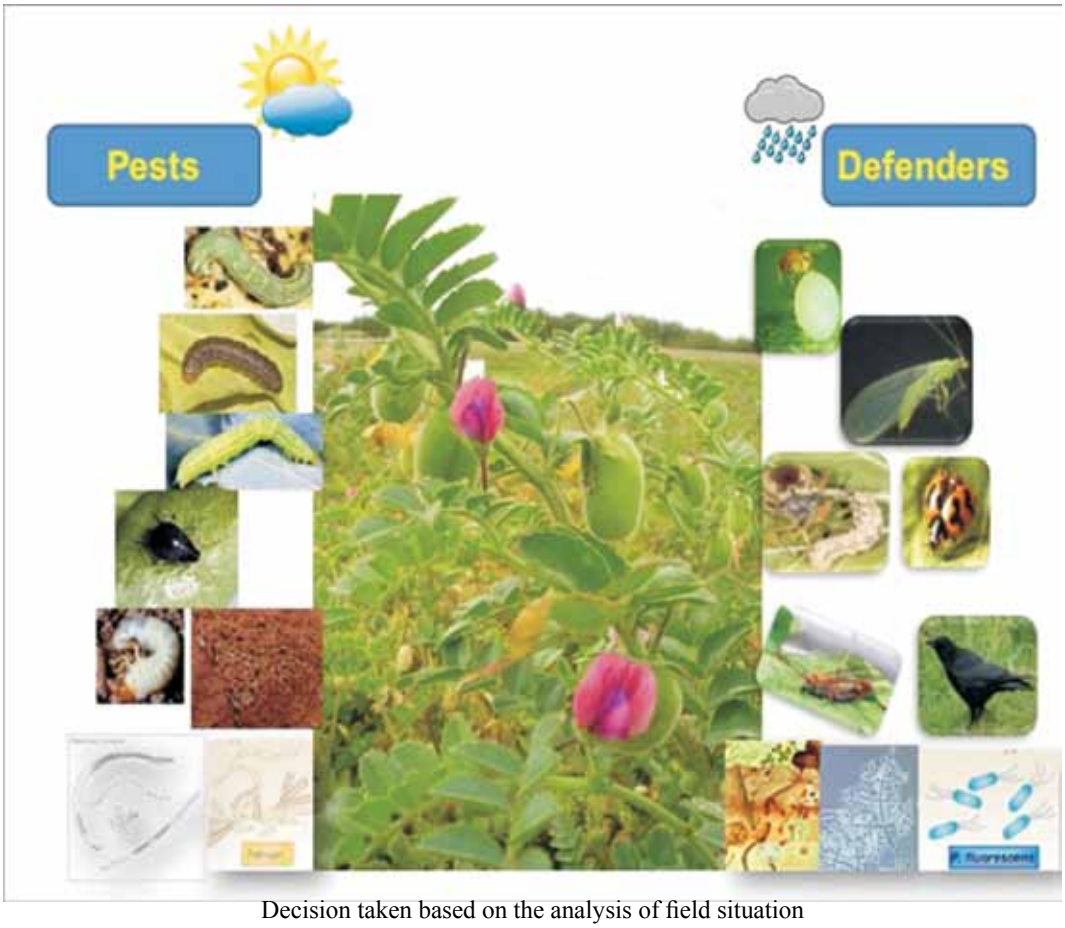
Spiders, which belong to class Arachnida, are a very diverse group of invertebrate predators found in agro-ecosystems a nd natural systems. Spiders are predators and aid us by eating many pests. Some spiders spin webs in which they patiently wait for their prey to become entangled, others actively hunt down their prey, and still others sit motionless on plants or flowers and pounce in ambush on unwary insects that wander near. Hunting spiders have prominent eyes and good eyesight to see their prey, and instead of large webs they construct small silken shelters in which to rest. Web spinners create silken webs, but have poor vision and rely on the vibrations of insects captured in their webs to detect their prey

Pest: Defender ratio (P: D ratio)

Identifying the number of pests and beneficial insects helps the farmers to make appropriate pest management decisions. Sweep net, visual counts etc. can be adopted to arrive at the numbers of pests and defenders. The P: D ratio can vary depending on the feeding potential of natural enemy as well as the type of pest.The natural enemies of chickpea pests can be divided into 3 categories 1. parasitoids; 2. predators; and 3. pathogens.

C.2.4 Model agro-ecosystem analysis chart

Date: **Village:** **Farmer:**



Decision taken based on the analysis of field situation

Soil conditions :

Weather conditions :

Diseases types and severity :

Weeds types and intensity :

Rodent damage (if any) :

No. of insect pests :

No. of natural enemies :

P: D ratio :

The general rule to be adopted for management decisions relying on the P: D ratio is 2:1. However, some of the parasitoids and predators will be able to control more than 2 pests. Wherever specific P: D ratios are not found, it is safer to adopt the 2: 1, as P: D ratio. Whenever the P: D ratio is found to be favourable, there is no need for adoption of other management strategies. In cases where the P: D ratio is found to be unfavourable, the farmers can be advised to resort to inundative release of parasitoids/predators depending upon the type of pest. In addition to inundative release of predators, the usage of microbial biopesticides and biochemical biopesticides such as insect growth regulators, botanicals etc. can be relied upon before resorting to synthetic chemical pesticides.

C.2.5 Feeding / Egg laying potential of different capacity Parasitoids / Predators

Lady bird beetle	Predatory rate of adult coccinellid on aphids is 50 aphids per day
Green lacewing	Each larva can consume 100 aphids, 329 pupa of whitefly and 288 nymphs of jassids.
Hover fly	1st instar larva can consume 15-19 aphids/day 2nd instar larva can consume 45-52 aphids/day 3rd instar larva can consume 80-90 aphids/day In total life cycle they can consume approx. 400 aphids.
Spider	5 big larvae/day
Predatory mite	Predatory rate of adult is 20-35 phytophagous mites/female/day
Bracon hebetor	Egg laying capacity is 100-200 eggs/female. 1-8 eggs/larva.

Some of Good Insectory Plants

Cosmos

Sunflower

Okra

Ageratum sp.

Marigold

Fennel

Carrot

Coriander

Tridax

Mustard

Radish

Alfalfa

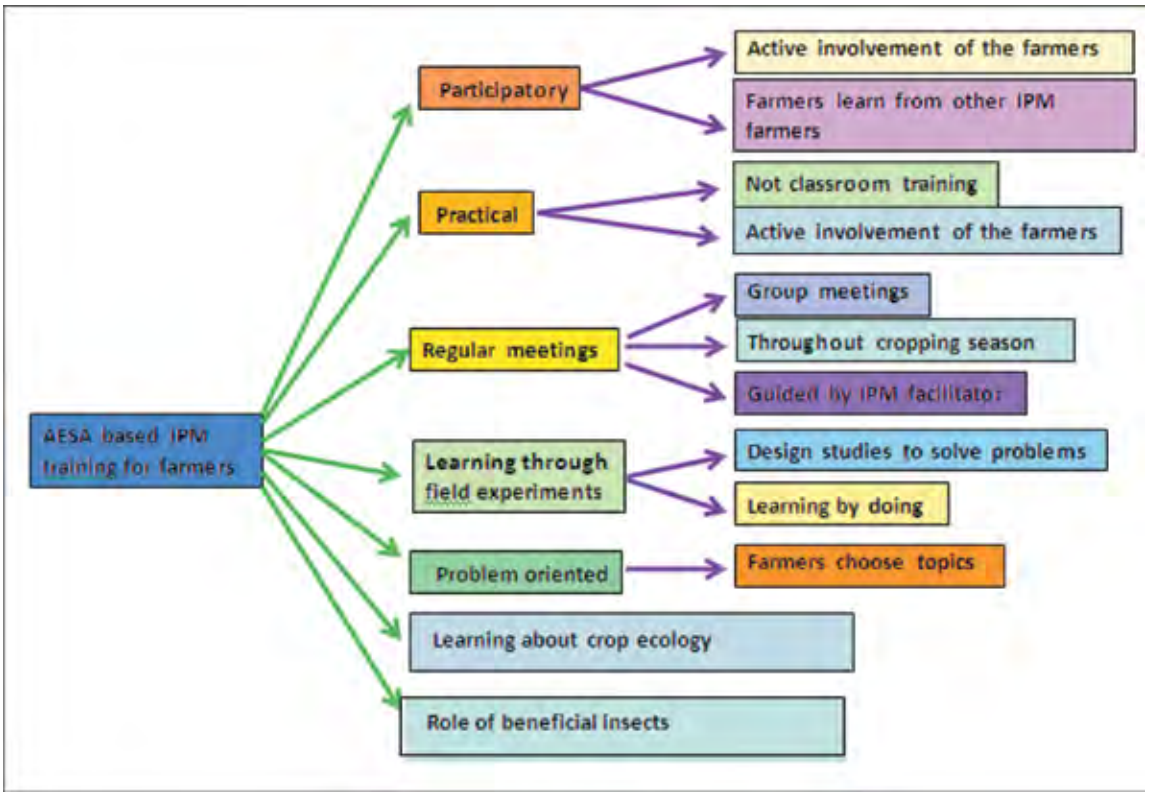
Good insectary plants belonging to Compositae, Malvaceae, Umbelliferae, Brassicae and Asteraceae etc families.

