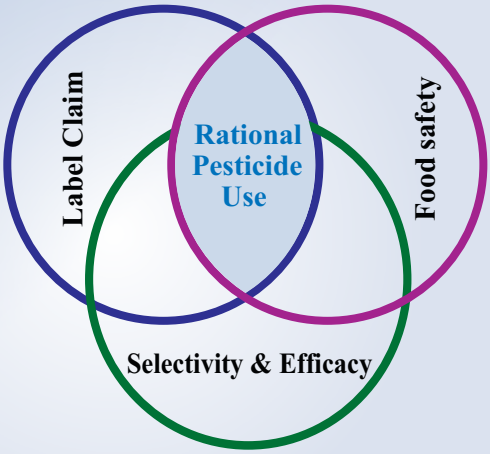
Extension Bulletin No. 50

Compendium on Pesticide Use in Vegetables



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IIVR Extension Bulletin No. 50

Printed: March 2013, 500 copies

Correct citation

Kodandaram, M.H., Sujoy Saha, A.B. Rai and Prakash S. Naik 2013. Compendium on pesticide use in vegetables. IIVR Extension Bulletin No. 50, IIVR, Varanasi, pp. 133

Published by

Dr. Prakash S. Naik
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Indian Institute of Vegetable Research
Post Bag No. 01, Post Office: Jakhini (Shahanshahpur)
Varanasi – 221 305, UP
E-mail: directoriivr@gmail.com

Printed at

Nirmal Vijay Printer, New Delhi - 110 028
Ph. : 45576780, M. : 98110 53617, E-mail: nvpnanda@gmail.com

Foreword

Vegetables are rich sources of dietary fibre, vitamins, minerals, antioxidants, phytochemicals and are important for food and nutritional security of the country. Area under vegetable crops is expanding contributing to increase in per capita income of the farmers and health benefits to the society. Presently, India produces about 156.33 million tonnes of vegetables from an area of 8.99 million hectares with an average productivity of 17.4 t/ha.

The crop losses in the country due to various pests range from 10 to 30 percent. Pesticides play an important role in sustaining vegetable production in keeping pest population below economic threshold. Per hectare consumption of pesticide in India is 381 g a.i., which is much less compared to the world average of 500 g a.i. However, comprehensive information on selection of pesticide, label claims and safe use of pesticides is not available at a single place leading to non-judicious and indiscriminate use of pesticides in vegetables resulting to several pesticide hazards including harmful residues.

The publication titled, *"Compendium on Pesticide Use in Vegetables"* brought out by the Indian Institute of Vegetable Research, Varanasi is commendable effort in this direction. This compendium contains complete information on pesticide use/status in vegetables, classification based on chemistry/mode of action, label claim, dosage, pre-harvest interval (PHI) and maximum residual limit (MRL).

The compilation will be very useful to the scientists, subject matter specialists (SMS) of KVK, agricultural extension officers, farmers and policy makers.

The efforts made by the Indian Institute of Vegetable Research, Varanasi deserve appreciation in bringing out such a useful publication.

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Preface

Pesticides are the most essential agricultural inputs for protecting crop plants and increasing agricultural production. In India, 241 pesticides and 41 combination products are registered as on date for use in agriculture. Out of these 62 insecticides, 40 fungicides and 7 plant growth promoters have been registered for use only in vegetable crops. The average pesticide consumption in India is around 0.381 kg a.i./ha as compared to world average of 0.5 kg a.i./ha. Around 13-14 per cent of pesticides are used in the country are applied on vegetables, maximum use is in chilli (5.13%) followed by brinjal (4.6%).

The information on status and safe use of pesticides on vegetable crops is scattred in various documents and is not readily available at one platform. This bulletin is inspired by the disscusions regarding safe use of pesticides in agriculture on various platforms. It has been designed to serve as ready reference on different aspects of pesticide use in vegetable pest management and contains useful information on the different groups/classes of pesticides, IRAC/ FRAC classification, mode of action, registered and banned pesticides and their formulations in India, dosage, target pests, label calims, permitted MRL values and their safe use.

The authors express deep sense of gratitude to Dr. N.K. Krishna Kumar, Deputy Director General (Horticulture), ICAR, New Delhi for his valuable suggestions and encouragement. We hope that this bulletin will be useful for researchers, extension functioneries, students, farming community, policy makers and all the stake holders.

Authors

Abbreviations

a.i.	Active ingredient
AChE	Acetylcholinesterase
AE	Aerosol dispenser
APEDA	Agricultural and Processed Food Products Export Development Authority
ATP	Adenosine triphosphate
BB	Block Bait
CAC	Codex Alimentarius Commission
CB	Bait Concentrate
CG	Encapsulated Granule
CIB & RC	Central Insecticide Board and Registration Committee.
CS	Capsule Suspension
DAC	Department of Agriculture and Cooperation
DBM	Diamond Back Moth
DC	Dispersible Concentrate
DDT	Dichloro Diphenyl Trichloroethane
DP	Dustable Powder
DS	Powder of Dry Seed
EC	Emulsifiable Concentrate
ES	Emulsion for Seed Treatment
EU	European Union
EW	Emulsion, oil in water
FAO	Food and Agricultural Organisation
FRAC	Fungicide Resistance Action Committee
FS	Flowable Concentrate for Seed Treatment
FSB	Fruit and Shoot Borer
FSSA	Food Safety and Standards Act
FSSAI	Food Safety and Standards Authority of India
g	Grams
GABA	Gamma-aminobutyric acid
GB	Granular Bait

GluCl	Glutamate-gated chloride channels
GR	Granule
ha	Hectare
IGR	Insect Growth Regultaor
IPM	Integrated Pest Management
IRAC	Insecticide Resistance Action Committee
IRM	Insecticide Resistance Management
Kg	Kilogram
l	Litre
ml	Mililitre
MoA	Mode of Action
MRL	Maximum Residue Limits
nAChR	Nicotinic acetylcholine receptor
NHB	National Horticultutre Board
NPOP	National Programme for Organic Production
OD	Oil Dispersion
PAM	Pralidoxime
PFA	Prevention of Food Adulteration
PGR	Plant growth regulators
PHI	Pre-harvest Interval
ppm	Parts per million
RB	Bait (ready for use)
SC	Suspension Concentrate
SE	Suspension Emulsion
SG	Water Soluble Granule
SL	Soluble Concentrate
SP	Water Soluble Powder
t	Tonnes
ULV	Ultra Low Volume
UV	Ultra Violet
WG	Water Dispersible Granules
WHO	World Health Organisation
WP	Wettable Powder
WS	Water Dispersible Powder for Slurry Treatment

Contents

1. Status of Pesticide Use in India

Vegetables are important component of Indian agriculture. Diverse agroclimatic conditions of the country permit growing of several vegetables round the year. Among these potato, tomato, onion, brinjal, cabbage, cauliflower and okra are most important and they have major share in vegetable production (Figure 1). Presently, India produces about 156.33 million tonnes of vegetables from an area of 8.99 million hectares with an average productivity of 17.4 t/ha. Though there has been phenomenal increase in area (2.99 folds), production (8.88 folds) and productivity (2.96 folds) of vegetables in our country during the last 6 decades, still there is huge gap between present production and future requirements.This necessitates enhancing vegetable production for meeting current and future needs.

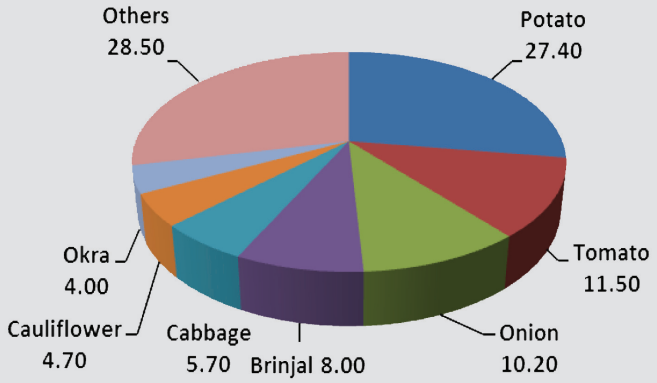

Figure 1: Production share (%) of major vegetable crops in India (NHB 2010-11)

One of the major constraints in vegetable production is pest problem and crop losses in the country due to various pests range from 10 to 30 percent each year depending upon the severity of pest attack (Figure 2). The estimated loss due to pests in horticultural crops is approximately Rs. 40,000-50,000 crores. Pest control by use of chemicals has been playing a vital role in sustainable increase in the vegetable production. Farmers use pesticides as first line of defense for the management of pests and frequently resort to

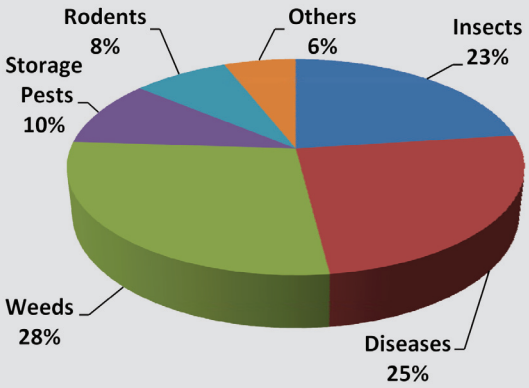

Figure 2: Losses caused by different pests

indiscriminate and non-judicious use of pesticides, which leads to several problems such as resistant development in insects / pathogens, resurgence of pests due to destruction of natural enemies, toxic hazards due to pesticide residues on the edible products and deficient pollination due to destruction of pollinators resulting in non setting of fruits and low yields.

Pesticide consumption in India and other countries

In developed countries like USA, Europe, Japan, China, etc., pesticide use is 20 times more than in India. Per hectare consumption of pesticide in India is 381 g a.i./ha which is lower than the world average of 500 g a.i/ha (Figure 3). Lower consumption of pesticides

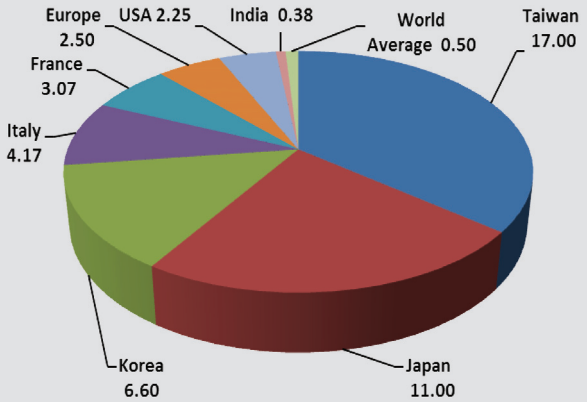

Figure 3: Pesticide consumption (a.i.kg/ha) in different countries

in India can be attributed to the fragmented land holdings, dependence on monsoons, inadequate awareness among farmers and low investment capabilities of small and marginal farmers. Only 25-30 percent of the total cultivated area in the country is under pesticide cover.

