



IPM PACKAGE NO. 9



INTEGRATED PEST MANAGEMENT PACKAGE

FOR

GROUNDNUT



Government of India
Ministry of Agriculture
Department of Agriculture & Cooperation
Directorate of Plant Protection, Quarantine & Storage
N. H. IV, Faridabad - 121 001.

IPM PACKAGE FOR GROUNDNUT

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Government of India
Ministry of Agriculture
Department of Agriculture & Cooperation
DIRECTORATE OF PLANT PROTECTION, QUARANTINE & STORAGE
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FOREWARD

Integrated Pest Management (IPM) approach has been globally accepted for achieving sustainability in agriculture. It has become more relevant due to a number of advantages like safety to environment, pesticide-free food commodities; low input cost based Crop Production Programme etc. Though IPM approach has been taken up since 1981, its impact has not been felt until 1994. Human Resource Development has helped to sensitize extension functionaries and farmers about the usefulness of IPM.

For successful implementation of IPM, gathering of the scattered information on various components of this eco-friendly approach in the form of package is basic necessity. In this direction, initial attempts were made in 1992 to harmonize the IPM Package of Practices of various crops. Subsequently, concerted efforts were made in 1998, 2001, 2002 and 2003 to update and develop IPM Package of Practices for agricultural and horticultural crops. Keeping in view, the development of resistance and attainment of pest status by certain insects, updating of IPM modules in five crops (Cotton, Rice, Sugarcane, Groundnut & Coconut) was done in 9th National Workshop held at CIL, Faridabad during 22nd-23rd December, 2003.


(P. S. Chandurkar)

P R E F A C E

In order to minimize the indiscriminate and injudicious use of chemical pesticides, INTEGRATED PEST MANAGEMENT (IPM) has been enshrined as cardinal principle of Plant Protection in the overall Crop Protection Programme under the National Agricultural Policy of the Govt. of India. IPM is an eco-friendly approach for managing pest and disease problems encompassing available methods and techniques of pest control such as cultural, mechanical, biological and chemical in a compatible and scientific manner. The greater emphasis has been given on biological control including use of biopesticides.

With a view to provide technical knowledge to the extension functionaries and farmers in the States, first National Workshop on IPM for harmonization of Package of Practices was organized at National Plant Protection Training Institute (NPPTI), Hyderabad during June 29-30, 1992. Subsequently workshops were organized on April 15-17, 1998 and Nov. 5-6, 1998 at the Directorate of Plant Protection, Quarantine & Storage, Faridabad and IPM Package of Practices for 20 crops were finalized on rice, cotton, vegetables, pulses and oilseeds. In this series, two National Workshops on IPM have been conducted at NPPTI, Hyderabad and Dte. of PPQ&S, Faridabad during May 14-17, 2001 and February 20-22, 2002 respectively to update 20 available IPM Packages and developed 31 new IPM Packages especially for horticultural crops. Sixth and Seventh National Workshops held at Central Insecticides Laboratory, Faridabad on 4th-5th July, 2002 and 9th-10th January, 2003 respectively for 18 IPM Packages and Eighth National Workshop was held at NPPTI, Hyderabad on 28th-29th May, 2003 for 8 IPM Packages. In these Workshops, 77 IPM Package of Practices for cereal crops (Rice, Wheat, Maize, Sorghum, Millets), commercial crops (Cotton, Sugarcane, Tobacco, Tea, Betelvine, Saffron), pulse crops (Pigeonpea, Gram, Black gram/Green gram, Peas, Rajma), oilseeds (Groundnut, Soybean, Rapeseed/Mustard, Sesame, Olive, Safflower, Castor, Sunflower, Oilpalm), vegetables (Potato, Onion, Tomato, Brinjal, Okra, Chillies, Cruciferous vegetables, Leguminous vegetables, Cucurbitaceous vegetables, Broccoli, Spinach, Lablab bean, Garlic), fruits (Citrus, Banana, Apple, Mango, Guava, Grapes, Jackfruit, Pineapple, Sapota, Pomegranate, Litchi, Papaya, Apricot, Peach, Pear, Cherry, Walnut, Ber, Amla, Loquat, Strawberry, Watermelon, Fig, Phalsa, Persimmon, Custard apple, Raspberry, Kiwi, Passion fruit), spice and plantation crops (Small Cardamom, Large Cardamom, Black Pepper, Ginger, Coriander, Cumin, Fennel, Coconut, Cashew and Arecanut) have been finalized. Moreover, 9th National Workshop for Review/Upgradation of IPM Package of Rice, Cotton, Sugarcane, Coconut and Groundnut crops was held during 22nd -23rd Decembe, 2003 at CIL, Faridabad. Latest research developments, pest problems and their management practices have been incorporated in these IPM packages.

IPM technology manages the pest population in such a manner that economic loss is avoided and adverse side effects of chemical pesticides are minimized. The IPM packages encompass various management strategies for containing the pest and disease problems. Pest monitoring is one of the important components of IPM to take proper decision to manage any pest problem. It can be done through Agro-Ecosystem Analysis (AES), field scouting, light, pheromone, sticky/yellow pan traps. The economic threshold levels (ETL) of important pests and diseases are also given in the packages to take appropriate control measures when pest population crosses ETL.

