



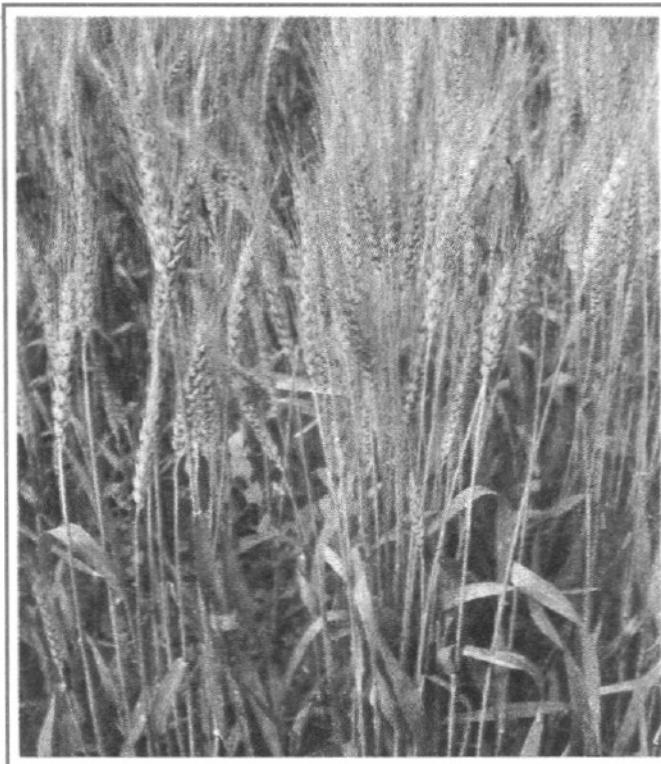
IPM PACKAGE NO. 2



INTEGRATED PEST MANAGEMENT PACKAGE

FOR

WHEAT



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 WHEAT

CONTENTS

Subject	Page No.
Foreward	i
Preface	ii
Acknowledgements	iii
I. Pests of Major importance:	
1. Diseases	1
2. Nematodes	1
3. Insect Pests	1
4. Rodents	2
5. Major Weeds	2
II. Pest Monitoring:	
1. Rapid Roving Survey	3
2. Trap Plot Nurseries (TPN)	3
3. Field Scouting	4
4. Agro-Eco System Analysis (AES)AESA	5
III. Economic Threshold Level (ETL)	6
IV. Integrated Pest Management Strategies:	
1. Disease Management	6
2. Nematode Management	9
3. Insect Pest Management	9
4. Rodent Management	11
5. Weed Management	12
V. Crop Stage-wise IPM Practices	13-14
VI. Do's and Don'ts in Wheat IPM	15
VII. Safety parameters	16-20
Annexures - I to III	21-28



Government of India
Ministry of Agriculture
(Department of Agriculture & Cooperation)

DIRECTORATE OF PLANT PROTECTION, QUARANTINE & STORAGE
NH IV, FARIDABAD - 121 001 (Haryana)

DR.V. RAGUNATHAN
Plant Protection Adviser
To the Government of India

FORWARD

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 based Crop Production Progamme etc. Though IPM approach has been taken up since 1981, its impact has not been felt until 1994. Human Resource Development has helped to sensitise extension functionaries and farmers about the usefulness of IPM.

For successful implementation of IPM, the scattered information on various components of this eco-friendly approach forms basic necessity. In this direction, initial attempts were made in 1992 to harmonise the IPM Package of Practices of various crops. Subsequently concerted efforts were made in 1998, 2001 and 2002 to update and develop IPM package of practices for agricultural and horticultural crops. Presently, IPM package of practices for 51 crops have been finalised to help the extension workers and farmers to manage the pests/ diseases and to minimise the over use/ misuse of chemical pesticides. Efforts have been made to incorporate the relevant available technical input provided by the scientists of ICAR Institutes/ SAUs and State Departments of Agriculture. However, suggestions for further improvement in future publication/ revision will be of immense help. Hopefully, these IPM Package of Practices will be useful for the Researchers, Plant Protection Workers and Farmers alike.

April 1, 2002

(V. Ragunathan)

PREFACE

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 from April 15-17, 1998 and Nov. 5-6, 1998 at Dte. of PPQ&S, Faridabad and IPM package of practices for 20 crops were evolved 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 Feb. 20-22, 2002 respectively to update 20 available IPM Packages and develop 31 new IPM Packages specially for Horticultural crops. In this workshop, 51 IPM Package of Practices for cereal crops (Rice, Wheat, Maize, Sorghum, Millets), Commercial crops (Cotton, Sugarcane, Tobacco, Tea), pulse crops (Pigeonpea, Gram, Black gram/Green gram, pea, Rajmah), Oilseeds (Groundnut, Soybean, Rapeseed/Mustard, Sesame, Safflower, Castor, Sunflower, Oilpalm), Vegetables (Potato, Onion, Tomato, brinjal, Okra, Chilies, Cruciferous vegetables, Leguminous vegetables, Cucurbitaceous vegetables), fruit crops (Citrus, Banana, Apple, Mango, Guava, Grapes, Pineapple, Sapota, Pomegranate, Litchi), spice and plantation crops (Small Cardamom, Large Cardamom, Black Pepper, Ginger, Coriander, Cumin, Fennel, Coconut, Cashew and Areca nut) have been finalized.