In India, annual consumption of pesticides showed a rising trend from 1955-56 to 1990-91 and thereafter it started declining (Table 1). The present consumption of technical grade pesticides in the country during year 2010-11 is around 55,542 tonnes. India's consumption of pesticides is only 2 percent of the total world consumption. Several reasons could be ascribed to this trend including the new eco-friendly novel molecules, where the quantities of newer pesticide molecules required per unit area are almost 8-100 times less than the conventional molecules (Bambawale 2007).

Table 1: Consumption of Pesticides in India

Year	Consumption (Tonnes Tech. Grade)	Year	Consumption (Tonnes Tech. Grade)	Year	Consumption (Tonnes Tech. Grade)
1955-56	2353	1995-96	61,260	2004-05	40,672
1965-66	14,630	1996-97	56,114	2005-06	39,773
1975-76	45,613	1997-98	52,240	2006-07	41,510
1985-86	61,881	1998-99	49,160	2007-08	44,770
1990-91	75,033	1999-00	46,200	2008-09	43,860
1991-92	72, 133	2000-01	43,584	2009-10	41,824
1992-93	70,794	2001-02	47,020	2010-11	55,542
1993-94	63,651	2002-03	48,300		
1994-95	61,360	2003-04	41,000		

(Source: Anonymous, 2002 and 2012)

Among different classes of pesticides used in India the percent share of insecticides (60%) is high followed by fungicides (19%), herbicides (16%), biopesticides (3%) and others (3%) (Figure 4). It is estimated that around 13-14 % of total pesticides used in the country are applied on vegetables, of which insecticides account

for two-thirds of total pesticides used in vegetables (Figure 5). Among different vegetable crops the maximum pesticide usage is in chilli (5.13 a.i kg /ha) followed by brinjal (4.60 a.i kg /ha), cole crops (3.73 a.i kg /ha) and okra (2-3 a.i kg /ha) (Figure 6). The global agro-chemical consumption on the other hand, is dominated by fruits and vegetables, which account for 25% of the total market.

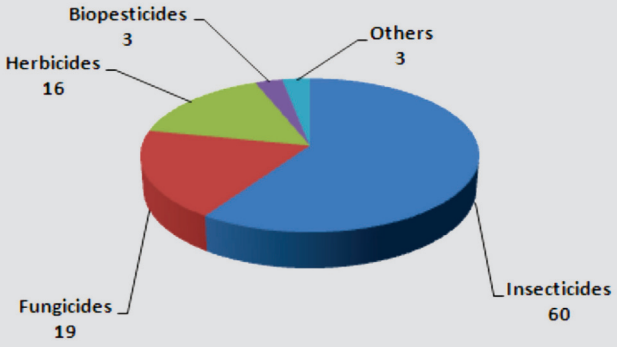

Figure 4: Share (%) of different classes of pesticides used in India

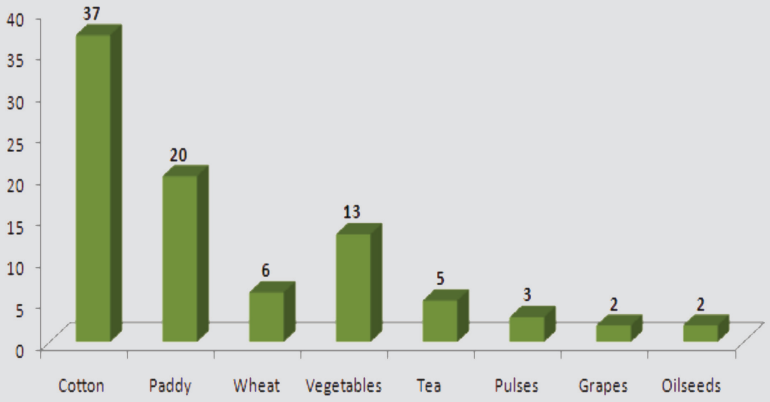

Figure 5: Consumption of pesticides (%) in different crops

Role of novel molecules in pest management

During last two decades the focus on insecticide research shifted to search and develop new green chemistries or newer bio-rational or "low risk" pesticides having novel modes of action, which have replaced many old and conventional pesticides. Biorational or

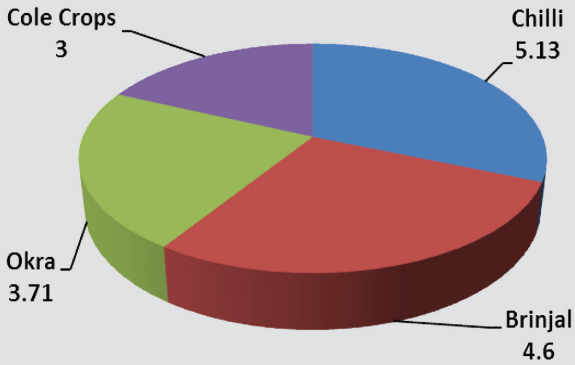

Figure 6: Pesticide consumption (a.i. kg/ha) in major vegetable crops

"reduced risk" insecticides are synthetic or natural compounds that effectively control insect pests, but have low toxicity to nontarget organisms and the environment (Hara, 2000). In India, around 27 new insecticides and their different formulations belonging to new chemistry with unique mode of action have been registered since late 1990s to early 2010, for insect control in vegetables. These new classes of insecticides belong to neonicotinoids, oxadiazines, diamides, tetramic/tetronic acid derivatives, phenylpyrazoles, pyridine, avermectins, spinosyns, pyrroles and insect growth regulators (IGRs). Most of the newer insecticides have several advantages over conventional insecticides like:

- greater specificity to target pests
- excellent efficacy at low rates or dosage
- high level of selectivity
- non persistance in the environment
- low mammalian toxicity
- less harmfull to natural enemies than other broad spectrum insecticides
- less likely to cause outbreaks of secondary pests that are well controlled by natural enemies
- extremely helpful for delaying development of resistance in key pests and have no cross-resistance with the old and already established insecticides.

All these advantages make many of the new insecticides safer, highly suitable and fit well into integrated pest management (IPM) or insect resistance management (IRM) programs. As growers and pest control advisors become familiar and aware of unique characteristics, novel mode of action, usage rates, their target pest spectrum and selectivity of these new insecticides, their adoption and judicious use is likely to increase.

2. Classification of Pesticides

(A) Classification of Insecticides

(i) Based on chemistry

	Insecticide Group	IRAC mode of action class	Examples
Synthetic insecticides			
1	Organochlorines	2A	Dicofol, Endosulfan
2	Organophosphates	1B	Acephate, Chlorpyrifos, Ethion, Quinolphos, Triazophos, Dimethoate, Malathion etc.
3	Carbamates	1A	Carbaryl, Carbofuran, Carbosulfan, Methomyl etc.
4	Synthetic pyrethroids	3A	Bifenthrin, Deltamethrin, Cypermethrin, Lamda cyhalothrin, Fenvalrate, Fenpropathrin etc.
5	Neonicotinoids	4A	Imidacloprid, Acetamiprid, Thiamethoxam, Thiacloprid, Clothianidin, Dinotefuran, Nitenpyram
6	Phenylpyrazoles	2B	Fipronil, Ethiprole
7	Pyridine	9A	Pymetrozine
8	Oxadiazines	22A	Indoxacarb
9	METI acaricides	21A	Pyridaben, Fenzaquin, Fenpyroximate
10	Nereistoxin	14A	Bensultap, Thiocyclam, Thiosultap-sodium
11	Formamidines	19A	Chlordimeform and Amitraz
12	Ketoenols	23A	Spirodiclofen, Spiromesifen, Spirotetramat
13	Diamides	28A	Flubendamide, Chlorantraniliprole, Cyantraniliprole

	Insecticide Group	IRAC mode of action class	Examples
Insecticides derived from soil microorganisms /macrocyclic lactones			
1	Avermectins	6A	Abamectin, Emamectin Benzoate, Ivermectin
2	Milbemycins	6A	Milbemectin, Milbemycin D
3	Spinosyns	5A	Spinosad, Spinetoram
4	Pyrrole Insecticides	13A	Chlorfenapyr
Insect growth regulators			
1	Chitin Synthesis Inhibitors (for lepidopterans)	15A	Diflubenzuron, Chlorofluazuron, Teflubenzuron, Hexaflumuron, Novaluron, Lufenuron, and Flufenoxuron
2	Chitin Synthesis Inhibitors (for Homoptera)	16A	Buprofezin
3	Chitin Synthesis Inhibitors (for dipterans)	17A	Cryomazine
4	Ecdysone Agonists and Diacylhdrazines	18A	Methoxyfenozide, Tebufenozide, Halofenozide, Methofenozide
5	Juvenile Hormone Mimics	17A	Pyriproxifen, Fenoxycarb, Diofenolan, Hydroprene, Methoprene and Kinoprene

(Source: Kodandaram *et al*., 2010)

(ii) Based on mode of action

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 1: **Acetylcholinesterase (AChE) inhibitors** Nerve action Inhibit AChE, causing hyperexcitation. AChE is the enzyme that terminates the action of the excitatory neurotransmitter acetylcholine at nerve synapses.	**1A** Carbamates	Alanycarb, Aldicarb, Bendiocarb, Benfuracarb, Butocarboxim, Butoxycarboxim, Carbaryl, Carbofuran, Carbosulfan, Ethiofencarb, Fenobucarb, Formetanate, Furathiocarb, Isoprocarb, Methiocarb, Methomyl, Metolcarb, Oxamyl, Pirimicarb, Propoxur, Thiodicarb, Thiofanox, Triazamate, Trimethacarb, XMC, Xylylcarb
	1B Organophosphates	Acephate, Azamethiphos, Azinphos-ethyl, Azinphos-methyl, Chlorfenvinphos, Chlorpyrifos, Chlorpyrifos-methyl, Coumaphos, Cyanophos, Demeton-S-methyl, Diazinon, Dichlorvos/ DDVP, Dicrotophos, Dimethoate, Dimethylvinphos, Disulfoton, EPN, Ethion, Ethoprophos, Famphur, Fenamiphos, Fenitrothion, Fenthion, Fosthiazate, Isofenphos, Isoxathion, Malathion, Mecarbam, Methamidophos, Methidathion, Mevinphos, Monocrotophos, Naled, Omethoate, Oxydemeton-methyl, Parathion, Parathion-methyl, Phenthoate, Phorate, Phosalone, Phosmet, Phosphamidon, Phoxim, Pirimiphos- methyl, Profenofos, Propetamphos, Prothiofos, Pyridaphenthion, Quinalphos, Sulfotep, Tebupirimfos, Temephos, Tetrachlorvinphos, Thiometon, Triazophos, Trichlorfon