These IPM packages developed with the technical inputs from experts from the various Institutes of Indian Council of Agricultural Research, State Agricultural Universities, Central Directorate of Plant Protection, Pesticide Industries and State Departments of Agriculture/Horticulture will provide technical backup in the management of pests, diseases, weeds, nematodes and rodents in the agriculture and horticulture. These will also be useful in reducing the pesticide residues in agricultural commodities and would also help in the management of pests/diseases/weeds/nematodes which may get inadvertently introduced in the country.

IPM Package of Practices for agricultural and horticultural crops will be helpful to minimize the ill-effects of chemical pesticides to promote the IPM for sustainable production. These IPM packages will be useful for the researchers, extension workers and farmers alike who are engaged in the agricultural practices.

31st December, 2003



(A. D. Pawar)

Addl. PPA-cum-Director(IPM)

ACKNOWLEDGEMENTS

The IPM Package of Practices for Groundnut crop was reviewed and upgraded in the 9th National Workshop on IPM held at Central Insecticide Laboratory, Faridabad during 22-23rd December, 2003. The inputs received from the following experts is thankfully acknowledged :

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- (v) Input Experts
1.Dr. J.S. Kular, Entomologist (Oil Seeds),PAU, Ludhiana
2.Dr. S.P. Sharma,PPO(E), CIPMC, Guwahati
3. Dr. A. Siddiqui, PPO(E), CIPMC, Hyderabad
4. Sh. A.K. Shukla, PPO(E), CIPMC, Baroda
5. Sh. K.W. Deshkar, PPO(E), CIPMC, Marmugao Harbour
7.Sh. K.P. Yadav, PPO(E), CIPMC, Dimapur
8.Sh. Rajendra Singh, ADO, Deptt. Of Agri.,Pubjab
- (vi) Technical Inputs
1.Sh. M. C. Sharma, SSA-III, Dte. of PPQ&S.Fbd
2..Sh. Surender Kumar,PA, CIL, Faridabad.

IPM PACKAGE FOR GROUNDNUT

I. MAJOR PESTS

A. Pests of national Significance:

1. Insect pests

- | | | |
|-----|---------------------|---|
| 1.1 | White grub | (<i>Holotrichia spp.</i>) |
| 1.2 | Leaf miner | (<i>Aproaerema modicella</i>) |
| 1.3 | Tobacco caterpillar | (<i>Spodoptera litura</i>) |
| 1.4 | Aphid | (<i>Aphis craccivora</i>) (As vector for Pstv) |
| 1.5 | Jassid | (<i>Empoasca kerri</i>) |
| 1.6 | Thrips | (<i>Scirtothrips dorsalis</i>) |
| 1.7 | Bruchids | (Storage pest) |

2. Diseases

- | | | |
|-----|-----------------------|---|
| 2.1 | Crown rot/ Collar rot | (<i>Aspergillus niger</i>) |
| 2.2 | Afla root | (<i>Aspergillus flavus</i>) |
| 2.3 | Leaf spots | (<i>Phaeoisariopsis personatum & Cercospora arachidicola</i>) |
| 2.4 | Rust | (<i>Puccinia arachidis</i>) |
| 2.5 | Bud necrosis | (Peanut bud necrosis virus) |
| 2.6 | Stem rot | (<i>Sclerotium rolfsi</i>) |
| 2.7 | Pod rots | (<i>Sclerotium rolfsi</i>) |

3. Weeds

- | | |
|-----|----------------------------------|
| 3.1 | <i>Digitaria sanguinalis</i> |
| 3.2 | <i>Eleusine indica</i> |
| 3.3 | <i>Dactyloctenium aegyptium</i> |
| 3.4 | <i>Tridax procumbens</i> |
| 3.5 | <i>Celosia argentia</i> |
| 3.6 | <i>Portulaca oleracea</i> |
| 3.7 | <i>Physalis minima</i> |
| 3.8 | <i>Trianthema portulacastrum</i> |
| 3.9 | <i>Cyperus rotundus</i> |

4. **Rodents**

- | | | |
|-----|-----------------------|----------------------------------|
| 4.1 | Smaller bandicoot | (<i>Bandicota bengalensis</i>) |
| 4.2 | Soft furred field rat | (<i>Millardia melitada</i>) |
| 4.3 | Indian gerbil | (<i>Tatera indica</i>) |

B. **Pests of Regional Significance:**1. **Insect pests**

- 1.1 Red Hairy Caterpillar (Andhra Pradesh, Tamil Nadu, Karnataka)
- 1.2 *Helicoverpa armigera* (A.P., T.N., Karnataka, Gujarat, Goa)
- 1.3 Bihar Hairy Caterpillar (Punjab)
- 1.4 Termite (Gujarat, A.P., Punjab, Rajasthan)
- 1.5 Wireworms (A.P., T.N., Gujarat)
- 1.6 Chrysomelid pod borer (A.P.)

2. **Nematodes**

- 2.1 Root knot nematode (*Meloidogyne spp.*) (parts of Bihar and Gujarat,Punjab).
- 2.2 Kalahaste Malady (*Tylenchorhynchus brevilineatus*) - (parts of Andhra Pradesh).

3. **Diseases:**

- 3.1 Peanut clump Virus (parts of Rajasthan)
- 3.2 Peanut stem necrosis in A.P.(Anantpur)

II. **PEST MONITORING**

The objective of pest monitoring is to detect the initial development of pests and diseases and also the biocontrol potentials in the field situations.