AESA and farmer field school (FFS)

AESA is a season-long training activity that takes place in the farmer field. It is season-long so that it covers all the different developmental stages of the crop and their related management practices. The process is always learner-centered, participatory and relying on an experiential learning approach and therefore it has become an integral part of FFS.

Farmers can be benefited from AESA

- Identification of pests and their nature of damage
- Identification of natural enemies
- Management of pests
- Water and nutrient management
- Influence of weather factors on pest buildup
- Role of natural enemies in pest management



FFS to teach AESA based IPM skills

D. INTEGRATED PEST MANAGMEENT STRATEGIES

D.1 Cultural

(a) Deep ploughing immediately after harvesting

(b) Destruction of stubbles.

(c) Incorporation of *Trichoderma viride* @ 5kg/ha. multiplied on decomposed FYM @100kg/ha under moist soil condition in wilt/root rot affected areas.

(d) Apply well decomposed FYM or Neem cake/ Mahua cake @ 500 kg/ha or nematode prone areas.

(e) Use tolerant/resistant varieties.

(f) Inter crop of linseed/mustard/wheat/coriander /rabi sorghum. Fix bird percher 20/ha. Mix 5g of Rabi sorghum or Sunflower seeds with Chickpea seeds while sowing to serve as bird attractants.

(g) Take up early and timely sowing and select early maturing varieties.

(h) Synchronous sowing in a village or area.

(i) Crop rotation with non-leguminous crop to reduce soil-borne diseases such as wilt and root rot.

(j) Sow marigold as trap/ disease indicator crop on border or in between the crop rows.

(k) In case of endemic area of *Fusarium* wilt/dry root rot (*Rhizoctonia*) chickpea should not be grown in infested fields for at least three years.

(l) Wider spacing (60 cm instead of 30 cm) for *Botrytis* grey mould or thinning out of infested crop to allow more light and reduce disease severity.

(m) Avoid excessive vegetative growth and undertake detopping at 30 dasy after sowing especially in deep black soils

(n) Removal of weeds (*Chenopodium album* and *Vicia sativa*) at the flowering stage of the crop.

(o) Avoid growing solanaceous crops during Kharif in the root knot nematode prone areas.

(p) Destroy rodent burrows and trim the bunds to avoid harbourage of rodents.

D.2 Genetical

Since diseases are the key pest problems and are difficult to manage economically following recommended varieties may be adopted:

List of moderatery resistant genotypes against pests and disease.

Pest/Disease	Tolerant/resistance genotype
Vascular wilt	Avrodhi, BG 212, KPG 59, BGD 72, Pusa 391, Vijay, Vishal, Rajas, BG 256, Gujrat Gram, GNG1581, GNG 1292,Virat, GJ 3, RSG88, JG315, JG74, JG11, JG322, JG63, JG12, JG14, JG16, JGK1, JGK2, JGK3, KAK2, Subhra BG 1053, HK2, JAK1 9218, Phule G9531, RSG 931, RSG 963, CSG 8962, DCP 92-3, JSC 55, JSC56, HK 05-169
Dry root rot	JSC 37, JG 25174, CSJ 556, MPJG 89- 1155, MPJG 89- 9023, CSJ 592, Rajas, JS 2000-07, ICCC 32, GL769
Ascochyta blight	C235, GS43,CG558, Himachal channa1, Himachal channa 2, IPC 08-11, 23094, GNG 1581, GPF2, PBG5, Gaurav(H75-35), BG 267, Vardhan, Samrat
Botrytis grey mould	BG 276, GL90159, GL 9-1071, GL92162, HK94-134, IPCK 2004- 29, ICC38, ICC 202, ICC1069
	IPC 2004-52, IPC 2000-06, NDG 10-11, Phule G 07112

Varieties of Chickpea Recommended in Different Parts of the Country

State	Varieties
Andhra Pradesh	Bh i (ICCV 10), JG 11, Phule G 95311 (K), MNK 1
Assam	JG 74, Udai (KPG 59), KWR 108, Pusa 372
Bihar	Pusa 372, Pusa 256, Pusa Kabuli 1003, Udai, KWR 108, Gujrat Gram 4, RAU 52
Chhatishgarh	JG 315, JG 16, Vijay, Vaibhav, Jawahar Gram Kabuli 1 (JGK 1), BG 372, Pusa 391, BG 072, ICCV 10
Gujarat	Pusa 372, Pusa 391, Vishwas, JG 16 (SAKI 9516), Vikas, Vijay, Dharwad Pragati (BGD 72), Gujrat Gram 1, Gujrat Gram 2, Jawahar Gram Kabuli 1 (JGK 1), IPCK 2002-29, IPCK 2004-29
Haryana	DCP 92-3, Haryana chana 1, Haryana Kabuli chana 1, Pusa 372, Pusa 362, PBG 1, Udai, Karnal Chana 1, Samrat (CNG 469), Vardan, GPF 2, Chamatkar, RSG 888, Haryana Kabuli Channa 2, BGM 547, Phule G 9425-9, GNG 1581
Himachal Pradesh	PBG 1, DCP 92-3, Samrat (CNG 469), BGM 547, Phule G 9425-9
Jammu & Kashmir	DCP 92-3, Samrat (CNG 469), PBG 1, Pusa Chamatkar (BG 1053), BGM 547, Phule G 9425-9
Jharkhand	Pusa 372, Pusa 256, Pusa Kabuli 1003, Udai, KWR 108, Gujrat Gram 4
Karnataka	JG 11, Annegeri 1, Chaffa, Bharati (ICCV 10), Phule G 9531, Sweta (ICCV 2) K, MNK 1
Maharastra	Vijay, Pusa 372, JG 16 (SAKI 9516), Pusa 391, Vishwas (Phule G 5), Dharwad Pragati, Vishal, Vikas, Phule G 12, Jawahr Gram Kabuli 1 (JGK 1), KAK 2, Vihar, BGD 128 (K), IPCK 2002-29 (K), PKV Kabuli 4 (K), IPCK 2004-29, Phule G 0517(K)
Madhya Pradesh	JG 74, JG 315, JG 322, Pusa 391, Vishwas (Phule G 5), Vijay, Vishal, JG 218, JG 16 (SAKI 9516), JG 130, JGG 1, Jawahar Gram Kabuli 1 (JGK 1), BGD 128 (K), IPCK 2002-29, PKV Kabuli 4(K), IPCK 2004-29(K)
Manipur	JG 74, BG 256, Pusa 372
Meghalaya	JG 74, BG 256, Pusa 372
Odissa	Pusa 391, JG 11, Phule G 9531, ICCV 10
Punjab	Pusa 256, PBG 5, Harayana chana 1, Pusa 329, Pusa 372, DCP 92- 3, Vardan, Samrat, GPF 2, Pusa 362, Alok, PBG 3, Pusa Chamatkar, GNG 1581(BG1053), BGM 547, Phule G 9425-9, RG 931, RSG 888, Rajas
Rajasthan	RSG 931, GNG 146, PBG 1, Harayna chana 1, Udai, Pusa 372, DCP 92-3, CNG 663, GPF 2, Samrat, Pusa 362, Alok (KGD 1168), Pusa Chamatkar (BG 1053), RGS 888, BGD 28 (K), GNG 1581, RSG 963, Rajas
Tamil Nadu	Bharti (ICCV 10), JG 11, Co 3, Co 4, Phule G 95311.
Tripura	JG 74, BG 256, Pusa 372
Uttar Pradesh	DCP 92-3, KWR 108, Pusa 256, Pusa 372, Vardan, JG 315, Udai, Alok (KGD 1168), Vishwas, Pusa 391, Samrat (GNG 469), GPF 2, Vijay, Pusakabuli 1003 (BG 1003), Gujrat Gram 4
Uttarakhand	Pant G 186, DCP 92-3, Samrat, KWR 108, Pusa Chamatkar (B6 1053), BGM 547, Phule G 9425-9
West Bengal	JG 74, Pusa 256, KWR 108, Mahamaya 1, Mahamaya 2, Gujrat Gram 4

D.3 Mechanical

a) Heaps of grasses on bud encourage congregation of larvae which should be mechanically destroyed.

b) Erection of 20 bird perches/ha. Bird perches should be removed just after maturity/harvesting of the crop.