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 2: GABA-gated chloride channel antagonists Nerve action Block the GABA-activated chloride channel, causing hyper-excitation and convulsions. GABA is the major inhibitory neurotransmitter in insects	**2A** Cyclodiene Organochlorines	Endosulfan
	2B Phenylpyrazoles	Ethiprole, Fipronil
Group 3: Sodium channel modulators Nerve action Keep sodium channels open, causing hyperexcitation and, in some cases, nerve block. Sodium channels are involved in the propagation of action potentials along nerve axons.	**3A** Pyrethroids and Pyrethrins	Acrinathrin, Allethrin, d-*cis-trans* Allethrin, d-*trans* Allethrin, Bifenthrin, Bioallethrin, Bioallethrin S-cyclopentenyl isomer, Bioresmethrin, Cycloprothrin, Cyfluthrin, *beta*-Cyfluthrin, Cyhalothrin, *lambda*-Cyhalothrin, *gamma*-Cyhalothrin, Cypermethrin, *alpha*-Cypermethrin, *beta*-Cypermethrin, *theta*-cypermethrin, *zeta*-Cypermethrin, Cyphenothrin [(1*R*)-*trans*- isomers], Deltamethrin, Empenthrin [(*EZ*)- (1*R*)- isomers], Esfenvalerate, Etofenprox, Fenpropathrin, Fenvalerate, Flucythrinate, Flumethrin, *tau*-Fluvalinate, Halfenprox, Imiprothrin, Kadethrin, Permethrin, Phenothrin [(1*R*)-*trans*- isomer], Prallethrin, Pyrethrins (pyrethrum), Resmethrin, Silafluofen, Tefluthrin, Tetramethrin, Tetramethrin [(1*R*)-isomers], Tralomethrin, Transfluthrin
	3B DDT Methoxychlor	DDT Methoxychlor

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 4: Nicotinic acetylcholinereceptor (nAChR) agonists Nerve action Mimic the agonist action of acetylcholine at nAChRs, causing hyperexcitation. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.	**4A** Neonicotinoids	Acetamiprid, Clothianidin, Dinotefuran, Imidacloprid, Nitenpyram, Thiacloprid, Thiamethoxam
	4B Nicotine	Nicotine
Group 5: Nicotinic acetylcholinereceptor (nAChR) allosteric activators Nerve action Allosterically activate nAChRs, causing hyperexcitation of the nervous system. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.	**5A** Spinosyns	Spinosad, Spinetoram
Group 6: Chloride channel activators Nerve and muscle action Allosterically activate glutamate-gated chloride channels (GluCls), causing paralysis. Glutamate is an important inhibitory neurotransmitter in insect.	**6A** Avermectins, Milbemycins	Abamectin, Emamectin benzoate, Lepimectin, Milbemectin

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 7 : Juvenile hormone mimics Growth regulation Applied in the pre-metamorphic instar, these compounds disrupt and prevent metamorphosis.	**7A** Juvenile hormone analogues	Hydroprene, Kinoprene, Methoprene
	7B Fenoxycarb	Fenoxycarb
	7C Pyriproxyfen	Pyriproxyfen
Group 8: Miscellaneous non-specific (multi-site) inhibitors	**8A** Alkyl halides	Methyl bromide and other alkyl halides
	8B Chloropicrin	Chloropicrin
	8C Sulfuryl fluoride	Sulfuryl fluoride
	8D Borax	Borax
	8E Tartar emetic	Tartar emetic
Group 9: Selective homopteran feeding blockers Incompletely defined MoA causing selective inhibition of aphid and whitefly feeding	**9B** Pymetrozine	Pymetrozine
	9C Flonicamid	Flonicamid

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 10: Mite growth inhibitors Growth regulation Incompletely defined MoA leading to growth inhibition	**10A** Clofentezine Hexythiazox Diflovidazin	Clofentezine, Hexythiazox, Diflovidazin
	10B Etoxazole	Etoxazole
Group 11: Microbial disruptors of insect midgut membranes Protein toxins that bind to receptors on the midgut membrane and induce pore formation, resulting in ionic imbalance and septicemia.	*Bacillus thuringiensis or Bacillus sphaericus* and the insecticidal proteins they produce	*Bacillus thuringiensis* subsp. *israelensis* *Bacillus sphaericus* *Bacillus thuringiensis* subsp. *aizawai* *Bacillus thuringiensis* subsp. *kurstaki* *Bacillus thuringiensis* subsp. *tenebrionis Bt* crop proteins: *Cry1Ab, Cry1Ac, Cry1Fa, Cry2Ab, mCry3A, Cry3Ab, Cry3Bb, Cry34/35Ab1*
Group 12 : Inhibitors of mitochondrial ATP synthase Energy metabolism Inhibit the enzyme that synthesizes ATP	**12A** Diafenthiuron **12B** Organotin miticides	Diafenthiuron Azocyclotin, Cyhexatin, Fenbutatin oxide
	12C Propargite	Propargite
	12D Tetradifon	Tetradifon

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 13: Uncouplers of oxidative phosphorylation via disruption of the proton gradient Energy metabolism Protonophores that short-circuit the mitochondrial proton gradient so that ATP can not be synthesized.	**13 A** Chlorfenapyr DNOC Sulfluramid	Chlorfenapyr DNOC Sulfluramid
Group 14 : Nicotinic acetylcholine receptor (nAChR) channel blockers Nerve action Block the nAChR ion channel, resulting in nervous system block and paralysis. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.	**14 A** Nereistoxin analogues	Bensultap, Cartap hydrochloride, Thiocyclam, Thiosultap-sodium
Group 15 : Inhibitors of chitin biosynthesis, type 0 Growth regulation Incompletely defined MoA leading to inhibition of chitin biosynthesis.	**15 A** Benzoylureas	Bistrifluron, Chlorfluazuron, Diflubenzuron, Flucycloxuron, Flufenoxuron, Hexaflumuron, Lufenuron, Novaluron, Noviflumuron, Teflubenzuron, Triflumuron
Group 16 : Inhibitors of chitin biosynthesis, type 1 Incompletely defined MoA leading to inhibition of chitin biosynthesis in a number of insects, including whiteflies	**16 A** Buprofezin	Buprofezin

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 17: Moulting disruptor, Dipteran Growth regulation Incompletely defined MoA that leads to moult disruption.	**17 A** Cyromazine	Cyromazine
Group 18: Ecdysone receptor agonists Growth regulation Mimic the moulting hormone, ecdysone, inducing a precocious moult	**18 A** Diacylhydrazines	Chromafenozide, Halofenozide, Methoxyfenozide, Tebufenozide
Group 19: Octopamine receptor agonists Nerve action Activate octopamine receptors, leading to hyperexcitation. Octopamine is the insect equivalent of adrenaline, the fight-or-flight neurohormone	**19 A** Amitraz	Amitraz
Group 20: Mitochondrial complex III electron transport inhibitors Energy metabolism Inhibit electron transport complex III, preventing the utilization of energy by cells.	**20A** Hydramethylnon **20B** Acequinocyl **20C** Fluacrypyrim	Hydramethylnon Acequinocyl Fluacrypyrim
Group 21: Mitochondrial complex I electron transport inhibitors Energy metabolism Inhibit electron transport complex I, preventing the utilization of energy by cells.	**21A** METI acaricides and insecticides **21B** Rotenone	Fenazaquin, Fenpyroximate, Pyrimidifen, Pyridaben, Tebufenpyrad, Tolfenpyrad Rotenone (Derris)

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 22: Voltage-dependent sodium channel blockers Nerve action Block sodium channels, causing nervous system shutdown and paralysis. Sodium channels are involved in the propagation of action potentials along nerve axons.	**22A** Indoxacarb **22B** Metaflumizone	Indoxacarb Metaflumizone
Group 23: Inhibitors of acetyl CoA carboxylase. Lipid synthesis & growth regulation Inhibit acetyl coenzyme A carboxylase, part of the first step in lipid biosynthesis, leading to insect death.	**23 A** Tetronic and Tetramic acid derivatives	Spiromesifen, Spirodiclofen, Spirotetramat
Group 24: Mitochondrial complex IV electron transport inhibitors Energy metabolism Inhibit electron transport complex IV, preventing the utilization of energy by cells.	**24A** Phosphine **24B** Cyanide	Aluminium phosphide, Calcium Phosphide, Phosphine, Zinc phosphide Cyanide
Group 25: Mitochondrial complex II electron transport inhibitors Energy metabolism Inhibit electron transport complex IV, preventing the utilization of energy by cells.	**25 A** Beta-ketonitrile derivatives	Cyenopyrafen, Cyflumetofen

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Active Ingredients
Group 28: Ryanodine receptor modulators Nerve and muscle action Activate muscle ryanodine receptors, leading to contraction and paralysis. Ryanodine receptors mediate calcium release into the cytoplasm from intracellular stores	**28 A** Diamides	Flubendiamide, Chlorantraniliprole, Cyantraniliprole
UN Compounds of unknown or uncertain MoA2 (Target protein responsible for biological activity is unknown, or uncharacterized)	Azadirachtin Benzoximate Bifenazate Bromopropylate Chinomethionat Cryolite Cyflumetofen Dicofol Pyridalyl	Azadirachtin Benzoximate Bifenazate Bromopropylate Chinomethionat Cryolite Cyflumetofen Dicofol Pyridalyl

(Source: Insecticides Resistance Action Committee, IRAC April 2012 Version 7.2)

(B) Classification of fungicides

(i) Based on chemistry

Chemical group	Sub group	FRAC Code	Fungicides
Aliphatic nitrogen fungicides	Quinones (anthraxquinones)	M9	Cymoxanil
Amide Fungicides	Thiophene carboxamides	38	Silthiofam, Carpropamid, Fenoxanil, Mandipropamid, Metominostrobin, Prochloraz
	Acylamino acid	4	Benalaxyl, Metalaxyl, Metalaxyl M, Valifenalate.
	Anilide fungicides	4	Boscalid, Carboxin, Fenhexamid, Fluxapyroxad isotianil, Oxycarboxin, Thifluzamide, Tiadinil
	Benzanilide fungicides	7	Flutolanil
	Furanilide fungicides	7	Furalaxyl, Furcarbanil
	Sulfonanilide fungicides	36	Flusulfamide
	Benzamide fungicides	43	Fluopicolide
	Toluamides	22	Zoxamide
	Valinamide fungicides	40	Benthiavalicarb, Iprovalicarb
Antibiotic fungicides	Hexopyranosyl antibiotic Glucopyranosyl antibiotic Glucopyranosyl antibiotic	24 25 26	Kasugamycin Streptomycin Validamycin
Strobilurin fungicides	Methoxyacrylate Methoxycarbanilate	11 11	Azoxystrobin Pyraclostrobin, Pyrametostrobin
	Methoxyiminoacetamide	11	Dimoxystrobin, Fenaminstrobin, Metominostrobin
	Methoxyiminoacetate	11	Kresoxim-methyl, Trifloxystrobin
Aromatic fungicides	Chloronitriles (phthalonitriles)	M5	Chlorothalonil
	Benzophenone	U8	Metrafenone,
Benzimidazole fungicides	Benzimidazoles	1	Benomyl, Carbendazim,
Benzimidazole precursor fungicides	Thiophenates	1	Thiophanate-methyl