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 encompasses various management strategies for constraining the pest and disease problems. Pest monitoring is also one of the important component 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 level (ETL) of important pests and diseases are also given in the packages to take appropriate control measure when pest population crosses ETL.

These IPM packages developed with the technical inputs from experts from Indian Council of Agriculture 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 Indian Agriculture and Horticulture. These 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.

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 packages will be useful for the Researchers, Extension Workers and Farmers alike who are engaged in the agricultural practices.

.....

(A.D. Pawar)
Addl. PPA-cum-Director (IPM)

ACKNOWLEDGEMENTS

The IPM Package of Practices for Wheat crop was discussed and finalised in the National Workshop on IPM held at National Plant Protection Training Institute (NPPTI), Hyderabad during May 14-17, 2001. The technical input received from the following experts is thankfully acknowledged. The input received from Dr. A.K. Sharma, Principal Scientist & P.I. (Crop Protection), Dte of Wheat Research (ICAR), Karnal is also gratefully acknowledged.

- I. Chairman, Technical Session : Dr. A.D. Pawar, Director (IPM), Dte of PPQS, Faridabad
- II. Coordinator, Technical Session : Dr. M.P. Misra, Dy. Director (Ent.), Dte. of PPQS, Faridabad
- III. Co-chairman, Technical Session : Dr. Brajendra Singh, Entomologist, Dte of PPQS, Faridabad
- IV. Expert input :
 - 1. Sh. D. Chattopadhyay, APPO, NPPTI, Hyderabad.
 - 2. Dr. R.P. Misra, PPO(E), Central IPM Centre, Lucknow
 - 3. Sh. Ram Samujh, PPO(E), Central IPM Centre, Gangtok
 - 4. Sh. M.K. Das, APPO, central IPM Centre, Burdwan
 - 5. Dr. A.M.K. Mohan Rao. Rodent Specialist, NPPTI, Hyderabad
 - 6. Dr. D. Kanungo, Jt. Director, CIL, Dte of PPQS, Faridabad
 - 7. Dr. R.B.L. Bhaskar, Jt. Director (Bio.), Dte of PPQS, Faridabad
 - 8. Dr. B.S. Phogat, Agronomist (H), Dte of PPQS, Faridabad
 - 9. Sh. S.P. Kulshreshtha, Dy. Director (PP), Dte of PPQS, Faridabad
 - 10. Dr. Jasvir Singh, AD(E), Dte of PPQS, Faridabad

- V. Technical input:
 - 1. Sh. S.P. Singh, APPO, IPM Div., Dte of PPQS, Faridabad.
 - 2. Sh. S.P. Tripathi, APPO, Pesticide Unit, Dte of PPQS, Faridabad
 - 3. Sh. K.S. Sharma, SSA, IPM Div., Dte of PPQS, Faridabad.
 - 4. Sh. Yogesh Kumar, SSA, IPM Div., Dte of PPQS, Faridabad.
 - 5. Sh. R.S. Tomer, SSA, IPM Div., Dte of PPQS, Faridabad.
 - 6. Sh. Laxmi Chand, SSA, IPM Div., Dte of PPQS, Faridabad.
 - 7. Mohd. Abrar Alam, Stenographer, IPM Div., Dte of PPQS, Faridabad.
 - 8. Sh. N.K. Mishra, LDC, IPM Div., Dte of PPQS, Faridabad.

IPM PACKAGE FOR WHEAT

I. PESTS OF MAJOR IMPORTANCE

1. DISEASES

	COMMON NAME	DISTRIBUTION
1.1.	Leaf (brown) rust	Throughout the wheat growing zones.
1.2.	Stripe (yellow) rust	Cooler regions of Northern India (Northern hill Zone and NWPZ).
1.3.	Stem (black) rust	PZ, CZ, & sometimes in NEPZ. Rarely in very late sown crop in NWPZ.
1.4.	Foliar blights	Major problem in NEPZ; moderate in CZ & PZ, newly emerging problem in NWPZ.
1.5.	Loose smut	Major problem in NWPZ; NHZ & NEPZ.
1.6.	Karnal bunt	Major (endemic) in NWPZ, minor in NEPZ & Northern parts of CZ.
1.7.	Powdery mildew	Disease of cooler and humid areas in NHZ & NWPZ.
1.8.	Head scab	Newly emerging problem in sub-mountaneous parts of NWPZ.