1. **Rapid Roving Survey (RRS):-**

In the beginning of the crop season, survey routes are required to be identified in the pest & disease endemic areas to undertake Rapid Roving Surveys (RRS). During survey the observations are to be made at every 5-10 kms. distance

in the pre-selected routes at 7-10 days intervals depending upon pest & disease situation. Record the incidence of pest, disease and defender population at each spot in 5 plants at random and 12 spots per ha.

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 populations once in 7-10 days in their own fields as per agro Eco System Analysis (AESA) approach. The state Departments of Agriculture should make all possible efforts using different media, mode and publicity to inform the farmers the need for field scouting in the specific crop areas having indication of pest or disease build up.

3. Agro Eco System Analysis (AESA):

AESA 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 practices. 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.

The details of the AESA are given in Annexure - I.

4. Pheromone trap - monitoring:-

Use pheromone traps for monitoring *Spodoptera/Helicoverpa* and leaf miner. Install pheromone traps at a distance of 50 m @ one trap per ha. for *Spodoptera/Leaf miner* and 5 traps/ha. for *Helicoverpa*. Use specific lure for each pest species and change it after every 15-20 days. Trapped moths should be removed daily.

5. ECONOMIC THRESHOLD - LEVELS (ETLs)

Pest	Economic Threshold Levels
1. Leaf Miner	2-3 larvae / plant
2. <i>Spodoptera</i>	2 larvae/ plant.
3. Jassids	15-20 jassids/ plant
4. White grub	1 grub / 1 m ²
5. Rodents	15 live burrows/ ha
6. Defoliators	10% foliage damage.

III. INTEGRATED PEST MANAGEMENT STRATEGIES

A. Cultural Practices:-

1. Wherever suitable, use KSS-II, ICGS 44, ICGS 11, ICGS 37, ICGV 86325, JCG 88, CSMG 884, Chandra and Kadiri 3 genotypes which are tolerant to bud necrosis and TPT -3 against Kalahasty malady.
2. Deep ploughing in summer to expose soil - borne pathogens, white grubs, nematodes, hibernating defoliators and under ground bulbs and rhizomes of perennial weeds.
3. Crop rotation with sorghum or pearl millet or rice or maize after Kharif crop may reduce the incidence of early leaf spot, late leaf spot, rust and PBNB.
4. Sowing early by coinciding with pre- monsoon showers to avoid damage due to white grub and bud necrosis (if protective irrigation is available).

5. Inter-cropping with sorghum or pigeonpea or pearl millet 3-6 rows of groundnut and one row of inter-crop.
6. Stray planting of cowpea or soybean as trap crops for leaf miner; castor or sunflower for *Spodoptera*. The Sunflower acts as bird percher as well.
7. Dense cropping (increased seed rate) to reduce bud necrosis damage and weed population.
8. Two hand hoeings at 15-20 days and 30 to 45 days after sowing for effective weed control.
9. Soil application of castor cake/Neem cake @ 1000 kg./ha against stem rot/termite in endemic areas only.
10. Rogue out bud necrosis affected clump and infected plants.
11. Avoid prolonged mid season drought (>20 days) during vegetative phase (if irrigation is available) to prevent pre- harvest infection of *A. flavus* (Aflatoxin contamination)
12. Harvest at optimum maturity stage to avoid pod infection by *A. flavus* (neither immatured nor over - matured stage)
13. Dry pods to optimum kernel moisture level of about 7%.
14. Store in polythene - lined gunny bags and fill the top of the bag with 3 cm ht. sand. The bag should not be sealed or stitched to avoid loss of germination.

B. **Mechanical Practices**

1. Installation of 12 light traps / ha. or bonfire against Red Hairy Caterpillar (RHC) in endemic areas.

2. Collection and destruction of RHC egg masses in the field round to the light trap areas.
3. Collection and destruction of gregarious stage larvae of Bihar Hairy caterpillar.
4. Vegetative trapping of migratory larvae of RHC by keeping twigs of *Jatropha* or *Calotropis* on bunds.
- 5.. Collection of egg masses/ early instar larvae of *S.litura* from trap crops.
6. Collection and destruction of adults of white grub beetles from jujuba or neem trees around the field, immediately after the early rains.
7. Installation of pheromone trap @ 1/ha. for monitoring and 10/ ha. as mass trapping of *S.litura*.
8. Erection of bird perches at the rate of 10-12 / ha.
9. Trenching all around the field to trap migrating larvae of Hairy caterpillar and destruction.
10. Remove the collateral host during the season.
11. Use of aggregating pheromones on the preferred hosts of White grub beetles.

C. **Biological Control Practices:-**

1. Seed treatment with *Trichoderma viride*/*T. harzanium* @ 4 g/kg. seed for controlling seed rots/ seedling rots.
2. Conserve the natural biocontrol population of anthocorids, damsel bugs, assassin bugs, predatory pentatomid bugs, lady bird beetles, ground beetles, rove beetles, hover flies, robar flies, praying mantis, green and brown lacewings, predatory crickets, long horned grasshoppers, predatory earwigs, ants, spiders, vespids, damaselflies, dragonflies, tachnid flies, Ichneumonid wasps, Braconid wasps, Trichogrammatid wasps and beneficial pathogen like Nuclear Polyhedrosis Virus, green and white muscardine fungus. For details see Annexure - II.
3. Release of *Telenomus remus* @ 50000/ha. 4 times (7-10 days interval) against *S. litura* based on pheromone trap catching.