Chemical group	Sub group	FRAC Code	Fungicides
Carbamate fungicides	Vanilamides	40	Iprovalicarb
	Carbamates	28	Propamocarb
	Carbanilate fungicides	10	Diethofencarb
	Conazole fungicides (triazoles)	3	Difenoconazole, Diniconazole, Epoxiconazole, Flusilazole, Hexaconazole, Ipconazole, Myclobutanil, Penconazole, Propiconazole, Simeconazole, Tebuconazole, Tetraconazole, Triadimefon.
Copper fungicides	-		Bordeaux mixture, Basic copper hydroxide
Dicarboximide fungicides	Phthalimide fungicidesx	11	Famoxadone
		M4	Captan
Dinitrophenol fungicides	Dinitrophenol	29	Dinocap
Dithiocarbamate fungicides	Dithiocarbamate	M3	Thiram, ziram
	Polymeric dithiocarbamate fungicides	M3	Mancopper, Mancozeb, Maneb, Metiram, Propineb, Zineb
Dithiolane fungicides	Dithiolanes	6	Isoprothiolane
	Imidazolinones	11	Fenamidone
	Dicarboximides	2	Iprodione
	Conazole fungicides (imidazole)	3	Prochloraz, Triflumizole
Mercury fungicides	Inorganic mercury fungicides	-	Mercuric chloride
	Organomercury fungicides	-	2-methoxyethylmercury chloride
Morpholine fungicides	-	5	Dimethomorph, Flumorph, Tridemorph
Organophosphorus fungicides	Phosphoro-thiolates	6	Edifenphos
Oxathiin fungicides	Oxathin-carboxamides	7	Carboxin, Oxycarboxin
Pyrimidine fungicides	-	3	Fenarimol
Triazolopyrimidine fungicides	-	45	Ametoctradin
Urea fungicides	Phenylureas	20	Pencycuron, Quinazamid
Unclassified fungicides	Benzo- thiadiazole	P	Acibenzolar-s-methyl

(Source: Fungicides Resistance Action Committee (FRAC) 2012)

(ii) Based on mode of action

MOA	Target Site And Code	Group Name	Chemical Group	Common Name
A: Nucleic acid synthesis Inhibits RNA polymerase I and DNA topoisomerase type II (gyrase) enzymes required for the synthesis of nucleic acids	**A1:** RNA polymerase I	PA – fungicides (Phenyl Amides)	Acylalanines	Benalaxyl, Benalaxyl-M (=kiralaxyl), Furalaxyl, Metalaxyl, Metalaxyl-M (=mefenoxam)
			Oxazolidinones	Oxadixyl
			Butyrolactones	Ofurace
	A2: Adenosin deaminase	Hydroxy-(2-amino-) pyrimidines	Hydroxy-(2-amino-pyrimidines)	Bupirimate, Dimethirimol, Ethirimol
	A3:DNA/RNA synthesis	Hetero aromatics	Isoxazoles Isothiazolones	Hymexazole Octhilinone
	A4: DNA topoisomerase type II (gyrase)	Carboxylic acid	Carboxylic acids	Oxolinic acid
B: Mitosis and cell division Inhibits ß-tubulin assembly in mitosis.	**B1:** ß-tubuline assembly in mitosis	MBC-fungicides (Methyl Benzimidazole Carbamates)	Benzimidazoles	Benomyl, Carbendazim, Fuberidazole Thiabendazole

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
Causes several target site mutations, mostly E198A E198/G/K, F200Y in b-tubulin gene. Also causes delocalisation of spectrin-like proteins			Thiophanates	Thiophanate Thiophanate-methyl
	B2:ß-tubulin assembly in mitosis	N-phenyl carbamates	N-phenyl carbamates	Diethofencarb
	B3:ß-tubulin assembly in mitosis	Benzamides	Toluamides	Zoxamide
	B4: Cell division (proposed)	Phenylureas	Phenylureas	Pencycuron
	B5: Delocalisation of spectrin-like proteins	Benzamides	Pyridinylmethyl-benzamides	Fluopicolide
C. Respiratory enzyme inhibitors Inhibits several enzymes involved in pathogen respiration e.g. I NADH Oxido-reductase (pyrimidinamines); succinate-dehydro-genase SDHI	**C1:**Complex I NADH Oxido-reductase	Pyrimidin amines	Pyrimidinamines	Diflumetorim
	C2: Complex II: succinate-dehydrogenase	SDHI (Succinate dehydrogenase inhibitors)	Phenyl-benzamides	Benodanil, Flutolanil, Mepronil
			Pyridinyl-ethyl-benzamides	Fluopyram
			Furan-carboxamides	Fenfuram
			Oxathiin-carboxamides	Carboxin Oxycarboxin

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
(Succinate Dehydrogenas inhibitors)with target site mutations in sdh gene, e.g. H/Y (or H/L) at 257, 267, 272 or P225L, dependent on fungal species; cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) with target site mutations in cyt b gene (G143A, F129L); cytochrome bc1 t Qi site. also inhibits oxidative phos-phorylation and ATP synthase	**C3:** Complex III: cytochrome bc1 (ubiquinol oxidase) at Q site (cyt bgene)	QoI-fungicides (Quinone outside Inhibitors)	Thiazole-carboxamides	Thifluzamide
			Pyrazole-carboxamides	Benzovindiflupyr, Bixafen, Fluxapyroxad, Furametpyr, Isopyrazam, Penflufen, Penthiopyrad, Sedaxane
			Pyridine-carboxamides	Boscalid
			Methoxy-acrylates	Azoxystrobin, Coumoxystrobin, Enoxastrobin, Flufenoxystrobin, Picoxystrobin, Pyraoxystrobin
			Methoxy-carbamates	Pyraclostrobin, Pyrametostrobin
			Oximino acetates	Kresoxim-methyl Trifloxystrobin
			Oximino-acetamides	Dimoxystrobin, Fenaminostrobin Metominostrobin, Orysastrobin
			Oxazolidine-diones	Famoxadone
			Dihydro-dioxazines	Fluoxastrobin
			Imidazolinones	Fenamidone
			Benzyl-carbamates	Pyribencarb

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
	C4: Complex III: cytochrome bc1(ubiquinone reductase) at Qi site	QiI - fungicides (Quinone inside Inhibitors)	Cyano- imidazole Sulfamoyl-triazole	Cyazofamid Amisulbrom
	C5: Uncouplers of oxidative phosphorylation	-	Dinitrophenyl-crotonates	Binapacryl, Meptyldinocap, Dinocap
			2,6-dinitro-anilines	Fluazinam
			Pyr-hydrazones	Ferimzone
	C6: Inhibitors of oxidative phosphorylation, ATP synthase	Organo tin compounds	Tri phenyl tin compounds	Fentin acetate, Fentin chloride, Fentin hydroxide
	C7:ATP production (proposed)	Thiophene-carboxamides	Thiophene-carboxamides	Silthiofam
	C8: Complex III: cytochrome bc1 (ubiquinone reductase) at Q x (unknown) site	QxI – fungicide (Quinone x Inhibitor)	Triazolo-pyrimidylamine	Ametoctradin

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
D: Amino acid and protein synthesis Inhibits methionine biosynthesis (cgs gene) and protein synthesis	**D1**: Methionine biosynthesis (proposed) (cgs gene)	AP - fungicides (Anilino-Pyrimidines)	Anilino-pyrimidines	Cyprodinil Mepanipyrim Pyrimethanil
	D2: Protein synthesis	Enopyranuronic acid antibiotic	Enopyranuronic Acid antibiotic	Blasticidin-S
	D3: Protein synthesis	Hexopyranosyl antibiotic	Hexopyranosyl antibiotic	Kasugamycin
	D4: Protein synthesis	Glucopyranosyl antibiotic	Glucopyranosyl antibiotic	Streptomycin
	D5: Protein synthesis	Tetracycline antibiotic	Tetracycline antibiotic	Oxytetracycline
E: Signal transduction Inhibits G-proteins in early cell signalling. Histidine-Kinase in	**E1**: Signal transduction (mechanism unknown)	Aza-naphthalenes	Aryloxyquinoline Quinazolinone	Quinoxyfen Proquinazid
osmotic signal transduction	**E2**:MAP/ Histidine-Kinase in osmotic signal transduction (os-2, HOG1)	PP-fungicides (Phenyl Pyrroles)	Phenylpyrroles	Fenpiclonil Fludioxonil
	E3: MAP/ Histidine-Kinase in osmotic signal transduction (os-1, Daf1)	Dicarboximides	Dicarboximides	Chlozolinate Iprodione Procymidone Vinclozolin

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
F: Lipid synthesis and membrane integrity	**F1: -**	Formerly dicarboximides		
Inhibits phospho lipid biosynthesis, by inactivating methyl transferase enzymes or lipid peroxidation. Hampers the cell membrane permeability and disrupts cell wall deposition	**F2:** Phospholipid biosynthesis, methyltrans-ferase	Phosphoro-thiolates	Phosphoro-thiolates	Edifenphos, Iprobenfos (IBP), Pyrazophos
		Dithiolanes	Dithiolanes	Isoprothiolane
	F3: Lipid peroxidation (proposed)	AH-fungicides (Aromatic Hydrocarbons) (chlorophenyls nitroanilines)	Aromatic hydrocarbons	Biphenyl, Chloroneb, Dicloran, Quintozene (PCNB), Tecnazene (TCNB), Tolclofos-methyl
		Heteroaromatics	1,2,4-thiadiazoles	Htridiazole
	F4: Cell membrane permeability, fatty acids (proposed)	Carbamates	Carbamates	Iodocarb Propamocarb Prothiocarb
	F5: -	Formerly CAA-fungicides	-	-
	F6: Microbial disrupters of pathogen cell membranes	Microbial (*Bacillus* sp.)	*Bacillus subtilis* and the fungicidal lipopeptides produced	*Bacillus subtilis* strain QST 713 *Bacillus subtilis* strain FZB24
	F7: Cell membrane disruption (proposed)	Plant extract	Terpene hydrocarbon Sand terpene alcohols	Extract from *Melaleuca alternifolia* (tea tree)

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
G: Sterol biosynthesis in membranes Inhibits C14-demethylase in sterol biosynthesis (erg11/cyp51) (De Methylation Inhibitors) or Δ14Reductase and Δ8→Δ7 Isomerase in sterol biosynthesis or 3-keto reduc-tase, or squalene-epoxidase	**G1**: C14- demethylase in sterol biosynthesis (erg11/cyp51)	DMI-fungicides (DeMethylation Inhibitors) (SBI: Class I)	Piperazines Pyridines Pyrimidines Imidazoles Triazoles Triazolinthiones	Triforine Pyrifenox, Pyrisoxazole Fenarimol, Nuarimol Imazalil, Oxpoconazole, Pefurazoate, Prochloraz Azaconazole, Bitertanol, Bromuconazole, Cyproconazole, Difenoconazole, Diniconazole, Epoxiconazole, Etaconazole, Fenbuconazole, Fluquinconazole, Flusilazole, Flutriafol, Hexaconazole, Imibenconazole, Ipconazole, Metconazole, Myclobutanil, Penconazole, Propiconazole, Simeconazole, Tebuconazole, Tetraconazole, Triadimefon, Triadimenol, Triticonazole, Prothioconazole
	G2: Δ14Reductase and Δ8→Δ7 Isomerase in sterol biosynthesis (erg24, erg2)	Amines (Morpholines) (SBI: Class II)	Morpholines Piperidines Spiroketal-Amines	Aldimorph, Dodemorph, Fenpropimorph, Tridemorph Fenpropidin, Piperalin Spiroxamine