Monitoring

The aerial monitoring of adult moth can be assessed by using water pan/trays placed below light traps or commercially available light traps. Use of Pheromone traps for monitoring gram pod borer is strongly recommended.

Field scouting

The objective through roving surveys is to monitor the initial development of pests in endemic areas. Therefore, in the beginning of crop season survey routes based upon the endemic areas are required to be identified to undertake roving surveys. Based upon the results of the roving surveys, the state extension functionaries have to concentrate for greater efforts at block and village levels as well as through farmers to initiate field scouting. Therefore, for field scouting farmers should be mobilised to observe the insect pest and disease occurrence at the intervals as stipulated hereunder. The plant protection measures are required to be taken only when insect pests and diseases cross Economic Threshold Level (ETL) as per results of field scouting.

1. Roving survey: -Undertake roving survey at every 10 km distance at 7-10 days intervals (depending upon pest population). Everyday at least 20 spots should be observed.
2. Field scouting: - Field scouting for pests and bio-control fauna by extension agencies and farmers once in 3-5 days should be undertaken to workout ETL

AESA requires skill, so only the trained farmers can undertake their exercise. However, other farmers also can do field scouting in their own fields at regular intervals to monitor the major pest situation.

Aphids

Count and record the number of both nymphs and adults on five randomly selected leaves per plant.

Helicoverpa and *Spodoptera*

Total number of fruits, damaged fruits due to *Helicoverpa* and *Spodoptera* and number of larvae on individual plants per meter row or 1 sq meter should be counted and recorded.

Surveillance through pheromone trap

Pheromone traps for two insects viz., *Helicoverpa armigera* and *Spodoptera litura* @ 5/ha have to be installed. Install the traps for each species separated by a distance of >75 feet in the vicinity of the selected fixed field. Fix the traps to the supporting pole at a height of one foot above the plant canopy. During each week of surveillance, the number of moths/trap should be counted and entered. Total number of moths of *Helicoverpa armigera* and *Spodoptera litura*/trap/week should be recorded year round. The trapped moths should be destroyed and removed after each recording.

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).

Nematode sampling

Collect 100 to 300 cm^3 (200-300 g) soil sample. Mix soil sample and pass through a coarse sieve to remove rocks, roots, etc. Take a 600 cc subsample of soil, pack lightly into a beaker uniformly. Place soil in one of the buckets or pans half filled with water. Mix soil and water by stirring with paddle; allow to stand until water almost stops swirling. Pour all but heavy sediment through 20-mesh sieve into second bucket; discard residue in first bucket; discard material caught on sieve. Stir material in second bucket; allow to stand until water almost stops swirling. Pour all but heavy sediment through 200-mesh sieve into first bucket; discard residue in second bucket. Backwash material caught on 200-mesh sieve (which includes large nematodes) into 250-ml beaker. Stir material in first bucket; allow to stand until water almost stops swirling. Pour all but heavy sediment through 325-mesh sieve into second bucket; discard residue in first bucket. Backwash material caught on 325-mesh sieve (which includes small to mid-sized nematodes and silty material) into 250-ml beaker. More than 90% of the live nematodes are recovered in the first 5-8 mm of water drawn from the rubber tubing and the sample is placed in a shallow dish for examination.

Economic Threshold Levels (ETLs)

S. No	Pest insects	Stage of the crops	Economic threshold Levels (ETLS)
Insects			
1.	Cut worm (*Agrotis ipsilon* HufInagel and *Spodoptera exigua* Hubner)	Seedling stage	One larvae/ square meter under the soil near cut plant.
2.	Termite (*Odontotermes obesus* or *Microtermes obesi*)	Seedling stage	5 damaged plants/sq. meter.
3.	White grub (*Phyllophaga implicita*)	Seedling stage	5 grubs/sq. meter
4.	Gram pod borer (*Helicoverpa armigera*)	Vegetative/ reproductive	5 to 8 eggs or 2 early instar /10 plants or one mature larvae (more than 1cm in length)/10 plants or I meter row.
5.	Semilooper (*Autographa nigrisigna*)	Vegetative phase	2 larvae/10 plants
Diseases			
6.	Wilt & root rot (*Fusarium oxysporum*)	Seedling/vegetative	5-10% plants infested
Rodents			
7.	Working index(ETL)	Before podding	25 live burrows/ha
Nematodes			
8.	Nematodes	Vegetative phase	1-2 larvae/g of soil

Flowering plants that attract natural enemies/repel pests

Insect	Natural enemies	Flowering plants that attract natural enemies/repel pests
Gram pod borer	**Parasitoids:** *Telenomus* spp. (egg), *Chelonus blackburni* (egg-larval), *Carcelia* spp. (larval-pupal), *Campoletis chlorideae* (larval), *Goniophthalmus halli* (larval), *Bracon* spp. (larval) etc. **Predators:** *Chrysoperla carnea*, coccinellids, King crow, common mynah, wasp, dragonfly, spider, robber fly, reduviid bug, prayi ng mantis, fire ants, big eyed bugs (*Geocoris* sp), pentatomid bug (*Eocanthecona furcellata*), earwigs, ground beetles, rove beetles etc.	• Repellant plants: Basil • Attractant plants: Coriander, buckwheat, alfalfa, (minute pirate bug and lacewing) • Nectar rich plants with small flowers i.e. anise, caraway, dill, parsely, mustar, Malvaceae sunflower, buck wheat and cowp ea(wasp)
Tobacco caterpillar	**Parasitoids:** *Trichogramma chilonis* (egg), *Telenomus* spp. (egg), *Chelonus blackburni* (egg-larval), *Carcelia* spp. (larval-pupal), *Campoletis chlorideae* (larval), *Eriborus argentiopilosus* (larval), *Microplitis* sp, *Bracon hebetor* (larval) etc. **Predators:** *Chrysoperla carnea*, coccinellids, King crow, common mynah, wasp, dragonfly, spider, robber fly, reduviid bug, praying mantis, fire ants, big eyed bugs (*Geocoris* sp), pentatomid bug (*Eocanthecona furcellata*), earwigs, ground beetles, rove beetles etc. *Ovomermis albicans*, a nematode,	Repellant plants: Basil • Attractant plants: Carrot family, sunflower family, buck wheat, alfalfa, corn, shrubs (minute pirate bug and lacewing) • Nectar rich plants with small flowersi.e. anise, caraway, dill, parsely, mustard, sunflower, buck wheat and cowpea (wasp)
Agrotis ipsilon	**Parasitoids:** *Microgaster* sp., *Bracon kitcheneri, Fileanta ruficanda* (Larval parasitoid) **Predators:** *Broscus punctatus*, *Liogryllus bimaculatus* (Larval predators)	• Repellant plants: Basil • Attractant plants: Carrot family, sun flower family, buck wheat, alfalfa, corn, shrubs (minute pirate bug and lacewing)
Aphis craccivora (Aphids)	*Aphytis* spp, *Trixys indicus*, *Lipolexix scutellaris*, *Coccinella septempunctata*, *C. transversalis*, *C. nigritis*, *Menochilus sexmaculatus*, *Brumus suturalis*, *Chrysoperla* spp. and (Larva and adult predators)	• Repellant plants: Basil • Attractant plants: Carrot family, sunflower family, buck wheat, alfalfa, corn, shrubs (minute pirate bug and lacewing)

D.4 Biological

(a) Seed treatment with effective strain of *Trichoderma viride* (of local specific isolate) @ 4 -10 g/kg of seed.

(b) Spray crude NSKE 5% or Azadirachtin 0.03% (300 ppm) Neem oil based WSP @ 2500 to 5000 ml /ha at pre-flowering stage at 15 days interval.