4. Use *S.litura* NPV @ 250 LE (6 x 10⁹/LE)/ ha. or B.t. @ 1 k.g. / ha. when large number of egg masses and early instar larvae are noticed.
5. Use 5% neem seed kernel extract against *S. litura* , leaf miner and foliar diseases on need basis.
6. Release *Trichogramma chilonis* @ 50000 / ha. 2 times (7- 10 days interval) against leaf miner and other defoliators based on pheromone trapping/field observation.
7. Augment the release of *Cheilonenes sexmaculata* @ 1250/ha against *A. craccivora*
8. Release of *Bracon hebetor* @ 5000/ha. two times at 7- 10 days interval against leaf miner and defoliators.

D. **Chemical Control Practices:-**

1. Seed treatment with Chlorpyriphos* 20 E.C.@ 2.5 to 12.5 ml. / kg. seed or Quinalphos* @ 25 ml. / kg. seed (in endemic areas against white grub)
2. Kill the beetles by spraying 200 gm Sevin/Hexavin 50 W.P. (Carbaryl) in 100 litres of water on the preferred hosts such as Ber, Guava, Grapevine, Almonds.
3. Application of Alachlor 2.5 kg. a.i. / ha. , Pendimethalin @ 0.75 to 1.5 kg. a.i./ ha. ,Oxyfluorfen 0.1 to 0.2 kg. a.i. / ha. as pre- emergence and Fluchloralin @ 1.0 kg. a.i. / ha. as pre- sowing soil incorporation for weed control.
4. Seed treatment with carbendazim* @ 2 g/kg. seed against seed/ seedling rot diseases.
5. Use Carbendazim @ 375 g/ha for controlling leaf spots/ rusts 4-5 weeks after sowing.
6. Use 0.005% Bromodialone in ready - to -use form or wax blocks for rodent control.
7. Soil application of Phorate or Carbofuran granules @ 1.0 kg a.i./ha. against white grubs.

E. Integrated Weed Management in Groundnut

I. Cultural Practices:

1. Summer deep ploughing of fields for destroying the underground vegetative parts of perennial weeds.
2. Two mechanical weedings each at 15-20 days and 30 -45 days after sowing to keep the crop weed free for 6 weeks.

II. Chemical Control:

Apply Oxyfloufen @ 0.15 – 0.25 kg a.i./ha. as pre-emergence or Fluchloralin @ 1.0 kg a.i./ha as pre-plant incorporation or Pendamethalin @ 0.75 – 1.5 kg a.i./ha. as pre-emergence or Imazethepyr @ 0.1 – 0.15 kg a.i./ha. as early/post emergence to weeds within 7-14 DAS for effective weeds control.

* Not approved by the Registration Committee constituted under the Insecticides Act, 1968 for seed treatment.

F. Integrated Management of nematode pests in groundnut :

Major species Root- knotnematodes (*Meloidogyne javanica*, *M.arenaria*, *M.halpa*)

Kalahasti Malady (*Tylenchorhynchus brevilineatus*)

Minor species Lesion nematodes (*Pratylenchus spp.*)

Management Practices:-

1. Deep summer ploughing:

Plough the soil down to a depth of minimum 20 cm. in the hot summer months to expose the soil to solar radiation. The nematodes die due to desiccation. This practice can be coupled with summer fallow to make it more effective.

2. Resistant varieties:

Nematode

Variety

I. Kalahasti

Kadiri-3

II. *M.halpa*

MC- 303,

III. *M.javanica* G 201, 4018 Japtin 220 -15, Ambali

IV. *Pratylenchus* P-1295233, and 1290606.

3. Application of carbofuran @ 1kg. a.i. per . ha at planting.

4. Crop rotation with paddy or other cereal crops like sorghum and maize. Rotation with paddy is very effective in reducing the population of Kalahasti nematode. Rotation with maize, or sorghum reduces root -knot nematode population.

5. Green manuring and incorporation of organic manure to the soil can help in minimizing the Kalahasti and root knot nematodes.

6. Quarantine regulations need to be strictly monitored to check the entry of *Aphelenchoides arachidis* and *Belonolaimus longicaudatus*.

G. Rodent Management in Groundnut :

1. Major rodent species:

Bandicota bengalensis, Millardia meltada, Tatera indica

2. Working index: (E.T.L.)

Fifteen live burrows /ha.

3. Management practices:

- a) Ploughing of fields to demolish existing rodent burrows.
- b) Application of 0,005% Bromadiolone in ready -to-use form or wax blocks.
- c) Repeat above control operation when rodent burrows exceeds working index (ETL)

NOTE: Optimum period for undertaking control operation is flowering stage and pod maturity stage.

IV. CROP STAGE / PEST viz. -a - viz IPM PRACTICES:

<p>Crop Stage/Pest 1.</p>	<p>IPM Component 2.</p>	<p>IPM Practice 3.</p>
<p>1. Pre-sowing (a) White grubs (b) Nematodes (c) Budnecrosis (d) Red Hairy caterpillars</p>	<p>Cultural practice</p>	<ol style="list-style-type: none"> 1. Partial or complete lopping of host plants and retaining of a few most preferred host trees in the area for congregation of white grub adults. 2. Deep ploughing in summer to expose soil borne pathogens, white grubs, nematodes and hibernating defoliators and under ground bulbs and rhizomes of perennial weeds. 3. Crop rotation with sorghum/ pearl millet or maize. 4. Early sowing to avoid damage due to insect pests and bud necrosis (if irrigation facility is available) except pest endemic area.
	<p>Mechanical Practice</p>	<ol style="list-style-type: none"> 1. Collection and destruction of white grub adults. 2. Installation of 12 light traps/ha. or bonfire against Red Hairy Caterpillar (RHC) in endemic areas.