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
	G3:3-keto reduc-tase, C4- de-methylation (erg27)	Hydroxy anilides (SBI: Class III)	Hydroxyanilides	Fenhexamid
	G4:squalene-epoxidase in sterol biosynthesis (erg1)	(SBI class IV)	Thiocarbamates Allylamines	Pyributicarb Naftifine, Terbinafine
H: Cell wall biosynthesis Inhibits trehalase and inositol-biosynthesis	**H3:** trehalase and inositol-biosynthesis	Glucopyranosyl antibiotic	Glucopyranosyl antibiotic	Validamycin
	H4: Chitin Synthase	Polyoxins	Peptidyl Pyrimidine Nucleoside	Polyoxin
	H5: Cellulose synthase	CAA-fungicides (Carboxylic Acid Amides)	Cinnamic Acid Amides	Dimethomorph, Flumorph
			Valinamide Carbamates Mandelic acid amides	Benthiavalicarb, Iprovalicarb, Valifenalate Mandipropamid
I: Melanin synthesis in cell wall Inhibits reductase in melanin biosynthesis or dehydratase	**I1:** Reductase in melanin biosynthesis	MBI-R (Melanin Biosynthesis Inhibitors – Reductase)	Isobenzo-Furanone Pyrrolo-Quinolinone Triazolobenzo-Thiazole	Fthalide Pyroquilon Tricyclazole
	I2: Dehydratase in melanin biosynthesis	MBI-D (Melanin Biosynthesis Inhibitors – Dehydratase)	Cyclopropane-Carboxamide Carboxamide Propionamide	Carpropamid Diclocymet Fenoxanil

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
P: Host plant defence induction Plays a role in initiating salicylic acid pathway which induces resistance and also antibacterial and antifungal activity	**P1**:Salicylic Acid Pathway	Benzo-Thiadiazole BTH	Benzo-Thiadiazole BTH	Acibenzolar-S-Methyl
	P2	Benz-isothiazole	Benzisothiazole	Probenazole (also antibacterial and antifungal activity)
	P3	Thiadiazole-Carboxamide	Thiadiazole-Carboxamide	Tiadinil Isotianil
	P4	Natural Compound	Polysaccharides	Laminarin
	P5	Plant extract	Complex mixture, ethanol extract	Extract from *Reynoutria sachalinensis* (giant knotweed)
Unknown mode of action (The mode of action is under study)	Unknown	Cyano acetamide-oxime	Cyano-acetamide-oxime	Cymoxanil
	Unknown	Phosphonates	Ethyl -phosphonates	Fosetyl-Al Phophorous acid and salts
	Unknown	Phthalamic Acids	Phthalamic Acids	Teclofthalam (Bactericide)
	Unknown	Benzotriazines	Benzotriazines	Triazoxide
	Unknown	Benzene-Sulfonamides	Benzene-Sulphonamides	Flusulfamide
	Unknown	Pyridazinones	Pyridazinones	Diclomezine
	Unknown	Thiocarbamate	Thiocarbamate	Methasulfocarb
	Microtubule disruption (proposed)	Thiazole Carboxamide	Ethylamino-Thiazole Carboxamide	Ethaboxam

MOA	Target Site and Code	Group Name	Chemical Group	Common Name
	Unknown	Phenyl-Acetamide	Phenyl-Acetamide	Cyflufenamid
	Actin disruption (proposed)	Aryl-phenyl-ketone	Benzophenone Benzoylpyridine	Metrafenone Pyriofenone
	Cell membrane disruption (proposed)	Guanidines	Guanidines	Dodine
	Unknown	Thiazolidine	Cyano-methylene-thiazolidine	Flutianil
	Unknown	Pyrimidinone-hydrazones	Pyrimidinone-hydrazones	Ferimzone
Not Classified	Unknown	Diverse	Diverse	Mineral oils, Organic oils, Potassium bicarbonate, Material of biological origin
Multi-site contact activity	Multi-site contact activity	Inorganic Inorganic	Inorganic Inorganic	Copper (Different Salts) Sulphur
		Dithio-carbamates and relatives	Dithio-carbamates and relatives	Ferbam, Mancozeb, Maneb, Metiram, Propineb, Thiram, Zineb, Ziram
		Phthalimides	Phthalimides	Captan, Captafol, Folpet
		Chloronitriles (Phthalonitriles)	Chloronitriles (Phthalonitriles)	Chlorothalonil
		Sulfamides	Sulfamides	Dichlofluanid, Tolylfluanid
		Guanidines	Guanidines	Guazatine, Iminoctadine
		Triazines	Triazines	Anilazine
		Quinones (Anthrax-Quinones)	Quinones (Anthra-Quinones)	Dithianon

(Source: Fungicides Resistance Action Committee, FRAC 2012)

(iii) Classification of insecticides and fungicides based on toxicity/hazard

(i) WHO recommended classification of pesticides by hazard

WHO Class		LD50 for the rat (mg/kg body weight)		Colour of toxicity triangle	Symbol in toxicity triangle
		Oral	Dermal		
Ia	Extremely hazardous	< 5	< 50	Red	Skull+Poision
Ib	Highly hazardous	5–50	50–200	Yellow	Poison
II	Moderately hazardous	50–2000	200–2000	Blue	Danger
III	Slightly hazardous	Over 2000	Over 2000	Green	Caution
U	Unlikely to present acute hazard	5000 or higher		Green	Caution

(Source: Anonymous, 2009)

(ii) Grouping of approved pesticides based on WHO recommended classification by hazard for use in vegetables

	Common name	Insecticide/ Fungicides	Strength and Formulation
Ia = Extremely hazardous			
1	Phorate	Insecticide	10% G
2	Phosphamidon	Insecticide	40% SL
Ib = Highly hazardous			
3	Carbofuran	Insecticide	3 % G
4	Dichlorvos	Insecticide	76% EC
5	Methomyl	Insecticide	40 % SP
6	Oxydemeton methyl	Insecticide	25% EC
7	Triazophos	Insecticide	40% EC
II = Moderately hazardous			
8	Carbaryl	Insecticide	5% DP, 10 % DP
9	Carbosulfan	Insecticide	25 % EC
10	Cartap Hydrochloride	Insecticide	50 % SP, 4% G
11	Chlorfenpyre	Insecticide	10 % SC
12	Chlorpyrifos	Insecticide	20% EC
13	Cypermethrin	Insecticide	0.25 % DP
14	Deltamethrin	Insecticide	2.8 % EC

	Common name	Insecticide/ Fungicides	Strength and Formulation
15	Dicofol	Insecticide	18..5 % EC
16	Dimethoate	Insecticide	30% EC
17	Endosulfan	Insecticide	35 % EC
18	Ethion	Insecticide	50 % EC
19	Fenazaquin	Insecticide	10 % EC
20	Fenpropathrin	Insecticide	30 % EC
21	Fenpyroximate	Insecticide	5 % EC
22	Fenvalrate	Insecticide	20 %EC
23	Fipronil	Insecticide	5 % SC
24	Imidacloprid	Insecticide	70 % WG, 48 % FS, 70 % WS, 17.8 % SL
25	Indoxacarb	Insecticide	14.5% SC, 15.8 % SC
26	Lambda Cyhalothrin	Insecticide	5 % EC
27	Permethrin	Insecticide	25 %EC
28	Phosalone	Insecticide	35 % EC
29	Quinalphos	Insecticide	25% Gel
30	Thiacloprid	Insecticide	21.7% SC
31	Thiodicarb	Insecticide	75% WP
32	Trichloforon	Insecticide	5% Gr, 5% Dust,50% EC
33	Copper Sulphate	Fungicide	2.62% SC
34	Copper Hydroxide	Fungicide	77% WP
35	Difenoconazole	Fungicide	25% EC
36	Dinocap	Fungicide	48% EC
37	Flusilazole	Fungicide	40% EC
38	Myclobutanil	Fungicide	10% WP
39	Triadimefon	Fungicide	25% WP
40	Tebuconazole	Fungicide	25.9% m/m EC
41	Ziram	Fungicide	80% WP
III = Slightly hazardous			
42	Buprofezin	Insecticide	25 % SC
43	*Bacillus thuringiensis var. kurstaki*	Insecticide	5% WP
44	Difenthiuron	Insecticide	50 % WP
45	Flufenoxuron	Insecticide	10 % DC
46	Malathion	Insecticide	50% EC
47	Propargite	Insecticide	57%EC

	Common name	Insecticide/ Fungicides	Strength and Formulation
48	Spinosad	Insecticide	2.5% SC, 45% SC
49	Fenarimol	Fungicide	12%EC
50	Hexaconazole	Fungicide	2% SC
51	Sulphur	Fungicide	80% WP, 80% WG, 40% WP, 52% SC, 85% DP
U = Unlikely to present acute hazard in normal use			
52	Chlorantranilprole	Insecticide	18.5% SC
53	Flubendamide	Insecticide	39.5 % SC , 20 % WG
54	Hexythiazox	Insecticide	5.45 % EC
55	Novaluron	Insecticide	10% EC
56	Azoxystrobin	Fungicide	23% SC
57	Benomyl	Fungicide	50% WP
58	Carbendazim	Fungicide	50% WP
59	Captan	Fungicide	50% WG
60	Dimethomorph	Fungicide	50% WP
61	Mancozeb	Fungicide	75% WG, 35% SC, 75% WP
62	Mandipropamid	Fungicide	23.4%SC
63	Metarim	Fungicide	70% WG
64	Propineb	Fungicide	70% WP
65	Thiophanate Methyl	Fungicide	70% WP
66	Zineb	Fungicide	75% WP
Unclassified group			
1	Acetamiprid	Insecticide	20% SC
2	Emamectin benzoate	Insecticide	5 % SG
3	Flubendamide	Insecticide	39.35 % SC
4	Flumite/ Flufenzine	Insecticide	20 % SC
5	Lufenuron	Insecticide	5.4% EC
6	Metaflumizone	Insecticide	22 % Sc
7	Milbemectin	Insecticide	1 % EC
8	Pyridalyl	Insecticide	10%EC
9	Spiromesifen	Insecticide	22.9% SC
10	Thiamethoxam	Insecticide	25% WDG 70% WG
11	Thiameton	Insecticide	25 % EC

(Source: Anonymous, 2009)

3. Pesticides Registered for Use in India

(A) List of pesticides registered under Section 9(3) of the Insecticides Act, 1968 for use in India (As on 30.11.2012)