(c) Spray *Bacillus thuringiensis* var. *kurstaki* (HD-1, serotype 3a, 3b or H-3a, 3b, Strain -52 or 0.5% WP serotype 3a, 3b, 3c, Strain DOR Bt-1) against Pod borer @1 Kg/ha.

(d) Spray Beauveria bassiana 1% WP(Strain No: NBRI – 9947) @ 3kg/ha

(e) Spray *Ha*NPV 2.0% AS (Strain No. IBH-17268 or Strain No. BIL/HV-9) @ 250 LE (POB $5x10^{11}$/ml)/ha + 0.5% Jaggery + 0.1 % fabric whiteners (tinopal, blue etc)/ha on noticing 1st instar larvae or eggs of pod borer (3 sprays at weekly intervals in evening hours).

(f) Conserve *Campoletis*, lady bird beetles, *Chrysopa*, Stinkbugs, Reduviid bug, Predatory wasps and spiders by intercropping with coriander.

D.5 Chemicals

a. Insects

Insecticides	Insect	Dose per hectare
Azadirachtin 0.03% (3000 ppm)	Pod borer	2500-5000 ml
Chlorpyriphos 20EC	Pod borer, Cut worm	2,500 ml
Chlorpyriphos 20 EC	Termite (seed treatment)	15- 30 ml/kg of seed
Quinalphos 25EC	Pod borer	1000 ml
Deltamethrin 2.8% EC	Pod borer	400 – 500 ml
Carbaryl 10% DP	Pod borer	25000 ml
Monocrotophos 36% SL	Pod borer	625ml
Ethion 50 EC	Pod borer	1000 – 1500 ml
Emamectin benzoate 5% SG	Pod borer	220 ml
Novaluron10% EC	Pod borer	700 ml
Chlorantraniliprole18.5%SC	Pod borer	125 ml

b. Diseases

Fungicides	Diseases	Dose g/kg seed
Trichoderma viride	Wilt/Root rot	5 g/kg seed.

c. Nematodes

Seed treatment with *Trichoderma viride* @ 10g/kg of seeds helps to reduce root knot, lesion nematode and wilt problems also.

d. Rodents in Chickpea

Lesser bandicoot: *Bandicota bengalensis* (Gray) (throughout India) Nibbles the germinating seeds. And at maturity damages the pods/seeds

E. Management practices

- Plough the fields to demolish the rodent habitat and maintain weed free fields to reduce alternate source of food and habitat
- Practice burrow smoking using natural smoking materials in ANGRAU/ NIPHM burrow fumigator for 2-3 min. for each burrow
- Application of 0.005% bromadiolone in ready to use form (wax blocks) or loose bait in packets near rodent burrows
- Apply 2% Zinc phosphide poison baits when the rodent infestation is very high. Practice pre-baiting incase of ZNP poison baiting. Don't apply ZNP poisons more than one time in a crop season as rodents develop bait shyness to this poison.

E.1 Weed Management Practices

(a) Follow recommended agronomic practices for land preparation, seed rate, proper fertilizer and irrigation management so as to achieve optimum plant population and healthy crop to reduce weed competition at early crop stage.

(b) The crop should be maintained weed free initially for 6-8 weeks by following timely inter culture and hand weeding.

F. Crop Stage- wise IPM practices

S. No.	Crop stage	Pest	IPM component	IPM practices
1	Pre-sowing	Pod borer/ Cut worm/ Termite	Cultural practices	1. Deep summer ploughing after harvest. 2. Apply well decomposed FYM or neem cake 3. Synchronised sowing single recommended varieties in village/area. 4. Marigold plantation should be adopted as trap/ indicator crop/ antagonistic crop for nematode. 5. Inter cropping with Linseed/Coriander/Mustard/ Wheat/Sorghum (*rabi*) or 'sprinkle' crop of Sorghum/ Sunflower as described under cultural practices. 6. Early planting i.e., mid-October to escape the peak activity of *H. armigera.* 7. Use tolerant/ resistance varieties
		Wilt/ root rots		1. Destruction of disease crop debris/ un-decomposed organic matter by deep tillage/ burn. 2. Timely sowing to avoid drought.
		Ascochyta Blight	Cultural practices	1. Destruction and burial of diseased crop debris by deep tillage. 2. Timely sowing to avoid drought. 3. Cultivation of resistant varieties (C235, GS43,CG558, Himachal channa1, Himachal channa 2, IPC 08-11, 23094, GNG 1581, GPF2, PBG5,
				Gaurav (H75-35),BG 267, Vardhan, Samrat)
		Botrytis grey Mould	Cultural practices	1. Avoid late sowing and adopt wider spacing. 2. Cultivation of resistant variety (BG 276, GL90159, GL 9- 1071, GL92162, HK94-134, IPCK 2004- 29, ICC38, ICC 202, ICC1069) 3. Use disease free certified seed.
		Dry root rot Collar root rot	Cultural practices	1. Timely sowing to avoid drought 2. Mild irrigation at the time of disease incidence under stress condition to minimize the soil temp. 3. Cultivation of resistant variety (JSC 37, JG 25174, CSJ 556, MPJG 89- 1155, MPJG 89-9023, CSJ 592, Rajas, JS 2000-07, ICCC 32, GL769)

S. No.	Crop stage	Pest	IPM component	IPM practices
		Nematode (Root knot, Reniform, Root lesion)	Cultural practices	Use of organic amendments including neem and castor cake @ 1 ton/ha 10 days before sowing in infested field and their combination with seed treatment with carbosulfan (25 DS) @ 3% a.i (w/w).
			Biological control	Seed treatment with *Trichoderma viride* each @ 10g/kg seed
2	Seed & Seedling	Cut worm/ Termite/ Collar rot/ Dry root rot/ Botrytis Grey mould *Ascochyta*	Mechanical cultural practices	1. Use *Rhizobium* culture @ 1pkt (200g) per ha for effective nodulation. 2. Thinning should be done a month after in case of dense plant population
		Nematode	Biological control	Seed treatment with *Trichoderma viride* (effective strain) @ 10g/kg of seed.
		Weed	Cultural practices	Follow recommended agronomic practicesfor land preparation, proper seed rate and balanced fertilizer for good crop stand.
3	Vegetative stage	Weed	Cultural practices	1. Inter-culture and hand weeding for keeping the crop weed free for 6 to 8 weeks. 2. Detopping or nibbing wherever possible at 30 days after sowing to reduce pest occurrence and induce branch initiations.
		Pod borer	Mechanical	Regular monitoring of gram pod borer during entire crop season.
			Biological control	Conservation of predatory wasp, spider, insect parasitoidetby growing coriander as intercrop.
			Chemical control	If the pest crosses ETL level (C6) use pesticide having label claim only.
4	Flowering and podding stage	Gram Pod borer	Biological control	*Ha*NPV 250 LE (POB $5x10^{11}$/ml)/ha or *Bt.* var kurstaki 1kg/ha or NSKE 5% or neem oil 0.03% (3000 ppm). *Beauveria bassiana* @ 3 kg/ha.
			Chemical control	Spray Chlorantraniliprole 18.5% SC @ 0.15ml/l or Emamectin benzoate 5 SG @ 0.2g/l, or Novaluron 10 EC @ 1.5ml/l or Ethion 50 EC 2ml/l or Monocrotophos 36 SL @ 0.04% (1ml per litre of water or Chlorpyriphos 20 EC @ 0.05% (3.5ml per litre of water) or Deltamethrin @ 0.5 ml/litre of water 500 to 600 litre of water/ha or dust Quinalphos 1.5 D, or Chrlorpyriphos 1.5 D @ 25kg /ha.
		Semilooper	Biological control	1. Conservation of predators like spiders, *Chrysopa* and other natural enemies by avoiding indiscriminate use of pesticides. 2. Installation of bird perchers for predatory birds.
		Rodents	Chemical control	Apply Bromadiolone (0.005%) baits inside rodent's burrows.

S. No.	Crop stage	Pest	IPM component	IPM practices
5	After harvest		Mechanical	1. Destroy crop residue infested with disease and nematodes. 2. Remove and burn Nematode infested crop to destroy the inoculums and to check further multiplication and spread.

Note: - First spray preferably be started first with bio-pesticides and 2nd spray, if required, by conventional insecticides having label claim.

G. SAFETY PARAMETERS IN PESTICIDES USAGE

Safety parameters inter alia classification of toxicity as per Insecticides Rules, 1971, WHO classification of hazards, colour of toxicity triangle, First aid measures, symptoms of poisoning and treatment of poisoning, the extension functionaries of the State Department of Agriculture have to make use of this information as under:-

(i) Basic precautions which are required to be taken as per classification of toxicity as well as hazard criteria by WHO may be seen as per Annexure – IX.