2. NEMATODES

2.1.	Ear cockle (seed gall nematode)	Major problem in NEPZ, low to moderate in parts of CZ
2.2.	Tundu disease	Northern Rajasthan, Western & Southern Haryana
2.3.	Cereal cyst nematode	Moderate to high in drier areas of NWPZ (Northern Rajasthan, & Haryana).

3. INSECT PESTS

3.1	Termites	Major problem in dry areas of the wheat growing zones especially NWPZ, NEPZ and CZ
-----	----------	--

3.2.	Aphids	Major problem in most of the wheat growing areas (newly emerging problem)
3.3.	American Pod Borer	Mostly low; sometimes moderate (especially under cotton-wheat & Rice-wheat rotations).
3.4.	Armyworm/ Rice Caterpillar	NWPZ, NEPZ and CZ (especially in late sown crops).
3.5.	Brown mite	Normally low in NWPZ, CZ, NEPZ but rarely moderate to high in dry winter in isolated pockets, mostly under rainfed situations.
3.6.	Pink Borer	Low in parts of NWPZ, CZ and NEPZ.
4.	<u>RODENTS</u>	
4.1.	Smaller Bandicoot	Throughout wheat growing areas.
4.2.	Soft furred field rat	NWPZ, CZ.
4.3.	Indian gerbil	
5.	<u>MAJOR WEEDS</u>	
5.1.	BROAD LEAVED WEEDS - <i>Chenopodium album</i> - <i>Melilotus alba</i> - <i>Fumaria parviflora</i> - <i>Coronopus didymus</i> - <i>Rumex</i> sp. - <i>Lathyrus aphaca</i> - <i>Cirsium arvense</i>	NWPZ, NEPZ & CZ.
5.2.	GRASSY WEEDS - <i>Phalaris minor</i> * - <i>Avena ludoviciana</i> - <i>Lolium</i> sp - <i>Poa annua</i>	*Major problem in NWPZ and NEPZ.

*NHZ- Northern Hill Zone (Hills of J&K, H.P. and U.P.); NWPZ-North Western Plain Zone(Punjab, Haryana, Western UP, Northern Rajasthan and foot hills of HP & J&K); NEPZ- North Eastern Plain Zone (Eastern UP, Bihar, West Bengal); CZ-Central Zone (MP, Gujarat and Southern Rajasthan); PZ-Peninsular Zone (Maharashtra and Karnataka)

II. PEST MONITORING

The objective of surveys is to monitor the initial development of pests and diseases in endemic areas. 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. Farmers should be mobilised to observe the pest and disease occurrence by field scouting at the intervals as stipulated here under. The plant protection measures are required to be taken only when pests and diseases cross ETL as per results of field scouting.

1. RAPID ROVING SURVEY :

Undertake roving survey at every 10 km initially at weekly intervals and thereafter at 10 days intervals (depending upon the pest, disease and weed incidence) in pre-fixed routes. Record incidence of pests/ diseases of the crop in the proforma annexed as Annexure – II. Also observe and record the population of different biocontrol fauna.

In case of nematodes, particularly in the month of February (Earhead stage), special attention should be given to monitor incidence of cereal cyst nematode exhibiting symptoms like stunted growth, yellowing, less tillering and pearl like white females attached to the rootlets. For seed gall nematodes, fields showing symptoms of curling, crinkling and twisting of leaves with spread out awns may be identified to avoid harvest of produce for the purpose of seed material.

2. TRAP PLOT NURSERIES (TPN) :

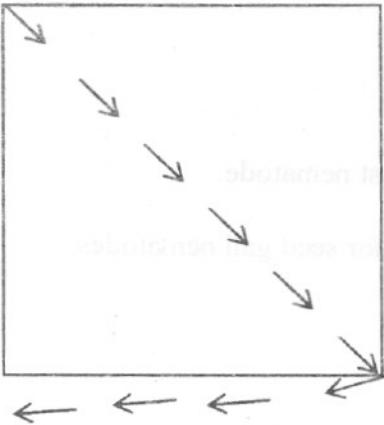
Such nurseries are planted at various strategic locations and regular watch is kept for the occurrence of the pests. Such type of nurseries, usually contain varieties or entries with known genetic constitution so that occurrence or appearance of the new race or pest could be identified. Under the All India Coordinated Wheat Improvement Project (AICWIP), the trap plot nursery (TPN) is planted at multi locations including those all along the western border. It helps in knowing the first appearance of disease, disease progress, disease situation and appearance of new variants or races or resistant materials. This also helps in monitoring the entry of new races (pathotypes) from across the border, especially for the yellow rust. Distribution pattern of the rust virulence (races) provides much needed indications for executing the resistant-gene deployment, thus helping in preparedness for the future.

3.