Insecticides

1. Acephate
2. Acetamiprid
3. Allethrin
4. Alphacypermethrin
5. Bendiocarb
6. Benfuracarb
7. Beta Cyfluthrin
8. Bifenazate
9. Bifenthrin
10. Buprofezin
11. Carbaryl
12. Carbofuran
13. Carbosulfan
14. Cartap Hydrochloride
15. Chlorantraniliprole
16. Chlorfenapyr
17. Chlorfluazuron
18. Chlorpyriphos
19. Chlorpyriphos Methyl
20. Chlothianidin
21. Chromafenozide
22. Cyfluthrin
23. Cypermethrin
24. Cyphenothrin
25. Deltamethrin
26. Diafenthiuron
27. Dichloro Diphenyl Trichloroethane (DDT)
28. Diclorvos (DDVP)
29. Dicofol
30. Diflubenzuron
31. Dimethoate
32. Dinotefuron
33. D-trans Allethrin
34. Emamectin Benzoate
35. Endosulfan*
36. Ethiprole
37. Ethion
38. Ethofenprox (Etofenprox)
39. Fenazaquin
40. Fenitrothion
41. Fenobucarb
42. Fenpropathrin
43. Fenpyroximate
44. Fenthion
45. Fenvalerate
46. Fipronil
47 Flonicamid
48 Flubendiamide
49 Flufenoxuron
50 Flufenzine
51 Fluvalinate
52 Hexythiazox
53 Imidacloprid
54 Imiprothrin
55 Indoxacarb
56 Lambdacyhalothrin
57 Lufenuron
58 Malathion
59 Metaldehyde
60 Methomyl

61 Methyl Parathion
62 Milbemectin
63 Monocrotophos
64 Novaluron
65 Oxydemeton-Methyl
66 Permethrin
67 Phenthoate
68 Phorate
69 Phosalone
70 Phosphamidon
71 Prallethrin
72 Primiphos-methyl
73 Profenophos
74 Propergite
75 Propetamphos
76 Propoxur
77 Pyridalyl
78 Pyriproxyfen
79 Quinalphos
80 S-bioallethrin
81 Spinosad
82 Spiromesifen
83 Temephos
84 Thiacloprid
85 Thiodicarb
86 Thiomethoxain
87 Thiometon
88 Transfluthrin
89 Triallate
90 Triazophos
91 Tricholorofon

Rodenticide (R) and Fumigant(F)

1 Aluminium Phosphide(F)
2 Barium Carbonate (R)
3 Bromadiolone (R)
4 Coumachlor (R)
5 Coumatetralyl (R)
6 Ethylene Dichloride and Carbon Tetrachloride mixture (EDCT Mixture 3:1) (F)
7 Magnesium Phosphide Plates (F)
8 Methyl Bromide (F)
9 Sodium Cyanide (F)
10 Zinc Phosphide (R)

Fungicides

1. Aureofungin
2. Azoxystrobin
3. Benomyl
4. Bitertanol
5. Captan
6. Carbendazim
7. Carboxin
8. Carpropamid
9. Chlorothalonil
10. Copper Hydroxide
11. Copper Oxychloride
12. Copper Sulphate
13. Cuprous Oxide
14. Cymoxanil
15. Diazinon
16. Difenoconazole
17. Dimethomorph
18. Dinocap
19. Dithianon
20. Dodine
21. Edifenphos
22. Famoxadone
23. Fenamidone
24. Fenarimol
25. Flusilazole
26. Fosetyl-Al

27. Hexaconazole
28. Iprobenfos
29. Iprodione
30. Iprovalicarb
31. Isoprothiolane
32 Kasugamycin
33 Kresoxim Methyl
34 Lime Sulphur
35 Mancozeb
36 Mandipropamid
37 Metalaxyl
38 Metalaxyl-M
39 Methoxy Ethyl Mercury Chloride (MEMC)
40 Metiram
41 Myclobutanil
42 Oxycarboxin
43 Penconazole
44 Pencycuron
45 Propiconazole
46 Propineb
47 Pyrachlostrobin
48 Streptomycin + Tetracycline
49 sulphur
50 Tebuconazole
51 Thifluzamide
52 Thiobencarb (Benthiocarb)
53 Thiophanate-Methyl
54 Thiram
55 Triadimefon
56 Tricyclazole
57 Tridemorph
58 Trifloxistrobin
59 Validamycin
60 Zineb
61 Ziram

Herbicides

1 2,4-Dichlorophenoxy Acetic Acid
2 Alachlor
3 Anilophos
4 Atrazine
5 Azimsulfuron
6 Bensulfuron Methyl
7 Bispyribac Sodium
8 Butachlor
9 Carfentazone Ethyl
10 Chlorimuron ethyl
11 Chlormequat Chloride (CCC)
12 Chlorpropham
13 Clodinafop-propargyl
14 Clomazone
15 Cyhalofop-butyl
16 Dazomet
17 Diclofop-Methyl
18 Diuron
19 Ethoxysulfuron
20 Fenoxaprop-p-ethyl
21 Fluazifop-p-butyl
22 Fluchloralin
23 Flufenacet
24 Glufosinate Ammonium
25 Glyphosate
26 Hexazinone
27 Imazamox
28 Imazethapyr
29 Isoproturon
30 Linuron
31 Mepiquate Chloride
32 Mesosulfuron Methyl + Iodosulfuron Methyl Sodium
33 Metaflumizone
34 Methabenzthiazuron
35 Methyl Chlorophenoxy Acetic Acid (MCPA)
36 Metolachlor

37 Metribuzin
38 Metsulfuron Methyl
39 Orthosulfamuron
40 Oxadiargyl
41 Oxadiazon
42 Oxyfluorfen
43 Paraquat dichloride
44 Pendimethalin
45 Pinoxaden
46 Pretilachlor
47 Propanil
48 Propaquizafop
49 Pyrazosulfuron ethyl
50 Pyrithiobac sodium
51 Quizalofop ethyl
52 Quizalofop-P-tefuryl
53 Sirmate
54 sulfosulfuron
55 Trifluralin

Plant Growth Regulators

1 Alphanaphthyl Acetic Acid
2 Ethephon
3 Forchlorfenuron
4 Gibberellic Acid
5 Hydrogen Cyanamide
6 Paclobutrazol
7 Triacontanol

Biopesticides

1 *Ampelomyces quisqualis*
2 Azadirachtin (Neem Products)
3 *Bacillus sphaericus*
4 *Bacillus thuringiensis* var. *israelensis*
5 *Bacillus thuringiensis* var. *kurstaki*
6 *Bacillus thuringiensis* var. *galleriae*
7 *Beauveria bassiana*
8 *Metarhizium anisopliae*
9 Nuclear polyhyderosis virus of *Helicoverpa armigera*
10 Nuclear polyhyderosis virus of *Spodoptera litura*
11 *Pseudomonas fluorescens*
12 *Pyrethrins*
13 *Trichoderma harzianum*
14 *Trichoderma viride*
15 *Verticillium lecanii*

*Endosulfan has been banned by the Supreme Court of India w.e.f. 13-05-2011 for production, use & sale, all over India.

[Source: Central Insecticide Board & Registration Committee (CIB & RC)]

(B) Combination products registered for agricultural use

Insecticide Combinations

1. Acephate 25% + Fenvalerate 3% EC
2. Acephate 5% + Imidacloprid 1.1%
3. Acephate 50% + Imidacloprid 1.8% SP
4 Betacyfluthrin 8.49% + Imidacloprid 19.81% OD

5 Cypermethrin 3% + Quinalphos 20% EC
6 Chlorpyriphos 50% + Cypermethrin 5% EC
7 Chloropyriphos 16% + Alphacypermethrin 1% EC
8 Deltamethrin 0.72% + Buprofezin 5.65% EC
9 Deltamethrin 0.75% + Endosulfan 29.75% EC
10 Ethion 40% + Cypermethrin 5% EC
11 Endosulfan 35% + Cypermethrin 5% EC
12 Indoxacarb 14.5% + Acetamiprid 7.7 % SC
13 Novaluron 5.25% + Indoxacarb 4.5% SC
14 Phosphamidon 40% + Imidacloprid 2% SP
15 Profenofos 40% + Cypermethrin 4% EC
16 Pyriproxyfen 5% EC + Fenpropathrin 15% EC

Fungicide Combinations

1 Captan 70% + Hexaconazole 5% WP
2 Carbendazim 12% + Mancozeb 63% WP
3 Carbendazim 25%+ Mancozeb 50% WS
4 Carbendazim 25 + Flusilazole 12.5% SE
5 Carboxin 37.5% + Thiram 37.5% DS
6 Cymoxanil 8% + Mancozeb 64% WP
7 Famoxadone 16.6% + Cymoxanil 22.1% SC
8 Fenamidone 4.44% + Fosetyl AI 66.7% WG
9 Fenamidone 10% + Mancozeb 50% WDG
10 Iprodione 25% + Carbendazim 25% WP
11 Metalaxyl M 4% + Mancozeb 64% WP
12 Metalaxyl 8% + Mancozeb 64% WP
13 Metiram 55% + Pyraclostrobin 5% WG
14 Tebuconazole 50% + Trifloxystrobin 25% WG

Herbicide combinations

1 Anilofos 24% +2,4-D ethyl Ester 32% EC
2 Bensulfuron methyl 0.6%+Pretilachlor 6% GR
3 Clodinafop Propargyl 15% + Metsulfuron Methyl 1% WP

4 Clomazone 20%+2,4-D EE 30% EC

5 Fenoxaprop-p-ethyl 7.77% w/w + Metribuzin 13.6% w/w EC

6 Hexazinone 13.2% + Diuron 46.8 % WP

7 Imazamox 35% + Imazethapyr 35% WG

8 Mesosulfuron Methyl 3% + Iodosulfuron Methyl Sodium 0.6% WG

9 Metsulfuron Methyl 10% + Chlorimuron ethyl 10% WP

10 Pendimethalin 30%+ Imazethapyr 2% EC

11 Sulfosulfuran 75%+ Metsulfuron Methyl 5%WG

(Source: CIB & RC)

(C) Pesticides and formulations banned for use in India

(i) Pesticides banned for manufacture, import and use

S.No	Name of the pesticide	Type of pesticide
1.	Aldrin	Insecticide
2.	Benzene Hexachloride	Insecticide
3.	Calcium Cyanide	Insecticide and Rodenticide
4.	Chlordane	Insecticide
5.	Copper Acetoarsenite	Fungicide
6.	Clbromochloropropane	Insecticide
7.	Endrin	Insecticide
8.	Ethyl Mercury Chloride	Insecticide
9.	Ethyl Parathion	Insecticide
10.	Heptachlor	Insecticide
11.	Menazone	
12.	Nitrofen	Herbicide
13.	Paraquat Dimethyl Sulphate	Herbicide
14.	Pentachloro Nitrobenzene	Fungicide
15.	Pentachlorophenol	Herbicide
16.	Phenyl Mercury Acetate	Fungicide
17.	Sodium Methane Arsonate	Herbicide
18.	Tetradifon	Acaricide
19.	Toxafen	Insecticide
20.	Aldicarb	Insecticide

S.No	Name of the pesticide	Type of pesticide
21.	Chlorobenzilate	Insecticide
22.	Dialdrine	Insecticide
23.	Maleic Hydrazide	Herbicide
24.	Ethylene Dibromide	Fumigant/Insecticide
25.	TCA (Trichloro acetic acid)	Herbicide
26.	Metoxuron	Herbicide
27.	Chlorofenvinphos	Insecticide
28.	Lindane*	Insecticide

*Banned vide Gazette Notification No S.O. 637(E) Dated 25/03/2011)-Banned for Manufecture, Import or Formulate w.e.f. 25th March, 2011 and banned for use w.e.f. 25th March, 2013.