(ii) The extension functionaries are to educate the farmers on safety use of pesticides with the help of colour toxicity triangle as the farming community can follow the colour and corresponding safety precautions.

(iii) The symptoms of poisoning must be known to the extension functionaries to enable them to extend first aid measures to affected persons to the extent possible.

(iv) Basically, the information on first aid measures and treatment of poisoning is required to be passed on by the extension functionaries to the doctors at Primary Health Centres as well as to Private Doctors in the vicinity of spraying of pesticides.

(v) Extension functionaries must ensure that names of common pesticides during plant protection measures along with a copy of the leaflet which is an integral part of a pesticide container must be made available to the doctors in the vicinity of plant protection operations.

(vi) Extension functionaries are to request the doctors to intervene in procurement of antidotes for different pesticides as cited under "Treatment of poisoning".

Protocol for Pesticide application techniques, equipments and nozzle specifications

Category A: Stationary, crawling pest/ disease		
Vegetative stage		
1. For crawling and soil borne pests	Insecticides and fungicides	• Lever operated knapsack sprayer • (Droplets of big size) • Hollow cone nozzle @ 35 to 40 psi • Lever operating speed = 15 to 20 strokes/min **or** • Motorized knapsack sprayer or • mist blower (Droplets of small size) • Air blast nozzle • Operating speed: 2/3rd throttle
2. For small sucking leaf borne pests		

Category A: Stationary, crawling pest/ disease		
Reproductive stage	Insecticides and fungicides	• Lev er operated knapsack sprayer (Droplets of big size) • Hollow cone nozzle @ 35 to 40 psi • Lever operating speed = 15 to 20 strokes/min
Category B: Field Flying pest/airborne pest		
Vegetative stage	Insecticides and fungicides	• Motorized knapsack sprayer or mist blower • (Droplets of small size) • Air blast nozzle • Operating speed: 2/3rd throttle **or** • Battery operated low volume sprayer (Droplets of small size) spinning disc nozzle
Reproductive stage (Field Pests)		
Category C: Weeds		
Post-emergence application	Weedicide	• Lever operated knapsack sprayer (Droplets of big size) • Flat fan or flood jet nozzle @ 15 to 20 psi • Lever operating speed = 7 to 10 strokes/min
Pre-emergence		• Trolley mounted low volume sprayer (Droplets of small size) • Battery operated low volume sprayer (Droplets of small size)

H. Do's and don't's in IPM

S. No.	Do's	Don'ts
1.	Deep ploughing is to be done on bright sunny days during the months of May and June. The field should be kept exposed to sun light at least for 2-3 weeks	Do not plant or irrigate the field after ploughing, at least for 2-3 weeks, to allow desiccation of weed's bulbs and/or rhizomes of erennial weeds
2.	Adopt crop rotation	Avoid growing monocrop.
3.	Grow only recommended varieties.	Do not grow varieties not suitable for the season or the region
4.	Sow early in the season	Avoid late sowing as this may lead to reduced yields and incidence of white grubs and diseases.
5.	Always treat the seeds with approved chemicals/bio products for the control of seed borne diseases/pests.	Do not use seeds without seed treatment with biocides/chemicals.
6.	Sow in rows at optimum depths under proper moisture conditions for better establishment.	Do not sow seeds beyond 5-7 cm depth.
7.	Apply only recommended herbicides at recommended dose, proper time as appropriate spray solution with standard equipment along with flat fan or flat jet nozzles.	Pre-emergent as well as soil incorporated herbicide y herbicides along with irrigation water or by mixing with soil, sand or urea.
8.	Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical stage of crop weed competition	Crops should not be exposed to moisture deficit stress at their critical growth stages.
9	Use the NPK fertilizers as per the soil test	Avoid imbalanced use of fertilizers.

S. No.	Do's	Don'ts
10	Use micronutrient mixture after sowing based test recommendations.	Do not apply any micronutrient mixture after sowing without test
11	Conduct AESA weekly in the morning preferably before 9 a.m. Take decision on management practice based on AESA and P: D ratio only.	Do not take any management decision without considering AESA and P: D ratio
12	Install pheromone traps at appropriate period.	Do not store the pheromone lures at normal room temperature (keep them in refrigerator).
13	Release egg parasitoids only after noticing adult moth catches in the pheromone trap or as pheromone trap or as per field observation	Do not apply chemical pesticides within seven days of release of parasitoids.
14	Spray pesticides thoroughly to treat the undersurface of the leaves, particularly for mites, whiteflies, Spodoptera etc.	Do not spray pesticides only on the upper surface of leaves.
15	Apply short persistent pesticides to avoid pesticide residue in the soil and produce.	Do not apply pesticides during preceding 7 days before harvest.
16	Follow the recommended procedure of trap crop technology.	Do not apply long persistent on trap crop, otherwise it may not attract the pests and natural enemies.

I. Operational, calibration and maintenance guidelines in brief

S. No.	Do's	Don'ts
1.	For application rate and dosage see the label and leaflet of the particular pesticide.	
2.	It is advisable to check the output of the sprayer (calibration) before commencementof spraying under guidance of trained person.	
3.	Clean and wash the machines and nozzles and store in dry place after use.	
4.	It is advisable to use protective clothing, face mask and gloves while preparing and applying pesticides. Do not apply pesticides without protective clothing and wash clothes immediately after spray application.	

S. No.	Do's	Don'ts
5.	Do not apply in hot or windy conditions.	
6.	Operator should maintain normal walking speed while undertaking application.	
7.	Do not smoke, chew or eat while undertaking the spraying operation	
8.	Operator should take proper bath with soap after completing spraying	
9	Do not blow the nozzle with mouth for any blockages. Clean with water and a soft brush.	

J. Method for calculation of pesticides for application

Methods for calculation of pesticides

(i) **Solid formulations** such as dust, wettable powder or granules, the active ingredient is mixed with inert material. The concentration is expressed as -

Active ingredient (%) in the total weight of commercial product

$$\text{Active ingredient (\%) in dust, WP or granules} = \frac{\text{Weight of a.i. x 100}}{\text{Total weight of WP, dust, etc.}}$$

Example. Carbendazim 50% WP means there are 50 g of carbendazim in every 100 g of commercial WP (50% a.i.).

Calculations when recommendation is in kg a.i. per ha.

For WP, dust, granules, etc.

Specification required:

(1) Area to be sprayed

(2) Concentration of a.i in formulation

(3) Recommended rate as kg a.i. ha^{-1}.

Formula.

$$\text{kg of WP/dust/granules} = \frac{\text{Recommended rate x spray area (sq.m)}}{\text{a.i (\%) in WP x 100}}$$

Example: If Carbendazim 50% WP is used at the rate of 2 kg a.i ha^{-1}, then amount of Carbendazim 50% WP required for 1 ha (10000 m^2) is:

$$\text{kg of Carbendazim 50\% WP required} = \frac{2 \times 10000}{50 \times 100} = 4 \text{ kg } ha^{-1}$$

(ii) **Liquid formulation** Here the a.i. is dissolved in a solvent with an emulsifying agent. It is expressed as an emulsifiable concentrate (EC). The concentration can be expressed in two ways.

a) $$\text{Active ingredient (\%) in EC} = \frac{\text{Weight of a.i. x 100}}{\text{Volume of EC}}$$

b) Grams/ L^{-1}

Example: **Hexaconazole** 5% **EC** means, 100 ml of commercial product has 5 ml of pure Hexaconazole

For emulsiflable concentrates

Specification required:

(i) Area to be treated

(ii) Recommended rate as kg a.i. ha^{-1}

(iii) Concentration of commercial EC as a.i (%) or kg L^{-1}

Formula.

$$\text{kg of WP/dust/granules} = \frac{\text{Recommended rate x spray area (sq.m)}}{\text{a.i (\%) in WP x 100}}$$

Example: If Carbendazim 50% WP is used at the rate of 2 kg a.i ha^{-1}, then amount of
Carbendazim 50% WP required for 1 ha (10000 m^2) is:

$$\text{kg of Carbendazim 50\% WP required} = \frac{2 \times 10000}{50 \times 100} = 4 \text{ kg } ha^{-1}$$

(ii) **Liquid formulation** Here the a.i. is dissolved in a solvent with an emulsifying agent. It is expressed as an emulsifiable concentrate (EC). The concentration can be expressed in two ways.

a) Active ingredient (%) in EC = $\frac{\text{Weight of a.i. x 100}}{\text{Volume of EC}}$

b) Grams L^{-1}

Example: **Hexaconazole** 5% **EC** means, 100 ml of commercial product has 5 ml of pure Hexaconazole

For emulsiflable concentrates

Specification required:

(i) Area to be treated

(ii) Recommended rate as kg a.i. ha^{-1}

(iii) Concentration of commercial EC as a.i (%) or kg L^{-1}

When concentration of EC is in a.i. (%)

Formula:

kg of EC required = $\frac{\text{Recommended rate x area } (m^2)}{\text{a.i (\%) in commercial EC x 100}}$ **or**

$= \frac{\text{Recommended rate x area (ha)}}{\text{a.i. (\%) in commercial EC x 100}}$

Example: : **Hexaconazole** 5% **EC** to be sprayed at the rate of 2 kg a.i. ha^{-1} for 10000 m^2 and : **Hexaconazole** 5% **EC** has 5% a.i. How much liters of Hexaconazole is required?