<p>2. Seed & Seedling</p> <p>White grubs</p>	<p>Chemical Practice</p>	<p>Spraying white grubs harbouring host trees with Monocrotophos * 1.5 ml./ltr., carbaryl* 1 gm/ltr.</p>
<p>Weeds</p> <p>Leaf miner</p> <p>Tobacco caterpillar</p> <p>Bud Necrosis</p> <p>Stem rot, White grubs and termites</p>	<p>Cultural Practice</p> <p>-do-</p> <p>-do-</p> <p>-do-</p>	<p>Two hand hoeings at 20 days and 35-45 days after sowing for effective weed control.</p> <p>Stray planting of cowpea or soybean (for leaf miner), castor and sunflower for <i>S. litura</i> as trap crops.</p> <p>Dense cropping (use increased seed rate) to reduce bud necrosis damage and weed population.</p> <p>Soil application of castor cake @ 1000 kg/ha or neem cake against stem rot (only in endemic areas).</p>
<p>Red hairy caterpillar</p>	<p>Mechanical Practice</p>	<p>Continue with light trap or bonfire against RHC.</p> <p>Collection and destruction of egg masses of RHC in the fields around light-trap areas.</p>

<p>Seed rots/collar rots</p> <p>Weeds</p>	<p>Biological Control Practice</p> <p>Chemical Control</p>	<p>Seed treatment with <i>Trichoderma viride</i>, <i>T. harzianum</i> @ 4 kg/kg seed.</p> <p>Application of Alachlor 2.5 kg a.i./ha, Pendimethalin @ 0.75 to 1.5 kg a.i./ha., Oxyfluorfen 0.1 to 0.2 kg. a.i./ha as pre-emergence or Fluchloralin @ 1.00 kg.a.i./ha. as pre sowing soil incorporation for weed control.</p>
<p>Seed/Collar rots</p> <p>White grubs</p>	<p>Chemical Control measures</p> <p>-do-</p>	<p>Seed treatment with Carbendazim* @ 4g/kg. seed or <i>T. viride</i> 4 g/kg of seed against seed/seedling rots.</p> <p>Seed treatment with chlorpyriphos* @ 2.5 to 12 ml./kg. or Quinalphos* 25 ml./kg. seed (in endemic areas against white grub)</p>

*Use not yet approved by Registration Committee (R.C.) and Literature available with Project Coordinator, (White Grub), ICAR.

<p>3. <u>Vegetative Phase</u></p> <p>Leaf spots Stem rot Budnecrosis Clump(Regional) Jassids Tobacco caterpillar Red Hairy caterpillar Bihar Hairy caterpillar Aflatoxin</p>	<p>Cultural practice</p>	<p>Rouge out bud necrosis affected and chump infected plants.</p> <p>Irrigate once to avoid prolonged mid season drought (>20 days) to prevent pre-harvest <i>A. flavus</i> infection (Aflatoxin contamination) if irrigation facility is available.</p>
	<p>Mechanical Practice</p>	<p>Continue with light trap or bonfire and mechanical collection of RHC egg masses/caterpillars.</p> <p>Install one pheromone trap per ha. for monitoring or 5 trap/ha for mass trapping of <i>Spodoptera</i></p> <p>Collection and destruction of early stage larvae of Bihar hairy cater pillar.</p> <p>Collection and destruction of white grub adults from jujube or neem trees around the field.</p> <p>Install 10-12 bird perches per ha.</p> <p>Two hand or mechanical weedings at 15-20 days after sowing.</p>

	Biological Control Practices	<p>Release egg parasite, <i>Telenomus remus</i> @ 50000/ha. 4 times (7-10 days interval) against <i>S. litura</i>.</p> <p>Spray <i>S. litura</i> NPV @ 250 LE (6×10^9 POB/LE./ha.) or <i>Bacillus thuringiensis</i> (B.t.) @ 1 kg./ha. for controlling defoliators like <i>Spodoptera</i></p>
	Chemical control practices	<p>Spray Carbendazim @ 375 g a.i./ha or 2 gm of Chlorothalanil/litre for control of leaf spots and rust.</p> <p>Spray Thiodan 35 EC (Endosulfan) or Ekalux 25 E.C. (Quinalphos) @ 1250 ml/ha or 500 ml of Nuvan (35 EC)/ 4 ml./ha to control full grown hairy caterpillar.</p>
<p>4. Flowering</p> <p>Leaf miner</p> <p>Spodoptera</p> <p>Rodent</p>	Mechanical Practices	<p>Collect and destroy egg masses and early instar larvae of <i>S. litura</i>.</p> <p>Continue Pheromone trap @ 1/ha. for monitoring or 5/ha. for mass trapping of <i>S. litura</i>.</p> <p>Spray of neem based formulation @ 2%.</p>
	Biological Control Practices	<p>Spray 5% neem seed kernel extract against <i>Spodoptera</i></p> <p>Release <i>Trichogramma chilonis</i> (50000/ha.) twice and <i>Cheilomenus sexmaculata</i> (1250/ha twice) against leaf miner and other defoliators.</p>