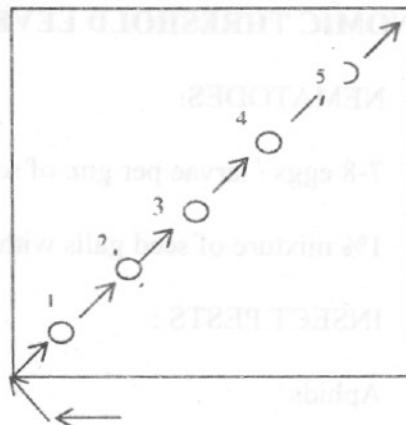
FIELD SCOUTING :

Field scouting should be undertaken by the farmers and extension functionaries for keeping a close watch on the appearance of disease, insect pests and biocontrol fauna.

During the visit to the field, a diagonal path should be followed. During the first course through the field, only occurrence of pests is recorded whereas during the second course, quantitative information is also recorded on 5 randomly selected spots of one metre row length/ 5 plants (Fig. A & b).



(a) First passage



(b) Second passage showing five sites for data recording

Pest infestation resulting damage in scattered patches in the field like root diseases, termites and nematodes should also be scouted.

4. AGRO-ECO-SYSTEM ANALYSIS (AES) :

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 :-

- Plant health at different stages. Monitor symptoms of diseases and nematodes.
- Built-in-compensation abilities of the plants.
- Pest and defender population dynamics.
- Soil conditions.
- Climatic factors.
- Farmer' past experience.

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

III. ECONOMIC THRESHOLD LEVEL (ETL) :

1. NEMATODES:
 - 1.1. 7-8 eggs / larvae per gm. of soil for cereal cyst nematode.
 - 1.2. 1% mixture of seed galls with healthy seeds for seed gall nematodes.
2. INSECT PESTS :
 - 2.1. Aphids
 - i). Five aphids per ear head / 10 aphids during vegetative stage
 - 2.2. Armyworm and American pod borer (*Helicoverpa*)
 - 4-5 larvae per meter row.
3. RODENTS.
 - I) 25 live burrows / hectare.
 - II) Damage index 2% tiller damage (diagonal method).

During AESA observations, small stem bits damaged by the rodents may be noted, which indicates the presence of reproducing / lactating females.

IV. INTEGRATED PEST MANAGEMENT STRATEGIES:

1. DISEASE MANAGEMENT :

1.1. Host Plant Resistance

The major emphasis of disease management in wheat is on resistance breeding i.e. host resistance. Whenever a newly released variety having disease resistance becomes popular and covers a major area in the zone, there is selective pressure on the disease causing organism leading to emergence of new races. This causes the break-down of resistance in the variety. It normally takes 4-5 years to complete this boom and burst cycle. At this stage the variety is replaced. Only in case of sudden break-down of resistance, the ETL is taken into consideration. For example, for loose smut, the ETL can be taken upto 2% and the seed harvested from such fields needs to be treated before it is used for the next crop.

In India, the major emphasis for the management of diseases has been on the cultivation of resistant/tolerant varieties. The emerging disease resistance approach has been adopted due to which the wheat eco-system is relatively free from pesticides as compared to other crops. The varieties recommended for cultivation in different zones should be planted to avoid the losses due to diseases specially the rusts. The disease resistant varieties are as under :-

For Rust

Zone	Varieties
Northern Hill Zone (Hills of J&K, H.P. and U.P)	HD 2380; HS 240; HS 277 ; HS 295 ; HPW 42
North Western Plain Zone (Punjab, Haryana, Western UP, Northern Rajasthan and foot hills of HP & J&K)	PBW 343 ; CPAN 3004 ; UP 2338 ; WH 542, HD2687
North Eastern Plain zone (Eastern UP, Bihar, West Bengal)	UP 1102 ; UP 262; HUW 206: HP 1209 ; K 8020
Central Zone (MP, Gujarat and Southern Rajasthan)	WH 147 ; GW 190 ; H 1977
Peninsular Zone (Maharashtra and Karnataka)	HD 2189 ; MACS 2496 ; DWR 162 ;

- In case of breakdown of resistance to yellow rust or appearance of foliar blight on leaf below flag leaf, covering 75% leaf area, spray propicanazole (0.1%).