Liters of 5% Hexaconazole required = $\frac{2 \times 10000}{5 \times 100} = 40$ L

When concentration expressed is in kg a.i. L^{-1}

Formula:

$= \frac{\text{Recommended rate in kg a.i. } ha^{-1} \text{ x area (ha)}}{\text{Concentration of a.i. in product (kg } L^{-1})}$

Example: Acetamiprid (0.01 kg a.i. L^{-1}) is to be applied @ 0.05 kg a.i. ha^{-1} How much will be required for 3 ha?

Liters of Acetamprid required = $\frac{0.05 \times 3.0}{0.01}$ = 15 liters

When recommendation is based on a.i (%) in the spray fluid

(i) Wettable powders (when diluted with water)

Specifications required:

1 Spray volume as L ha^{-1}

2 Concentration desired as a.i. (%) in spray

3 Concentration of commercial product as a.i. (%)

Formula :

WP = $\frac{\text{a.i. (\%) desired x spray volume (L)}}{\text{a.i. (\%) in commercial WP}}$

Example: To control *Helicoverpa armigera* in Chickpea in a plot. 500 L of 0.025% Emamectine benzoate is to be prepared. Thecommercial product to be used is Emamectine benzoate 5% SG. How much Emamectine benzoate is required?

kg of Emamectine benzoate required = $\frac{0.025 \times 500}{5}$ = 2.50 kg

(ii) Emulsifiable concentrates (EC)

Specification required:

1 Spray volume as L ha^{-1}

2 Concentration as percentage ot a.i desired.

3 Concentration of commercial EC as a.i. (%).

Formula:

Liter of EC = $\frac{\text{a.i. (\%) desired x spray volume (L)}}{\text{a.i. (\%) in commercial EC}}$

Example: 2000 L of 2% Quinalphos spray is to be prepared. How much Quinalphos commercial 25% EC is required?

Liters of Quinalphos = $\frac{2 \times 2000}{25}$ = 160 L

Annexure-I

List of Recommended Pesticides for Chickpea

(CIBRC, Faridabad : As on 15-10-2013)

Insecticides
Azadirachtin 0.03% (3000 ppm)
Bacillus thuringiensis var. *kurstaki* 0.5%WP
Bacillus thuringiensis var. *kurstaki* 2.5%AS
Bromadiolone 0.005% RB
Carbaryl 10% DP
Chlorantraniliprole18.5%SC
Chlorpyriphos 20 %EC
Chlorpyriphos 1.5 %DP
Deltamethrin 2.8% EC
Emamectin benzoate 5% SG
Endosulfan 35% EC
Endosulfan 4% DP
Ethion 50 EC
Lambda-cyhalothrin 5% EC
Monocrotophos 36% SL
NPV of *Helicoverpa armigera* 2.0%AS
Quinalphos 25EC
Novaluron10% EC
Fungicides
Trichoderma viride 1% WP

Annexure-II

Commonly Available Formulations of Pesticides for Agricultural Use

Class	Type	Abbreviation	Description
Dry	Dust	D	• Ready to use, off shelf available • Low percentage of active ingredients, • Very fine dry inert carrier made from tale, chalk, clay, or ash • Prone to high level of pesticide drift • Granule particles are larger and heavier
	Granule	G	• Granule particles are larger and heavier • Used for soil treatment and broadcasting to manage nematodes, weeds and insect pests
	Wettable	WP	• Finely grounded power
	Powder	W	• Mixed with water for spray application
	Micro encapsulated	M	• Particles of active ingredients (liquid or dry) surrounded by a plastic coating
Liquid	Emulsifiable concentrate	EC	• Liquid active ingredients, dissolved in petroleum based solvents • Easily absorbed through skin
	Concentrate solution	C LC	• Diluted with a liquid solvent before being applied
		ULV	• Very high percentage of active ingredient • Used before dilution or diluted with small quantities of solvent
		F L	• Finely grounded solid active ingredients suspended in the liquid with inert materials
Fumigants	Pellets liquids		• Solid or liquid that releases/vaporized into toxic gasses

Annexure-III

Pesticides and their Mode of Action

Type of pesticide	Mode of action	How it works
Insecticides and nematicides	Contact	Act through cuticle
	Ingestion	Act upon digestive track
	Systemic	Absorbed and translocated to affected portions
	Fumigants	Penetrates as a into cryptic parts
Herbicide	Contact	Act through cuticle and translocation
	Systemic	Absorbed through soil and translocated to different parts
Fungicide	Superficial protectants	Contact pathogen reproductive propagules
	Systemic	Absorbed through roots from soil, leaf and translocated to different parts

Annexure-IV

Mechanisms of Actions of Major Pesticides

Type of pesticide	Target tissue or organ	Mechanism
Insecticide	Central nervous	Interfere with electron system of nervous system Inhibit acetyl cholinesterase the enzyme responsible for the regulating biological activity
	Cuticle	Inhibit growth and prevent cuticle formulations
	Endocrine system	Disrupts hormonal metabolic system
Herbicide	Seed	Disrupts protein synthesis and inhibits germination
	Leaf, stem,	Prevent photosynthesis
	Leaf, stem, root	Interferes with the mitosis process
	Leaf, stem, root	Affects cell respiration and ATP synthesis
Fungicide	Seed, leaf, stem	Inhibits liquid synthesis affecting cell wall and membrane
	Root	Inhibits synthesis of essential ribosomal proteins Inhibits mitosis, osmoregulation and mitochondrial respiration

Annexure-V

General Guidelines for Management of Resistance

The general guidelines if adopted can prevent development of resistance by various pests in most of the agricultural situations. The general approaches to avoid them are as follows:

Insecticides

- Maintain good plant health,
- Delay the spray of insecticide as far as possible.
- Monitor populations and use economic thresholds
- Use all available tactics for management of a particular arthropod (insect or mite)
- Limit selection pressure throughout the season and remember spraying for one pest may influences another
- Limit use of one chemical molecule at a time and rotate chemical molecule and/or modes of action, and
- Use appropriate rates

Fungicides

- Avoid growing large areas of highly susceptible varieties in endemic areas. Resistant varieties should be used to reduce reliance on chemical pesticides.
- Make full use of non-fungicidal control measures e.g., dispose of crop debris and control collateral and alternate host, which harbor disease.
- Monitor crops regularly for disease and treat before the infection becomes established.
- Use fungicides only in the unavoidable situations where the risk of disease warrants treatment. Make full use of effective fungicides with different modes of action as alternate sprays. Mixtures of eradicant fungicides with protectants materials offer the most flexibility as well as reducing resistance risk.
- While formulating spray programmes, take into account any earlier use of fungicides groups as seed treatment.
- Do not exceed the maximum recommended numbers of applications to each crop for any particular fungicide group. Avoid repeated applications of very low doses.