	Chemical Control Measures	Apply 0.005% Bromadiolone in ready-to-use form or wax blocks for rodent control
<p>5. <u>Peg & Pod formation</u></p> <p>Spodoptera Leaf miner Rust Leaf spot Stem rot</p>	Mechanical Practice	<p>Collect egg masses and early instar larvae of <i>S. litura</i>.</p> <p>Spray of neem based formulations @ 2%.</p>
	Biological Control Practice	Spray <i>S. litura</i> NPV @ 250 LE/ha. or B.t. 1 kg./ha. on need basis.
	Chemical Control Practices	Spray Carbendazim @ 375 g a.i./ha or 2 g Chlorothalanil per litre if leaf spots & rust persist.
<p>6. <u>Maturity stage</u></p> <p>Pod rot Leaf spots Rust Pod borers Termites Rodents</p>		No chemical control measures are suggested as this action may leave pesticides residues in the harvested produce.
	Chemical Control Measures for rodents	Use 0.005% Bromadiolone in ready to use form or wax blocks.

<p>7. <u>Harvest & Storage</u></p> <p>Rodents Aflatoxins Bruchids</p>	<p>Cultural practices</p>	<p>Store the pods in polythene-lined gunny bags and fill the top surface of the bag with a layer of 1 or 2 cm.,ht. of sand. Mouth of bags not be stitched or closed to avoid germination loss.</p> <p>Dry the pods to optimum kernel moisture level of about 7%.</p> <p>Harvest at optimum maturity stage to avoid pod infection by <i>A. flavus</i> (neither immatured nor over-matured)</p>
	<p>Chemical Practices</p>	<p>Use 0.005% Bromadiolone in ready to use for wax blocks for rodents.</p> <p>In case Bruchids infestation, fumigate with Celphos one tablet (3 gm.)/30 kg.bag and cover with Tarpoline for 3-4 days. Care should be taken while fumigation to avoid fumes in residential areas.</p>

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V. INTEGRATED PEST MANAGEMENT STRATEGIES FOR INTER CROP WITH GROUNDNUT:

1. Groundnut and Castor:

For every 5 or 6 rows one row of castor is sown. After groundnut crop is harvested, castor crop is allowed to remain in the field. This gives additional income to the farmers besides acting as a trap crop / indicator crop for *Spodoptera* (Gujarat, M.P.).

Control measures taken against pests of groundnut crop takes care of pests on castor viz. Semi looper, Capsule borer, Hairy Caterpillar.

2. Groundnut and Redgram:

For every 5 or 6 rows of groundnut one row of redgram is sown. After the harvest of groundnut, redgram is allowed to remain in the fields. For management of *Helicoverpa armigera* use the following methods:-

1. Set up pheromone traps @ 5./ha to monitor *H. armigera*.
2. Conduct AESA weekly. If the pest population is in upward trend without corresponding increase in defender population, take decision on management practices on the basis of AESA as suggested below.
 1. Apply H-NPV @ 250 LE/ha. or B.t 1 kg/ha or 5% NSKE when large number of eggs and early instar larvae are noticed.
 2. If the above measures are not giving adequate control then apply only safe pesticide at recommended doses.

VI. DO's AND DON'Ts IN GROUNDNUT IPM

Do's

1. Deep ploughing is to be done on bright sunny days during the month of May and June. The field should be kept exposed to sun light at least for 2-3 weeks.

2. Grow only recommended varieties

3. Prefer to sow the crop from Mid April to mid May for North Zone and upto June end for South and Central Zones.

4. Always treat the seeds with approved chemicals/bio products for the control of seed borned diseases/pests

5. Sow in rows at optimum depths under proper moisture conditions for better establishment.

6. Pre-emergence herbicides should be applied immediately after sowing before the emergence of weeds and crop.

7. Herbicides like fluchloralin should be incorporated into the soil immediately after spraying, to avoid its photo-degradation.

8. Apply only recommended herbicides at recommended dose, proper time, as appropriate spray solution with standard equipment along with flat fan or flat jet nozzles.

Dont's

Do not plank or irrigate the field after ploughing at least for 2-3 weeks to allow desiccation of weed's bulbs and / or rhizomes of perennial weeds.

Do not grow varieties not suitable for the season or the region.

Avoid late sowing as this may lead to reduced yield and incidence of white grubs and diseases.

Do not use seeds without seed treatment with biocides/chemicals.

Do not sow seeds beyond 5-7 cm depth.

Pre-emergence herbicides should not be applied after emergence of crop and/or weeds as they cannot control the germinated weeds as well as they may cause phytotoxicity to the crop.

Soil incorporation of fluchloralin should not be delayed or avoided for achieving effective weed control.

Pre-emergence as well as soil incorporated herbicides should not be applied in dry soils. Do not apply herbicides alongwith irrigation water or by mixing with soil, sand or urea.