The following recommended varieties for various zones are mostly disease resistant:

Zone	Production condition			
	Timely sown irrigated	Late sown irrigated	Timely sown rainfed	Saline-alkaline soils
NHZ	HS 240, VL 738, VL 421	HS 295, Sonalika	VL 421, VL 738, DT-46 (Trit), HS 240, VL 616@, HS 365*, HPW 42*	-
NWPZ	PBW 343, HD 2687, UP 2338, WH 542, HD 2329, CPAN 3004	Raj 3765, PBW 373, UP 2338, PBW 226, HD 2285	C 306, PBW 175, Kundan	KRL 1-4, KRL-19

NEPZ	K 8804, K 9107, HP 1731, HP 1761, HUW 206, UP 262, NW 1012, HUW 468	HUW 234, HP 1744, NW 1014, HP 1633, HD 2643	C-306, K 8027	KRL 1-4, KRL-19
CZ	LOK-1, WH 147, GW 190, GW 273, DL 803-3, HI 8498(d), Raj 1555(d)	DK 788-2, GW 173, LOK-1	C-306, Sijata, HW 2004, A-9-30-1(d), HD 4672 (d)	KRL 1-4, KRL-19
PZ	MACS 2496, HD 2189, DWR 162, DDK 1009 (dic.), MACS 2846(d)	NIAW-34, HI 977, DWR 195	NI 5439, MACS 1967 (d), Bijaga Yellow (d),	KRL 1-4, KRL-19
SHZ	HW 1085, HW 2044, DDK 1009 (dic.), NP 200(dic.)	-	-	-

Trit- Triticale *High altitudes (d)- durum (dic.)- dicoccum @- Early sown

1.2 Other methods / approaches :

1.2.1 Loose Smut :

- (i) Use seed from disease free source or treat the seed with any of the recommended systemic fungicides like Carboxin (2.5g/kg of seed) or Carbendazim (2.5g/kg of seed).
- (ii) Seed can also be treated with a combination of half the dose of Carboxin* (1.25g/kg of seed) and *Trichoderma viride** @ 4-5 g/kg seed. For this, seed may be treated with the bioagent slurry followed by fungicide on the following day.
- (iii) Solarization Technique :

The seed is soaked in cold water during hot summer months in the morning hours and kept in hot sun from 8 AM to 12 noon and then dried in the afternoon. This kills the fungus inside the seed and provides a good disease control measure without use of fungicides. However precaution is to be taken so that there is no damage to the viability of seed.

- (iv) In the standing crop, the plants showing yellowing of the boot leaf tip normally are the ones which will give smutted ear heads on emergence. Uproot such plants before ear emergence to reduce the infestation of the healthy seeds at a later stage.

* This combination is not as per approved usage under Insecticide Act 1968.

1.2.2 Karnal bunt :

- (i) Use disease free seeds in the healthy fields. For seed production, disease free fields/areas be identified for having crop without considerable inoculum load.
- (ii) The infestation is more if it rains at the time of ear head emergence. In such situations, one spray of a chemical like Propiconazole or Bitertanol (0.1%) to reduce the disease severity and to restore crop health.

2. NEMATODE MANAGEMENT :

2.1. Cereal Cyst Nematode (Molya disease)

- (i) Deep ploughing of field soil in months of May-June or around approx. 40°C temp. to expose the nematode population to solar radiation.
- (ii) Non-host crops of gram, mustard, cumin, carrots, onion are suggested for 3 years. Growing of resistant varieties RD-2035 and RD-2052 of Barley is recommended.
- (iii) Early sowing of wheat is recommended wherever possible.
- (iv) At sowing application of 1.5 kg ai/ha. of Carbofuran 3 G in infested area.

2.2. Seed Gall Nematode (Ear Cockle & Tundu)

- (i) Use certified or gall free seeds.
- (ii) Mechanical sieving of wheat to remove the galls.
- (iii) Pour the contaminated seed into 2% salt solution. Galls float on surface. Decant them carefully and wash seeds in fresh water and dry before sowing. Brine floatation upto 5% may be used in heavy infestation.

3. INSECT PEST MANAGEMENT :

The damage due to insect pests in wheat is not much and at present, very little pesticides are needed for the control of insect pests. However, in specific cases. Insecticides may be used. The following general points may be followed for reducing the insect pest damage:-

3.1 Cultural Practices :

- i) Always use well rotten farm yard manure to avoid damage by termites.
- ii) Avoid late sowing of wheat to save the crop from damage caused by aphids, armyworm, shoot fly, *Heliothis armigera* and crows.
- iii) For termite control, prefer seed treatment as it is cheap and most effective and also causes less pollution. Treat seeds before sowing with Chlorpyrifos or Endosulfan.
- iv) Use the recommended dose of nitrogenous (N) fertilizers, as the higher levels it attract higher population of armyworm and aphids.
- v) Keep supervision of the crop, as in case of aphids, at initiation of attack spraying of border of fields only, will help in keeping the population under check.

3.2 Mechanical control :

- (i) Dismantle termitaria (termite mounds) around fields and kill the termite queen.

3.3 Biological control :

- (i) Conservation and exploitation of biological control agents like Coccinellid beetles, *Chrysopa*, Syrphid flies, *Cotesia* sp. etc.
- (ii) For the management of American pod Borer, NPV (He) preparation @ 250 LE/ Ha in the evening hours may be sprayed.
- (iii) Release *Trichogramma* sp. @ 50,000/ha for pink borer and armyworm control.