Annexure-VI

List of Banned Pesticides for Chickpea (01-01-2014)

A.	**Pesticides Banned for manufacture, import and use.**	
	1.	Aldicarb
	2.	Aldrin
	3.	Benzene Hexachloride
	4.	Calcium Cyanide
	5.	Chlorbenzilate
	6.	Chlordane
	7.	Chlorofenvinphos
	8.	Copper Acetoarsenite
	9.	Dibromochloropropane
	10.	Dieldrin
	11.	Endrin
	12.	Ethyl Mercury Chloride
	13.	Ethyl Parathion
	14.	Ethylene Dibromide
	15.	Heptachlor
	16.	Lindane (Gamma-HCH) (Banned vide Gazette Notification No S.O. 637(E) Dated 25/03/2011)-Banned for Manufecture,Import or Formulate w.e.f. 25th March,2011 and banned for use w.e.f. 25th March,2013.
	17.	Maleic Hydrazide
	18.	Menazon
	19.	Metoxuron
	20.	Nitrofen
	21.	Paraquat Dimethyl Sulphate
	22.	Pentachloro Nitrobenzene
	23.	Pentachlorophenol
	24.	Phenyl Mercury Acetate
	25.	Sodium Methane Arsonate
	26.	TCA (Trichloro acetic acid)
	27.	Tetradifon
	28.	Toxaphene(Camphechlor)
B.	**Pesticide formulations banned for import, manufacture and use**	
	1.	Carbofuron 50% SP
	2.	Methomyl 12.5% L
	3.	Methomyl 24% formulation
	4.	Phosphamidon 85% SL
C.	**Pesticide / Pesticide formulations banned for use but continued to manufacture for export**	
	1.	Captafol 80% Powder
	2.	Nicotin Sulfate

D.	**Pesticides Withdrawn** (Withdrawal may become inoperative as soon as required complete data as per the guidelines is generated and submitted by the Pesticides Industry to the Government and accepted by the Registration Committee. (S.O 915(E) dated 15th Jun,2006)	
	1.	Dalapon
	2.	Ferbam
	3.	Formothion
	4.	Nickel Chloride
	5.	Paradichlorobenzene (PDCB)
	6.	Simazine
	7.	Warfarin

Source: www.cibrc.nic.in

Annexure-VII

Pesticides Restrict Use in the Country (As on 1st Jan, 2014)

S.No.	Name of Pesticides	Details of Restrictions
1.	Aluminium Phosphide	The Pest Control Operations with Aluminium Phosphide may be undertaken only by Govt./Govt. undertakings / Govt. Organizations / pest control operators under the strict supervision of Govt. Experts or experts whose expertise is approved by the Plant Protection Advisor to Govt. of India except 1. Aluminium Phosphide 15 % 12 g tablet and 2. Aluminum Phosphide 6 % tablet.
2.	Captafol	The use of Captafol as foliar spray is banned. Captafol shall be used only as seed dresser. (S.O.569 (E) dated 25thJuly, 1989) The manufacture of Captafol 80 % powder for dry seed treatment (DS) is banned for use in the country except manufacture for export. (S.O.679 (E) dated 17thJuly, 2001)
3.	Cypermethrin	Cypermethrin 3 % Smoke Generator, is to be used only through Pest Control Operators and not allowed to be used by the General Public.
4.	Dazomet	The use of Dazomet is not permitted on Tea. (S.O.3006 (E) dated 31st Dec, 2008)
5.	Diazinon	Diazinon is banned for use in agriculture except for household use. (S.O.45 (E) dated 08th Jan, 2008)
6.	Dichloro Diphenyl Trichloroethane (DDT)	The use of DDT for the domestic Public Health Programme is restricted up to 10,000 Metric Tonnes per annum, except in case of any major outbreak of epidemic. M/s Hindustan Insecticides Ltd., the sole manufacturer of DDT in the country may manufacture DDT for export to other countries for use in vector control for public health purpose. The export of DDT to Parties and State non-Parties shall be strictly in accordance with the paragraph 2(b) article 3 of the Stockholm Convention on Persistent Organic Pollutants (POPs).
7.	Fenitrothion	The use of Fenitrothion is banned in Agriculture except for locust control in scheduled desert area and public health. (S.O.706 (E) dated 03rdMay, 2007)
8.	Fenthion	The use of Fenthion is banned in Agriculture except for locust control, household and public health. (S.O.46 (E) dated 08th Jan, 2008)
9.	Methoxy Ethyl Mercuric Chloride (MEMC)	The use of MEMC is banned completely except for seed treatment of potato and sugarcane. (S.O.681 (E) dated 17thJuly, 2001)
10.	Methyl Bromide	Methyl Bromide may be used only by Govt./Govt. undertakings/Govt. Organizations / Pest control operators under the strict supervision of Govt. Experts or Experts whose expertise is approved by the Plant Protection Advisor to Govt. of India. [G.S.R.371 (E) dated 20thMay, 1999 and earlier RC decision]

11.	Methyl Parathion	Methyl Parathion 50 % EC and 2% DP formulations are banned for use on fruits and vegetables. (S.O.680 (E) dated 17thJuly, 2001) The use of Methyl Parathion is permitted only on those crops approved by the Registration Committee where honeybees are not acting as a pollinators. (S.O.658 (E) dated 04th Sep., 1992.)
12.	Monocrotophos	Monocrotophos is banned for use on vegetables. (S.O.1482 (E) dated 10thOct, 2005)
13.	Sodium Cyanide	The use of Sodium Cyanide shall be restricted for Fumigation of Cotton bales under expert supervision approved by the Plant Protection Advisor to Govt. of India. (S.O.569(E) dated 25thJuly, 1989)

Annexure-VIII

Basic Precautions in Pesticide Usage

A. Purchase

1. Purchase only JUST required quantity e.g. 100, 250, 500 or 1000 g/ml for single application in specified area.
2. Do not purchase leaking containers, loose, unsealed or torn bags.
3. Do not purchase pesticides without proper/approved LABELS.

B. Storage

1. Avoid storage of pesticides in the house premises.
2. Keep only in original container with intact seal.
3. Do not transfer pesticides to other container.
4. Never keep them together with food or feed/fodder.
5. Keep away from the reach of children and livestock.
6. Do not expose to sun-light or rain water.
7. Do not store weedicides along with other pesticides.

C. Handling

1. Never carry/transport pesticides along with food materials.
2. Avoid carrying bulk - pesticides (dusts / granules) on head, shoulders or on the back.

D. Precautions for Preparing Spray Solution

1. Use clean water.
2. Always protect your NOSE, EYES, MOUTH, EARS and HANDS.
3. Use hand gloves, face mask and cover your head with c*a*p.
4. Use polyethylene bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover the head (Do not use polyethylene bag contaminated with pesticides).
5. Read the label on the container before preparing spray solution.
6. Prepare spray solution as per requirement.
7. Do not mix granules with water.
8. Concentrated pesticides must not fall on hands etc. while opening sealed containers. Do not smell the sprayer tank.
9. Avoid spilling of pesticide solution while filling the sprayer tank.
10. Do not eat, drink, smoke or chew while preparing solution.
11. The operator should protect his bare feet and hands with polyethylene bags.

E. Equipments

1. Select right kind of equipment.
2. Do not use leaky, defective equipment.
3. Select right kind of nozzle.
4. Don't blow/clean clogged- nozzle with mouth. Use old tooth- brushes tied with the sprayer and clean with water.
5. Do not use same sprayer for weedicide and insecticide.

F. Precautions for applying pesticides

1. Apply only at recommended dose and dilution.
2. Do not apply on hot sunny day or strong windy condition.
3. Do not apply just before the rains and also after the rains.
4. Do not apply against the wind direction.
5. Emulsifiable concentrate formulations should not be used for spraying with battery operated ULV sprayer.
6. Wash the sprayer and bucket etc with soap water after spraying.
7. Containers, buckets etc. used for mixing pesticides should not be used for domestic purposes.
8. Avoid entry of animals and workers in the fields immediately after the spraying.

G. Disposal

1. Left over spray solution should not be drained in ponds or water lines etc. Throw it in barren isolated area, if possible.
2. The used/empty containers should be crushed with a stone / stick and burned deep into soil away from water source.
3. Never re-use empty pesticide container for any purpose.