9. 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.
10. Use NPK fertilisers as per the soil test recommendations. Avoid imbalanced use of fertilisers
11. Use micronutrient mixture after sowing as top dressing separately. Do not mix micronutrients with fertilisers and incorporate into the soil.
12. Conduct AESA weekly in the morning preferably before 9 am . Take decision on mangement practice based on AESA, ETL, P:D ratio only. Do not apply chemical pesticides on calendar basis.
13. Install pheromone traps on 20-30 DAS for *Spodoptera* and leaf miner. Replace lures in 15-20 days. Do not store the pheromone lures at normal room temperature (keep them in refrigerator).
14. Release parasites only after noticing adult moth catches in the pheromone trap or as per field observation. Do not apply chemical pesticides within 7 days of release of parasites.
15. Apply, *S. litura* NPV at recommended dose when a large number of egg masses and early instar larvae are noticed. Apply NPV only in the evening hours after 5 pm. Do not use the same sprayer for application of chemical pesticides and biocides.
16. In case of pests which are active during night like *Spodoptera* spray recommended biocides chemicals at the time of their appearance during dusky hours. Do not apply pesticides/biocides when it is not absolutely required.

VII. SAFETY PARAMETERS

Annexure deals with the 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.
- 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 symptom 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 the 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".

SAFETY PARAMETERS IN PESTICIDES USAGE

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	Waiting period (No. of days)
INSECTICIDES								
ORGANOPHOSPHATE PESTICIDES								
1.	Monocrotophos	Extremely toxic	Bright red	Class I b - Highly hazardous	Remove the person from the contaminated environment.	Mild - anorexia, headache, dizziness, weakness, anxiety, tremors of tongue and eyelids, miosis, impairment of visual acuity.	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.	
2.	Chlorpyrifos	Highly toxic	Yellow	Class II - Moderately hazardous	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) Ingestion - 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.	Moderate- nausea, salivation, lacrimation, abdominal cramp, vomiting, sweating, slow pulse, muscular tremors, miosis.	Speed is imperative	
3.	Quinalphos	Highly toxic	Yellow	Class II - Moderately hazardous	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.	Severe - diarrhoea, pinpoint and non-reactive pupils, respiratory difficulty, pulmonary edema, cyanosis, loss of sphincter control, convulsions, coma and heart block.	<ul style="list-style-type: none"> - 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 	
					Medical aid: Take the patient to the docotr/Primary Health Centre			

					immediately along with the original container, leaflet and label.		<p>contact, wash with soap and water (eyes- wash with isotonic saline). Wear rubber gloves while washing contact areas.</p> <p>In addition to atropine give 2-PAM (2-pyridine aldoxime methiodide). 1 g and 0.25 g for infants intravenously at a slow rate over a period of 5 minutes and administer again periodically as indicated. More than one injection may be required.</p> <p>Avoid morphine, theophyllin, aminophyllin, barbiturates ofr phenothiazines.</p> <p>Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.</p>
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CARBAMATES

4.	Carbaryl	Highly toxic	Yellow	Class II – Moderately hazardous	Constriction of pupils, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhoea, epigastric pain, tightness in chest.	<ul style="list-style-type: none"> - Atropine injection 1 to 4 mg. Repeat 2 mg when toxic symptoms begin to recur (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
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							respiration as needed. - For ingestion, lavage stomach with 5% sodium bicarbonate, if not vomiting. For skin contact was with soap and water (eyes – wash with isotonic saline). Wear rubber gloves while washing contact area. - Oxygen - Morphine, if needed. Avoid theophyllin and aminophyllin or barbiturates. 2-PAM and other oximes are not harmful and in fact contra indicated for routine usatge. Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.
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FUNGICIDES

5.	Carbendazim	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.
6.	Mancozeb	-do-	-do-	-do-		
7.	Chlorothalonil	-do-	-do-	-do-		

HERBICIDES							
8.	Alachlor	Moderately toxic	Blue	Class III - Slightly Hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin etc.,	No specific antidote. Treatment is essentially symptomatic.
9.	Pendimethalin	Moderately toxic	Blue	-do-			
10.	Oxyfluorfen	Slightly toxic	Green	Table 5 - Unlikely to present acute hazard in normal use			
11.	Fluchloralin	Moderately toxic	Blue	Class III - Slightly hazardous			
RODENTICIDES							
12.	Bromodiolone	Extremely toxic	Bright red	Class I a - Extremely hazardous		<p>Bleeding from nose, gums and into conjunctiva, urine and stool & coma</p> <p>Possible polar and petechial rash, late-massive echymoses or hematoma of skin, joints, brain hemorrhage</p>	<ul style="list-style-type: none"> - Give Vitamin K1 15-25 mg for adults; 5-10 mg. for children orally; - Transfuse with fresh blood if bleeding is severe or until anemia is corrected. - Iron (Ferros sulfate) by mouth for correction of secondary anemia, 0.3 gm t.i.d.

AGRO ECO SYSTEM ANALYSIS (AESA)

AESA 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 practices. The basic components of AESA are:-

1. Plants 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.

The methodology of AESA is as under:-

A. Field Observations:-

- a) Enter the field at least 5 ft. away from the bund. Select a site with a dimension of 1 sq. mt. randomly.
- b) Record visual observations in following sequence:-
 - i) Flying insects (both pests & defenders)
 - ii) Close observation on pests and defenders which remain on the plants.
 - iii) Observe pests like *S.litura* and defenders like ground beetle/ rove beetle / earwigs by scrapping the soil surface around the plants.
 - iv) Record disease and its intensity.
 - v) Record insect damage in percentage.
- c) Record parameters like number of leaves, branches, plant height and reproductive parts of the selected plants which should be flagged for making observation in the following weeks.

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- c) Record parameters like number of leaves, branches, plant height and reproductive parts of the selected plants which should be flagged for making observation in the following weeks.