4.2. Chemical control :

- i) Insecticides should only be sprayed when the pest population crosses the economic threshold levels in consideration with P : D ratio.

i)	Termite Seed treatment :	Treat the seed before sowing with any one of the following insecticides : Chlorpyriphos @ 4 ml / kg seed or
ii)	Aphids	Spray 200-250 gm ai/ha of any one of the following insecticides : Dimethoate Oxydemeton methyl
iii)	Armyworm	Spray any one of the following insecticides : 50% WP Carbaryl @ 750-1000 gm a.i / ha. Fenitrothion @ 750 gm a.i / ha. Dichlorovos @ 500 gm a.i / ha. Quinalphos @ 400 gm a.i / ha. Trichlorphon @ 750 gm a.i / ha. For better control, spray the crop in evening hours.
iv)	American Pod Borer	Spray Carbaryl @ 750-1000 gm a.i / ha. or Quinalphos @ 400 gm a.i / ha.

4. RODENT MANAGEMENT :

4.1 Cultural practices :

- i) Trimming of the field bunds to destroy the existing rodent burrows.
- ii) Collapsing the existing rodent burrows through flooding etc.

4.2. Mechanical practices :

- i) Employing indigenous rat traps before the crop reaches primordium initiation stage.

4.3.

Biocontrol practices :

- i) Employing/ affixing a bird percher of 5 ft. height to attract biocontrol agent viz. owls during the night times. After flowering, bird percher should not be kept.

4.4.

Chemical control practices :

- i) When rodent infestation is less than 25 live burrows/ ha. Bromadiolone 0.005% bait (15 g per burrow) to be placed inside the live burrows.

- ii) When rodent infestation is high (more than 25 live burrows/ ha :-

Zinc Phosphide at 2.0-2.5% bait to be placed inside the live burrow @ 10 g per burrow after prebaiting with plain bait. The bait material may be commonly grown cereal of the area. For treating residual population, Bromadiolone (0.005%) baiting should be done @ 15 g bait per live burrow.

4.5. **Timings for control operations :**

Mid February/ early March/ at/ before milky stage of the crop.

WEED MANAGEMENT :

- 5.1. Crop should be sown timely at adequate moisture by using recommended seed rate, balance doses of fertilizers for achieving optimum plant population and healthy crop stand which would be capable of competing with weeds at initial stages of crop growth.
- 5.2. Practice of stale seed beds preparation (preparing the seed bed and leaving it undisturbed for some time for the germination of weeds and ploughed) should be adopted mainly for reducing wild oat population before sowing of wheat crop.
- 5.3. Crop should be maintained weed free initially upto 45 days after sowing by resorting two hand hoeings/ weedings at 20 and 40 days after sowing and/ or by pre-emergence application of Pendimethalin at 1.0 to 1.5 kg. ai/ha.
- 5.4. Application of 2, 4-D @ 0.5 – 0.75 kg ai/ha or Metsulfuron - Methyl @ 4 g a.i./ha at 30-35 days after sowing for controlling broad leaved weeds.
- 5.5. Application of Isoproturon, or Diclofop methyl @ 1.0 kg ai/ha or Metoxuron @ 1.2-1.6 kg ai/ha at 30-35 days after sowing for controlling grassy weeds.
- 5.6. Application of Pendimethalin @ 1.0-1.5 kg ai/ha as pre-emergence or Metribuzin @ 0.175-0.210 kg ai/ha post emergence at 30-35 days after sowing for controlling both broad leaved and grassy weeds.

5.7. Application of Sulfosulfuron @ 25 gms ai/ha or Fenoxaprop-p-ethyl @ 100-120 gms a.i./ha, or Piroxaop propargyl 100 gm ai/ha or Clodinafop @ 60 gm ai/ha at 30-35 days after sowing for controlling resistant biotypes of *Phalaris* and other grassy weeds.

HERBICIDES SHOULD BE ROTATED TO AVOID DEVELOPMENT OF RESISTANCE IN RESPECTIVE WEED SPECIES.

V. CROP STAGE-WISE IPM PRACTICES :

	Crop Stage		IPM Practices to be adopted
1.	Pre-sowing	i)	Deep summer ploughing in May-June to expose soil borne diseases and nematodes to solar radiation.
		ii)	Apply well rotten farm yard manure only to discourage termite infestation.
		iii)	Avoid late sowing of crop.
		iv)	Use only certified seed. Clean seed by sieving or by using 2-5% salt-water flotation to remove galls and prevent ear-cockle disease.
2.	Seed	i)	Treat the seed with Chlorpyrifos @ 4 ml/kg seed Before sowing to control termite damage. To control loose smut, treat the seed with Carboxin (@ 2.5 g/kg)
3.	Seedling stage	i)	If termite damage is noticed at seedling stage, apply treated soil by broadcasting @ 175 gm ai/ha. of Endosulfan.
		ii)	Observe the damage by root aphid.
		iii)	If the dead hearts inflicted by shoot fly/ pink borer are noticed, spray crop with Cypermethrin @ 50 gm ai/ha. at ETL.
4.	Vegetative stage	i)	To check the damage by Brown mite and aphids spray the crop with Dimethoate or Oxydemeton methyl or Formothion or Monocrotophos @ 250 gm ai/ha. at ETL.