Safe use of Pesticides
कीटनाशकों का सुरक्षित इस्तेमाल


कीटनाशकों को पदार्थों के साथ यहाँ–वहाँ न ले जाएं


ताला चाबी लगा कर रखें


बच्चों की पहुच से दूर रखें


मूल पैकिंग वाले कीटनाशक ही खरीदे


इस्तेमाल से पहले लेबल और पुस्तिका पढे


सुरक्षात्मक कपड़े पहने।


सुझाई गई मात्रा को सही–सही प्रमाण में इस्तेमाल करे।


लकड़ी या पैडल से पानी को अच्छी तरह मिलाए


कुप्पी का इस्तेमाल करते हुए बिना गिराए भरे।


खाद्य पदार्थों या पानी के संग्रह के लिए कीटनाशक के डिब्बें का इस्तेमाल न करे।


हवा की दिशा में ही छिड़काव करें


नौजल को साफ करने के लिए मुंह से हवा भीतर न डालें


छिड़काव करते समय कुछ खाए–पीएं नहीं तथा न ही धुम्रपान करें


रिसाव वाले स्प्रेयर व डस्टर का प्रयोग न करें


यदि गलती से कपड़े व शरीर पर लग जाए तो दूषित कपड़े व शरीर के हिस्से को अच्छी तरह धो डालें


बच्चों को छिड़काव न करने दें


इस्तेमाल किए जाने वाले स्थान पर खाद्य वस्तु न रखें


खाने–पीने या धुम्रपान करने के पहले हाथ व मुंह को धो लें।


विषैला असर दिखाई देने पर प्राथमिक उपचार व डॉक्टर को बुलाए।


डॉक्टर को डिब्बा व पुस्तिका बताएं


तुरंत विशेष चिकित्सा प्राप्त करें


खाली डिब्बें को तोड़–फोड़ कर नष्ट कर दें तथा गाड़ दे


इस्तेमाल के बाद स्नान करे व कपड़े धो लें


वातावरण को दूषित न होने दें


उपचार किए गए खेतों में चेतावनी सूचना लगा दें

कीटनाशकों की विषाक्तता की श्रेणियों के पहचान-चिह्न

अत्यंत विषैला

अत्यधिक विषैला

सामान्य रूप से विषैला

थोड़ा से विषैला

भारत सरकार
कृषि मंत्रालय
कृषि एवं सहकारिता विभाग
वनस्पति संरक्षण, संगरोध एवं संग्रह निदेशालय

केंद्रीय एकीकृत नाशीजीव प्रबंधन केंद्र

एन. एच. – 4, फरीदाबाद – 121001 हरियाणा

Annexure-IX

Symptoms of poisoning and the treatment of poisoning for different pesticides

S. No	Name of pesticide	Classification as per Insecticides Rules. 1971	Colour of Toxicity Triangle	WHO classification by hazard	First aid measures	Symptoms of poisoning	Treatment of poisoning
INSECTICIDES							
ORGANOPHOSPHATE INSECTICIDES							
1.	Quinalphos	Highly toxic	Yellow	Class II Moderately Hazardous	Remove the p erson from the contaminated environment In case of (a) Skin contact Remove all contaminated clothings and immediately wash with lot of water and soap. (b) Eye contamination Wash the eyes with plenty of cool and clean water; (c) Inhalation – Carry the person to the open fresh air, loosen the clothings around neck and chest, and (d) Indigestion – If the victim is fully conscious, induce vomiting by tickling back of the throat. Do not administer milk, alcohol and fatty substances. In case the person is unconscious make sure the breathing passage is kept clear without any obstruction. Victim's head should be little lowered and face should be turned to one side in the lying down position. In case of breathing difficulty, give mouth to mouth or mouth to nose breathing. Medical aid: Take the patient to the doctor/Primary Health Centre immediately along with the original container, leaflet and label	Nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death Mild – anorexia, headache, dizziness, weakness, anxiety, tremors of tongue and eyelids, miosis, impairment of visual acuity. Moderate- nausea, salivation, lacrimation, abdominal cramp, vomiting, sweating, slow pulse, muscular tremors, miosis. Severe – diarrhea, pinpoint and non-reactive pupils, respiratory difficulty, pulmonary edema, cyanosis, loss of sphincter control, convulsions, coma and heart block.	- Gastric lavage with 2-4 L. tap water. Catharsis with 30 gm (10 oz) sodium sulphate in the cup of water - Barbiturates in appropriate dosages repeated as necessary for restlessness or convulsions. - Watch breathing closely, aspirate oxygen and/or artificial respiration, if needed. Avoid oils, oil laxatives and epinephrine (Adrenalin) – do not give stimulants. - Give calcium gluconate (19% in 10 ml Ampules) intravenously every four hours. For extreme symptoms of O.P poisoning, injection of atropine (2-4 mg, for adults, 0/5-1.0 mg for children) is recommended, repeated at 5-10 minute intervals until signs of atropinization occur. Speed is imperative - Atropine injection – 1 to 4 mg. Repeat 2 mg, when toxic symptoms begin to recur (15-16 minute intervals), Excessive salivation good sign, more atropine needed. - Keep airways open, Aspirate, use oxygen, insert endotracheal tube. Do tracheotomy and give artificial respiration as needed. - For ingestion lavage stomach with 5% sodium bicarbonate if not vomiting. For skin contact, wash with soap and water (eye wash with isotonic saline). Wear rubber gloves while washing contact areas.
2.	Monocrotophos	Extremely toxic	Bright red	Class I b Highly hazardous			
3.	Acephate	Moderately toxic	Blue	Class III Slightly Hazardous			
4.	Chlorpyriphos	Highly toxic	Yellow	Class II Moderately Hazardous			
5.	Ediphenphos	Highly toxic	Yellow	Class I b -Highly hazardous			
6.	Phorate	Extremely toxic	Red	Class Ia- Extremely hazardous			

S. No	Name of pesticide	Classification as per Insecticides Rules. 1971	Colour of Toxicity Triangle	WHO classification by hazard	First aid measures	Symptoms of poisoning	Treatment of poisoning
CARBAMATES							
7.	Carbofuran	Extremely toxic	Red	Class I b Highly hazardous		Constriction of pupils, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhea, epigastric pain, tightness in chest.	- Atropine injection 1 to 4 mg, Repeat 2 mg when toxic symptoms begin to occur (15-60 minute intervals). Excessive salivation good sign, more atropine needed. - Keep airway open. Aspirate use oxygen, insert endotracheal tube. DO tracheotomy and give artificial respiration as needed. - For ingestion, larvae stomach with 5% sodium bicarbonate, if not vomiting. For skin contact wash with soap and water (eyes wash with isotonic saline), wear rubber gloves while washing contact areas. - Oxygen - Morphine, if needed. Avoid theophyllin and aminophyllin or barbituarates. 2-PAM and other oximes are not harmful and in fact contra indicated for routine usage. Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.
8.	Carbaryl	Highly toxic	Yellow	Class II Moderately Hazardous			
9.	Cartap	Highly toxic	Yellow	Class II Moderately Hazardous Class II Moderately Hazardous			
FUNGICIDES							
10.	Mancozeb	Slightly toxic	Green	Table 5 – Unlikely to present acute hazard in normal use		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin etc.	No specific antidote, Treatment is essentially symptomatic.
11.	Hexaconazole	Slightly toxic	Green	do-			
12.	Propiconazole	Moderately toxic	Blue	Class III Slightly Hazardous			
13	Validamycin	Slightly toxic	Green	Table 5 – Unlikely to present acute hazard in normal use			
14.	Tricyclazole	Highly toxic	Yellow	Class II Moderately Hazardous			
15.	Iprobenphos	Moderately toxic	Blue	Class III Slightly Hazardous			

S. No	Name of pesticide	Classification as per Insecticides Rules. 1971	Colour of Toxicity Triangle	WHO classification by hazard	First aid measures	Symptoms of poisoning	Treatment of poisoning
16.	Thiophanate methyl	Slightly toxic	Green	Table 5 – Unlikely to present acute hazard in normal use			
17.	Carbendazim	do-	do-	do-			
18.	Kasugamycin	do-	do-	do-			
HERBICIDES							
19.	Cyhalofopbutyl	Slightly toxic	Green	Table 5 – Unlikely to present acute hazard in normal use		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin etc.	No specific antidote, Treatment is essentially symptomatic.
20.	Butachlor	Moderately toxic	Blue	-do-			
21.	Pretilachlor	Slightly toxic	Green	Table 5 – Unlikely to present acute hazard in norma l use			
22.	Chlory-muramethyl Chlorymuramethyl	Moderately toxic	Blue	-do-			
OTHER							
23.	Fipronil	Highly toxic	Yellow	Class II Moderately Hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin etc.	No specific antidote, Treatment is essentially symptomatic.
24.	Imidacloprid	-do-	do-	-do-			

Pod borer

Black bean aphid

Tobacco caterpillar

Cut worm

Semi looper

Termite

Plate I. Key insect pests and their field symptoms

Rust

Stemphylium blight

Ascochyta blight

Collar rot

Wilt

Root rot

Plate II. Important diseases and their field symptoms

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