- d) Record the types of weeds, their size and population density in relation to crop plant.
- e) Record soil conditions viz. flooded, wet or dry.
- f) Observe rodent live burrows.
- g) Repeat the step (a) to (f) in four sites randomly selected.
- h) Record the climatic factors viz. sunny, partially sunny, cloudy, rainy etc. for the preceding week.

B. Drawing:

First draw the plant with actual number of branches/ leaves etc. at the centre on a chart. Then draw pests on left side and defender on the right side. Indicate the soil condition, weed population, rodent damage etc. Give natural colours to all the drawing, for instance, draw healthy plant with green colour diseased plant/ leaves with yellow colour. While drawing the pests and the defenders on the chart care should be taken to draw them at appropriate part of the plant, where they are seen at the time of observation. The common name of pest and defenders and their population count should also be given alongwith diagram. The weather factor should be reflected in the chart by drawing the diagram of sun just above the plant if the attribute is sunny. If cloudy, the clouds may be drawn in place of sun. In the case of partially sunny, the diagram of sun may be half masked with clouds.

C. Group Discussion and Decision making:

The observations recorded in the previous and current charts should be discussed among the farmers by raising questions relating to change in pest and defender population in relation to crop stages, soil condition weather factors such as rainy, cloudy or sunny, etc. The group may evolve a strategy based upon weekly AESA, ETL and corresponding change in P:D ratio and take judicious decision for specific pest management practices.

D. **Strategy for decision making: (Examples)**

- i) When large number of egg masses and early instar larvae of *Spodoptera/ Helicoverpa* are observed, the group may advocate application of NPV.
- ii) Some of the defenders like lady bird beetles groundnut beetles, rove beetles and wasps play useful role in arriving at P:D ratio (Detailed list is at Annexure – II).

AESA BY EXTENSION FUNCTIONARIES :-

The extension functionaries during their regular visit to the village mobilise the farmers, conduct AESA and critically analyse the various factors such as the pest population viz - a viz defender population and their role in natural suppression of the pest, the influence of prevailing weather condition / soil conditions on the likely build up of defender / pest population. They may also take the decision based on the AESA, which IPM components like release of defenders, application of neem formulations/safe pesticides are to be used for specific pest situation. Such an exercise may be repeated by the extension functionaries during every visit to the village and motivate the farmers to adopt AESA in their fields.

AESA BY FARMERS:-

After a brief exposure during IPM demonstrations/ field trainings, farmers can practice AESA in their own fields. Wherever trained farmers are available their experiences could be utilised in training their fellow farmers in their own villages. Thus a large group of farmers could be made proficiently competent in undertaking weekly AESA thereby empowering themselves in decision making on any specific pest situations. Farmers - to- farmers training approach will go a long way in practicing IPM on a large area on sustainable basis.

POTENTIAL NATURAL ENEMIES OF GROUNDNUT INSECT PESTS

Sl.No.	Name of the Predator/ Parasitoid/Pathogens	Pest	Stage attacked
1.	Flower bugs (Anthocorids)	Thrips, Mites, Lepidoptera Aphids	1. Eggs and young larvae of Lepidopteran pests. 2. Adults and nymph of aphids, Mites & Thrips.
2.	Shield bugs (Predatory Pentatomid)	Lepidoptera Bugs	Immature and adult stages.
3.	Lady bird beetles (Coccinellids)	Aphids, Mealy Bugs, Jassids Thrips	Nymphal and adult stage.
4.	Ground beetle (Carabids)	Lepidoptera Soft bodied Insects.	Small larvae of Lepidoptera. Larvae and adults
5.	Rove beetle (Staphilinids)	Soft bodied insects.	Larvae and adults
6.	Praying mantis	All insects (including grasshoppers)	All stages
7.	Hover flies (Syrphids)	Aphids	All stages
8.	Robar fly	<i>Helicoverpa</i> <i>Spodoptera</i> grasshopper	Larvae and adult stages.
9.	Ants	Soft bodied insects	Eggs and larvae
10.	Green lace wing (Chrysopids)	Soft bodied insects (including small larvae)	Eggs and larvae
11.	Long horned grasshoppers (Tettigonids)	Any insect	Egg masses
12.	Predatory crickets (Gryllids)	Lepidoptera	Eggs
13.	Earwig (Carcinophorids)	Lepidoptera	Larvae
14.	Spiders	All insects	All stages preferably moving stages
15.	Braconids / Ichneumonid wasps	Lepidoptera/ Coleoptera	Immature stages

- | | | | |
|-----|-----------------------------|--|------------------------|
| 16. | Damsel flies / Dragon flies | All insects
including
Jassids,
<i>H. armigera</i>
<i>S. litura</i> | Larval and adult stage |
| 17. | Trichogrammatids | Lepidoptera
Coleoptera | Eggs stage |
| 18. | NPV | Lepidoptera
Coleoptera | Larval Stage |
| 19. | Green muscardine fungus | Jassids
Lepidoptera
Coeoptera | Larval Stage |
-

BASIC PRECAUTIONS IN PESTICIDE USAGE**A. Purchase:**

1. Purchase only JUST required quantity e.g. 100,250,500 or 1000 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 cap.

4. Use polyethelene bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover the head (Do not use polyethelene 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 polyethelene bags.

E. Equipment:

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- brush 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 buried deep into soil away from water source.
3. Never re-use empty pesticide container for any purpose.