(ii) Pesticide formulations banned for import, manufacture and use

1	Carbofuron 50% SP	Insecticide
2	Methomyl 12.5% L	Insecticide
3	Methomyl 24% formulation	Insecticide
4	Phosphamidon 85% SL	Insecticide

(iii) Pesticide banned for use but continued to manufacture for export

1	Captafol 80% Powder	Fungicide
2	Nicotin Sulfate	Insecticide

(iv) Pesticides withdrawn**

1	Dalapon	Herbicide
2	Ferbam	Fungicide
3	Formothion	Insecticide
4	Nickel Chloride	Fungicide
5	Paradichlorobenzene (PDCB)	Insecticide
6	Simazine	Herbicide
7	Warfarin	Rodenticide

**Withdrawal may become in operative as soon as required complete data as per the guidelines is generated and submitted by the Pesticides Industry to the Government and accepted by the Registration Committee. (S.O 915(E) dated 15th June, 2006)

(v) List of pesticides refused registration

1.	Calcium Arsonate	Insecticide
2.	EPM	Not available
3.	Azinphos Methyl	Insecticide
4.	Lead Arsonate	Insecticide
5.	Mevinphos (Phosdrin)	Insecticide
6.	2,4, 5-T	Herbicide
7.	Carbophenothion	Insecticide
8.	Vamidothion	Insecticide
9.	Mephosfolan	Insecticide
10.	Azinphos Ethyl	Insecticide
11.	Binapacryl	Fungicide
12.	Dicrotophos	Insecticide
13.	Thiodemeton / Disulfoton	Insecticide
14.	Fentin Acetate	Fungicide
15.	Fentin Hydroxide	Fungicide
16.	Chinomethionate (Morestan)	Fungicide
17.	Ammonium Sulphamate	Herbicide
18.	Leptophos (Phosvel)	Insecticide

(vi) Pesticides restricted for use in India

S.N	Name of Pesticide	Insecticide/ Fungicide	Types of Restriction imposed
1.	Aluminium Phosphide	Insecticide (Fumigant)	The Pest Control Operations with Aluminium Phosphide may be undertaken only by Govt./Govt. undertakings / Govt. Organizations / Pest control operators under the strict supervision of Govt. Experts or experts whose expertise is approved by the Plant Protection Advisor to Govt. of India. [RC decision circular F No. 14-11(2)-CIR-II (Vol. II) dated 21-09-1984 and G.S.R. 371(E) dated 20th May 1999].

S.N	Name of Pesticide	Insecticide/ Fungicide	Types of Restriction imposed
			The production, marketing and use of Aluminium Phosphide tube packs with a capacity of 10 and 20 tablets of 3 g each of Aluminium Phosphide are banned completely. (S.O.677 (E) dated 17th July, 2001)
2.	Captafol	Fungicide	The use of Captafol as foliar spray is banned. Captafol shall be used only as seed dresser. (S.O.569 (E) dated 25th July, 1989) The manufacture of Captafol 80 % powder for dry seed treatment (DS) is banned for use in the country except manufacture for export. (S.O.679 (E) dated 17th July, 2001)
3.	Cypermethrin	Insecticide	Cypermethrin 3 % Smoke Generator is to be used only through Pest Control Operators and not allowed to be used by the General Public. [Order of Hon,ble High Court of Delhi in WP(C) 10052 of 2009 dated 14-07-2009 and LPA-429/2009 dated 08-09-2009]
4.	Dazomet	Herbicide	The use of Dazomet is not permitted on Tea (S.O.3006 (E) dated 31st Dec., 2008)
5.	Diazinon	Insecticide	Diazinon is banned for use in agriculture except for household use. (S.O.45 (E) dated 08th Jan., 2008)
6.	Dichloro Diphenyl Trichloroethane (DDT)	Insecticide	The use of DDT for the domestic Public Health Programme is restricted up to 10,000 Metric Tonnes per annum, except in case of any major outbreak of epidemic. M/S Hindustan Insecticides Ltd., the sole manufacturer of DDT in the country may manufacture DDT for export to other countries for

S.N	Name of Pesticide	Insecticide/ Fungicide	Types of Restriction imposed
			use in vector control for public health purpose. The export of DDT to Parties and State non-Parties shall be strictly in accordance with the paragraph 2(b) article 3 of the Stockholm Convention on Persistent Organic Pollutants (POPs). (S.O.295 (E) dated 8th March, 2006) Use of DDT in Agriculture is withdrawn. In very special circumstances warranting the use of DDT for plant protection work, the state or central Govt. may purchase it directly from M/S Hindustan Insecticides Ltd. to be used under expert Governmental supervision. (S.O.378 (E) dated 26th May, 1989)
7.	Fenitrothion	Insecticide	The use of Fenitrothion is banned in Agriculture except for locust control in scheduled desert area and public health. (S.O.706 (E) dated 03rd May, 2007)
8.	Fenthion	Insecticide	The use of Fenthion is banned in Agriculture except for locust control, household and public health. (S.O.46 (E) dated 08th Jan., 2008)
9.	Lindane (Gamma-HCH)	Insecticide	Lindane is banned for manufacture, import or formulate. However it is allowed for use up to 24th March, 2013 for termite control in building including wood, and termite control in Agriculture as per approved label claims by the Registration Committee and for exports. [S.O.637 (E) dated 25th March, 2011 AND S.O.1472 (E) dated 29th Aug., 2007]

S.N	Name of Pesticide	Insecticide/ Fungicide	Types of Restriction imposed
10.	Methoxy Ethyl Mercuric Chloride (MEMC)	Fungicide	The use of MEMC is banned completely except for seed treatment of potato and sugarcane. (S.O.681 (E) dated 17th July, 2001)
11.	Methyl Bromide	Insecticide (Fumigant)	Methyl Bromide may be used only by Govt./Govt. undertakings/Govt. Organizations / Pest control operators under the strict supervision of Govt. Experts or Experts whose expertise is approved by the Plant Protection Advisor to Govt. of India. [G.S.R.371 (E) dated 20th May, 1999 and earlier RC decision]
12.	Methyl Parathion	Insecticide	Methyl Parathion 50 % EC and 2% DP formulations are banned for use on fruits and vegetables. (S.O.680 (E) dated 17th July, 2001) The use of Methyl Parathion is permitted only on those crops approved by the Registration Committee where honeybees are not acting as pollinators. (S.O.658 (E) dated 04th Sep., 1992.)
13.	Monocrotophos	Insecticide	Monocrotophos is banned for use on vegetables. (S.O.1482 (E) dated 10th Oct, 2005)
14.	Sodium Cyanide	Insecticide/ Fumigant	The use of Sodium Cyanide shall be restricted for Fumigation of Cotton bales under expert supervision approved by the Plant Protection Advisor to Govt. of India. (S.O.569(E) dated 25th July, 1989)

(Source: CIB & RC)

(D) Formulations of pesticides registered for use in India

	Name of the Pesticides	Type of pesticides	Formulation* registered
1	2 ,4-Dichlorophenoxy Acetic Acid (2,4-D Sodium Amine and Ester Salt	Herbicide	a) 2,4-D Sodium Salt used as Tech a.i. 80% w/w min.b)2,4-D Amine Salt 58% SL 22.5% SLc)2,4-D Ethyl Ester 38% EC, 4.5% Gr., 20%WP,
2	Acetamiprid	Insecticide	20 SP
3	Acephate	Insecticide	75% SP
4	Alachlor	Herbicide	50%EC, 10% GR
5	Allethrin	Insecticide	0.5% Coil, 4% Mat, 0.5% Aer., 3.6% L, 0.2% & 0.02% Coil
6.	Alphacypermethrin	Insecticide	10% EC, 5% WP, 0.5% Chalk, 10% SC, 0.1%RTU
7.	Alphanaphthyl Acetic Acid	Plant Growth Regulator	4.5% Sol.
8.	Aluminium phosphide **(R)	Insecticide	56% Tab', 56% P,77.5% GR
9.	Anilofos	Herbicide	30% EC, 18% EC
10.	Atrazine	Herbicide	50% WP
11.	Aureofungin	Fungicide	46.15% SP
12.	Azadirachtin (neem products)	Insecticide	25%, 10%, 0.03% EC 0.1 EC, 0.15 EC, 5 EC, 0.3% 15% extract concentrate, 1% EC
13.	Azoxystrobin	Fungicide	23% SC(FI)
14.	*Bacillus thuringiensis (B.t.)*	Biopesticide	Liquid & WP formulations, 5% AS
15.	Barium Carbonate	Rodenticide	1% P
16.	Betacyfluthrin	Insecticide	2.45% SC
17.	*Beauveria bassiana*	Biopesticide	1.15% WP, 1.0% WP
18.	Bendiocarb	Insecticide	80% WP
19.	Benfuracarb	Insecticide	40%EC, 3.0% GR
20.	Bensulfuron Methyl	Herbicide	60% DF(FI)
21.	Bispyribac sodium	Herbicide	10% SC
22.	Benomyl	Fungicide	50% WP
23.	Bitertanol	Fungicide	25% WP
24.	Bifenthrin	Insecticide	10% EC,2.5%EC,23.4%, MUP(Imp), 8% SC(FI)
25.	Bromadiolone	Rodenticide	0.25% CB, 0.005% RB & 0.005% RB cake
26.	Buprofezin	Insecticide	25% SC

	Name of the Pesticides	Type of pesticides	Formulation*registered
27.	Butachlor	Herbicide	50% EC, 5% Gr., 50% EW,
28.	Captan	Fungicide	50% WP, 75% WP, 50% WDG
29.	Carbaryl	Insecticide	5% DP, 10% DP, 50% WP, 85% WP, 4% Gr., 40% LV, 42% Flow
30.	Carbendazim	Fungicide	25% DS, 50% WP, 46.27% SC
31.	Carbofuran	Insecticide	3% CG, 50% SP for Govt use.
32.	Carbosulfan	Insecticide	25% DS, 25% EC, 6% Gr.
33.	Carboxin	Fungicide	75% WP
34.	Carpropamid	Fungicide	27.8% SC
35.	Cartap Hydrochloride	Insecticide	4% Gr., 50% SP
36.	Chlorfenapyr	Insecticide	10% SC (FI)
37.	Chlorimuron ethyl	Herbicide	25% WP,
38.	Chlormequat Chloride	Herbicide	50% Sol.
39.	Chlorofenviphos	Insecticide	10% Gr.
40.	Chlorothalonil	Fungicide	75% WP
41.	Chlorpyriphos	Insecticide	20% EC, 10% Gr, 1.5% DP, 50% EC, 2% RTU
42.	Chlorpyriphos Methyl	Insecticide	40% EC
43.	Chlopropham	Herbicide	50% HN
44.	Cinmethylene	Rodenticide	10% EC
45.	Chlorantraniliprole	Insecticide	18.5% SC, 0.4% Gr.
46.	Clodinafop-propargyl (Pyroxofop-propinyl)	Herbicide	15% WP
47.	Clomazone	Herbicide	50% EC
48.	Clothianidin	Insecticide	50%WG(FI)
49.	Copper Oxychloride	Fungicide	50% WP, 40% Paste, 5% DP, 50 WG
50.	Copper Hydroxide	Fungicide	77% WP
51.	Copper Sulphate	Fungicide	Used as Tech. 8%, 25% w/w min., 2.62% SC
52.	Coumachlor	Rodenticide	0.5% CB, 0.025% RB
53.	Coumatetralyl	Rodenticide	0.75% TP, 0.037% Bait.
54.	Cuprous Oxide	Fungicide	4% DP
55.	Cyfluthrin	Insecticide	10% WP, 5% EW,Cyfluthrin + Propoxur (0.5%) (0.015%)
56.	Cyhalofop-butyl	Herbicide	10% EC
57.	Cymoxonil	Fungicide	80% WP
58.	Cypermethrin	Insecticide	10% EC, 25% EC, 1% Chalk, 0.1% Aquous (HH), 0.25 DP, 3% Smoke Generator
59.	Cyphenothrin	Insecticide	5% EC, 0.15% in combination as Aer.
60.	Dazomet	Herbicide	Dazomet Technical GR