5.	Earhead stage	i)	Release <i>Trichogramma</i> sp. @ 50,000/ha for the control of borer 2-3 times.
		ii)	Spray NPV @ 250 LE/ha for <i>Helicoverpa</i> control.
		iii)	To control aphid, use the above mentioned pesticides
		iv)	For armyworm control, spray Carbaryl @ 750-1000 gm a.i./ha Fenitrothion @ 750 gm a.i./ha in the late evening.
		v)	For American pod borer control spray Carbaryl @ 750-1000 gm a.i./ha or Quinalphos @ 400 gm a.i./ha.

- SPRAY THE INSECTICIDES ONLY IF THE PEST REACHES ETL STAGE.

VI. DO'S AND DON'TS IN WHEAT IPM

	<u>DO'S</u>	<u>DON'TS</u>
1.	Grow only recommended varieties.	Do not grow varieties which are not recommended for a particular area or which have become susceptible to diseases or pests in general.
2.	Sow the varieties which are recommended for timely sown or late sown or rainfed conditions at proper time.	Do not grow varieties which are not recommended for that particular time or situation.
3.	Always use recommended doses of NPK fertilizers.	Do not use N fertilisers in excess.
4.	Regular surveillance/ monitoring for timely detection of ETL which are must for undertaking chemical control measures.	Do not spray insecticides without detecting ETL of a pest.
5.	Use only recommended pesticides at the recommended dosages for control of various pests.	Do not use unrecommended pesticides or mixtures of various pesticides.
6.	Use certified, healthy, clean seeds free of seed galls.	Do not use farm implements contaminated with soil to avoid spreading soil borne infestation from one field to another.
7.	Practice deep summer ploughing.	
8.	For rodent control pre-baiting should be done for zinc-phosphide poison bait.	Zinc phosphide baiting should not be done more than once.

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**ORANOCHLORINE PESTICIDES**

1.	Endosulfan	Highly toxic	Yellow	Class II - Moderately Hazardous	<p>Remove the person from the contaminated environment.</p> <p>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.</p> <p>Medical aid: Take the patient to the doctor/Primary Health Centre immediately along with the original container, leaflet and label.</p>	<p>Nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death</p>	<ul style="list-style-type: none"> - Gastric lavage with 2-4 L. tap water – Catharsis with 30 gm. (10 oz) sodium sulphate in one 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 (10% in 10 ml. Ampules) intravenously every four hours. 	
----	------------	--------------	--------	---------------------------------	---	---	---	--

CARBAMATES

CARBOFURAN						
2.	Carbofuran	Extremely toxic	Red	Class I b – Highly hazardous		<p>Constriction of pupils, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhoea, epigastric pain, tightness in chest.</p> <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.
3.	Carbaryl	Highly toxic	Yellow	Class II – Moderately hazardous		<ul style="list-style-type: none"> - Keep airway 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 (eyes – wash with isotonic saline). Wear rubber gloves while washing contact area. - Oxygen - Morphine, if needed.
4.	Dipropofos					Avoid theophyllin and aminophyllin or barbiturates.
5.	Methomyl					2-PAM and other oximes are not harmful and in fact contra indicated for routine usatge.
6.	Prochloraz					Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.
INSECTICIDES						
7.	Organophosphates	toxic	Yellow	Class III – moderately hazardous		
8.	Malathion	moderately toxic	Yellow	Class III – moderately hazardous		
9.	Cyanoform	toxic	Orange	Class IV – highly hazardous		

FUNGICIDES

4.	Carboxin	Moderately toxic	Blue	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.
5.	Carbendazim	Slightly toxic	Green	-do-			
6.	Propiconazole	Moderately toxic	Blue	Class III – Slightly hazardous			

HERBICIDES

7.	Metasulfuron	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.
8.	Isoproturon	Moderately toxic	Blue	Class III – Slightly hazardous			
9.	Pendimethalin	Moderately toxic	Blue	Class III – Slightly hazardous			
10.	Diclofop methyl	Moderately toxic	Blue	-do-			
11.	Metoxuron	Moderately toxic	Blue	Table 5 – Unlikely to present acute hazard in normal use			
12.	Metribuzin	Moderately toxic	Blue	-do-			
13.	Clodinofap	Slightly toxic	Green	Class III –			

14.	Tralkoxydim	Moderately toxic	Blue	Slightly hazardous -do-			
15.	Fenoxapro p-p-ethyl Sulfosulfuron	-do-	Green				
16.							
17.	2,4-D	Highly toxic	Yellow	Class II - Moderately toxic	Weakness, lethargy, anorexia, diarrhoea, muscle weakness-may involve the muscles of mastication and swallowing. Ventricular fibrillation and /or cardiac arrest or death.	For ingestion, lavage stomach with tap water. For skin contact, wash exposed area. Supportive treatment. Quinidine sulfate or quinine to relieve myotonia or suppress abnormal ventricular cardiac rhythm.	

RODENTICIDES

18.	Bromadiolone	Extremely toxic	Bright red	Class I a - Extremely hazardous	Bleeding from nose, gums and into conjunctiva, urine and stool & coma Possible petechial rash, late-massive ecchymoses or hematoma of skin, joints, brain hemorrhage	- 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.	
19.	Zinc phosphide	Extremely toxic	Bright red	Class I b - Highly hazardous	Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and Skin etc.	No specific antidote. Treatment is essentially symptomatic.	

SYNTHETIC PYRETHROIDS								
20.	Cypermethrin	Highly Toxic	Yellow	Class II – Moderately Hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin, allergic manifestations etc.,	No specific antidote. Treatment is essentially symptomatic.	
OTHERS								
21.	Vitavax					Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin etc.,	No specific antidote. Treatment is essentially symptomatic.	
22.	Piroxaop propargyl							

AGRO ECO SYSTEM ANALYSIS (AES)

ASEA 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 ASEA are:-

1. Plants health at different stages. Monitor symptoms of diseases and nematodes.
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 ASEA 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 the visual observation 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 aphid, pinkborer, etc. and defenders like *Coccinellid*, *Chrysopa*, ground beetle/ rove beetle and earwigs etc. by scrapping the soil surface around the plants.
 - iv) Record disease and its intensity.
 - v) Record insect damage and disease incidence in percentage.
- c) Record parameters like number of leaves, plant height and reproductive parts of the selected plants for making observation in the following weeks. Observe nematode damage symptoms.
- 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) Record the climatic factors viz. sunny, partially sunny, cloudy, rainy etc. for the preceding week.

B. Drawing:-

First draw the plant 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 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 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 post management practices.

D. Strategy for decision making : (Examples) :

- i) When large number of egg masses and early instar larave of American Pod Borer are observed, the group may conclude application of NPV.
- ii) Some of the defenders like lady beetles, groundnut beetles, rove beetles, wasps play useful role in arriving at P:D ratio.

E. 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 vis-a-vis 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 need 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

F. AESA BY FARMERS:

After a brief exposure during IPM demonstrations / field trainings, farmers can practice AESA in their own fields. Whenever 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.

ANNEXURE - II**WHEAT CROP HEALTH MONITORING**

Surveyor' Name: _____

Date of Visit : _____ Stop No. : _____

Name of the Village : _____ Location/District : _____

Variety : _____ Date of sowing: _____

Crop growth stage: _____ Soil type : _____

Cropping sequence : _____

Field size: Less than 0.5 ha/ more than 0.5 ha / _____

Method of planting : Lines sowing / broadcasting

Field preparation: zero tillage / conventional tillage / _____

Crop Stand (No. of tillers / m row length) _____

Crop Status : good / average / poor / _____

Fertilizer applied : N P K _____ kg/ha FYM: _____ t/ha

Irrigated / Rainfed : IR / RF No. of irrigations _____

Pesticides used :

Name _____

Mode of application _____

Purpose _____

Weed management :

Chemical used _____

Hand weeding _____

DAE/DAS _____

1. DISEASE SITUATION

Disease	Prevalence (%)	Severity (%)	Reaction type (for rusts only)
1. Yellow rust			
2. Brown rust			
3. Black rust			
4. Foliar blight			
5. Loose smut			
6. Any other			

2. INSECT PESTS AND WEEDS

A.	Incidence (%)	Damage
----	---------------	--------

- 2.1 Termites
- 2.2 Stem borer
- 2.3 Army worm
- 2.4 Any other

3. weeds

Incidence

Low (1/m) Medium (5/m) High (>5/m)

- Canary grass
- Lamb square
- Any other

4. Nematode :

	Earhead infested		
	Low	Medium	High
Ear cockle	--	--	--
Tundu	--	--	--
Cyst Nematode	--	--	--

5. Rodents :

-- -- live burrows/ha.

6. Biocontrol fauna:

Present/absent if present, mention P : D

1. *Coccinellids*
2. *Chrysoperla*
3. *Spiders*
4. *Syrid*

Remarks

Signature of the Surveyor

ANNEXURE - III

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.
1. 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 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. **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 some 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.

- Avoid entry of animals and workers in the fields immediately after the spraying.

G. Disposal:

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