	Name of the Pesticides	Type of pesticides	Formulation*registered
61.	Deltamethrin	Insecticide	2.5% Flow, 2.5% WP, 2.8% EC, 0.5% Chalk, 1.25% ULV, 25% Tab., 11% EC, 0.5% Tablet bait
62.	Diafenthiuron	Insecticide	50% WP
63.	Diazinon	Insecticide	20% EC, 10% GR, 2% DP, 40% WP, 5% GR, 25% Micro Encapsulation
64.	Dichloro Diphenyl Trichloroethane (DDT)	Insecticide	50% WP, 75% WP
65.	Dichloropropene and Dichloropropanes mixture (DD Mixture) **	Insecticide	1:1
66.	Diclorvos (DDVP)	Insecticide	76% EC
67.	Diclofop-methyl	Herbicide	28% EC
68.	Dicofol	Insecticide	18.5% EC
69.	Difenoconazole	Fungicide	25% WP
70.	Diflubenzuron	Insecticide	25% WP,2%Tab,2%GR.(FI)
71.	Dimethoate	Insecticide	30% EC
72.	Dimethomorph	Fungicide	50% WP
73.	Dinocap	Fungicide	48% EC
74.	Dithianon	Fungicide	75% WP
75.	Diuron	Herbicide	80% WP
76.	Dodine	Fungicide	65% WP, 50% flow
77.	D-trans allethrin	Insecticide	2% Mat, 0.1% coil, 0.1% coil (12 hr.)
78.	Edifenphos	Fungicide	50% EC
79.	Emamectin Benzoate	Insecticide	5% SG (FI) & (FIM)
80.	Endosulfan	Insecticide	2% DP, 4% DP, 35% EC, 4% GR
81.	Ethephon	Plant Growth Regulator	39% SL, 10% Paste
82.	Ethion	Insecticide	50% EC
83.	Ethofenprox (Etofenprox)	Insecticide	10% EC
84.	Ethoxysulfuron	Herbicide	10% EC
85.	Ethylene Dichloride and Carbon Tetrachloride mixture (EDCT mixture 3:1)	Fumigant	3:1
86.	Fenarimol	Fungicide	12% EC
87.	Fenazaquin	Insecticide	10% EC

	Name of the Pesticides	Type of pesticides	Formulation*registered
88.	Fenitrothion	Insecticide	5% DP, 40% WP, 50% EC, 82.5% EC, 2% Spray, 20% OL
89.	Fenobucarb (BPMC)	Insecticide	50% EC
90.	Fenoxaprop-p-ethyl	Herbicide	10% EC, 9.3% EC one time import, 6.7% EC
91.	Fenpropathrin	Insecticide	10% EC, 30% EC
92.	Fenthion	Insecticide	82.5% EC, 2% GR, 2% Spray
93.	Fenvalerate	Insecticide	0.4% DP, 20%EC
94.	Fenpyroximate	Insecticide	5% SC
95.	Fipronil	Insecticide	0.3% Gr., 5% SC, 0.05% Gel (Import) & FIM, 80%WG
96.	Flubendiamide	Insecticide	39.35% SC, 20% WG
97.	Fluchloralin	Herbicide	45% EC
98.	Flumite	Insecticide	20% SC
99.	Flusilazole	Fungicide	40% EC
100.	Flufenacet	Herbicide	60% WP
101.	Flufenoxuron	Insecticide	10% DC
102.	Fluvalinate	Insecticide	25% EC
103.	Forchlorfenuron (CPPU)	Plant Growth Regulator	0.1%, 0.12% EC (FI)
104.	Fosetyl-Al	Fungicide	80% WP
105.	Gibberellic Acid	Plant Growth Regulator	Tech. P, 0.186% SP, 0.001% W/W
106.	Glufosinate Ammonium	Herbicide	13.5% SL
107.	Glyphosate	Herbicide	41% SL, 20.2% SL, 5% SL
108.	Glyphosate ammonium salt	Herbicide	71% SG
109.	Hexaconazole	Fungicide	5% EC, 5% SC, 2% SC
110.	Hexythiazox	Insecticide	5.45% EC
111.	Hydrogen cyanamid	Fumigant	50% SC, 49%
112.	Imazethapyr	Herbicide	10% EC
113.	Imidacloprid	Insecticide	17.8% SL, 70% WS, 48% FS, 30.5% SC, 2.5% Gel, 70%WG
114.	Iprobenfos (Kitazin)	Fungicide	48% EC, 17% GR

Name of the Pesticides	Type of pesticides	Formulation*registered
115. Imiprothrin	Insecticide	50% MUP (Imiprothrin 0.1% + Cyfenothrin 0.15%)
116. Indoxacarb	Insecticide	14.5% SC,15.8%EC
117. Iprodione	Fungicide	50% WP
118. Isoprothiolane	Fungicide	40% EC
119. Isoproturon	Herbicide	50% WP, 75% WP, 50% Flow
120. Kasugamycin	Fungicide	3% SL
121. Kresoxim-methyl	Fungicide	44.3%
122. Lambdacyhalothrin	Insecticide	5% EC, 10% WP, 2.5% EC, 0.5% Chalk, 22.9%CS(FI), 4.9%
123. Lime Sulphur	Fungicide	22% SC
124. Lindane **	Insecticide	0.65% DP, 1.3% DP, 6.5% WP, 20% EC, 6% GR
125. Linuron	Herbicide	50% WP
126. Lufenuron	Insecticide	5.4% EC
127. Magnesium phosphide Plates	Fumigant	56%Min. Plates (FI)
128. Malathion	Insecticide	5% DP, 25% WP, 50% EC, 0.25% Spray and 96% ULV, 2% Spray, 5% Spray
129. Mancozeb	Fungicide	75% WP, 35% SC, 75%WG
130. Mepiquat Chloride	Herbicide	5%AS, 50% TK
131. Milbemectin	Insecticide	1% EC
132. Metaflumizone	Herbicide	22% SC (FI)
133. Metalaxyl	Fungicide	35% WS, 40% WS
134. Metalaxyl – M	Fungicide	31.8% ES
135. Metaldehyde	Molloscucide	2.5% DP
136. Metiram	Fungicide	70% WG
137. Methomyl	Insecticide	40% SP
138. Methabenzthiazuron	Herbicide	70% WP
139. Methoxy ethyl mercury chloride **	Fungicide	3% FS, 6% FS
140. Methyl bromide **	Fungicide	99% L, 98% L
141. Methyl chlorophenoxy acetic acid (MCPA)	Herbicide	40% SL or 40% AS
142. Methyl Parathion **	Insecticide	2% DP, 50% EC

Name of the Pesticides	Type of pesticides	Formulation*registered
143. Metasulfuron -methyl	Herbicide	20% WD, 20%WG(FI)
144. Metolachlor	Herbicide	50% EC
145. Metoxuron	Herbicide	80% WP
146. Metribuzin	Herbicide	70% WP
147. Monocrotophos	Insecticide	36% SL
148. Myclobutanil	Fungicide	36% SL
149. Novaluron	Insecticide	10% EC (FI)
150. NPV of *Helicoverpa armigera*	Biopesticide	0.43% AS, 2.0% AS
151. NPV of *Spodoptera litura*	Biopesticide	0.5% AS
152. Oxadiazon	Herbicide	25% EC
153. Oxadiargyl	Herbicide	80% WP, 6% EC
154. Oxycarboxin	Fungicide	20% EC
155. Oxydemeton-methyl	Insecticide	25% EC
156. Oxyfluorfen	Herbicide	23.5% EC, 0.35% GR
157. Paclobutrazol	Plant Growth Regulator	23% SC
158. Paraquat dichloride	Herbicide	24% SL
159. Penconazole	Fungicide	10% EC
160. Pendimethalin	Herbicide	30% EC, 5% GR,38.7% CS
161. Pencycuron	Fungicide	22.9% SC
162. Permethrin	Insecticide	25% EC, 5% SG
163. Phenthoate	Insecticide	2% DP, 50% EC
164. Phorate	Insecticide	10% CG
165. Phosalone	Insecticide	4% DP, 35% EC
166. Phosphamidon	Insecticide	40% SL,
167. Pinoxaden	Herbicide	5.1% EC
168. Primiphos-methyl	Insecticide	25% WP, 50% EC, 1% Spray
169. Prallethrin	Insecticide	0.8% mat for 12 hours, 1% Mat, 0.8% L, 1.6% L, 0.5% mosquito coil, 0.04% Mosquito coil, 1.2% mat, 19% w/w VP, 0.6% mat
170. Pretilachlor	Herbicide	50% EC, 30.7% w/w EC, 37.0% EW
171. Profenophos	Insecticide	50% EC
172. Propanil	Herbicide	35% EC
173. Propergite	Insecticide	57% EC

Name of the Pesticides	Type of pesticides	Formulation*registered
174. Propetamphos	Insecticide	20% EC, 1% Spray
175. Propiconazole	Fungicide	25% EC
176. Propineb	Fungicide	70% WP
177. Propoxur	Insecticide	20% EC, 1% Aer., 2% Aer. 1% HH Spray, 2% Bait
178. Propaquizafop	Herbicide	10% EC(FI)
179. Pyrethrins (Pyrethrum)	Insecticide	0.2% DP, 2.5% EC, 0.05% Spray, 0.2% PH, 2.0% EC
180. Pyraclostrobin	Fungicide	20% WG
181. Pyrazosulfuron -ethyl	Herbicide	10% WP
182. Pyriproxifen	Insecticide	0.5% GR
183. Quinalphos	Insecticide	1.5% DP, 25% EC, 20% AF
184. Quizalofop ethyl	Herbicide	5% EC (FI)
185. Quizalofop-p-tefuryl	Herbicide	4% EC (FI)
186. S-Bioallethrin	Insecticide	2.4% mat
187. Sirmate	Herbicide	38 WP, 4 GR
188. Sodium Cyanide **	Rodenticide	Used as Tech., 96% a.i. min
189. Spinosad	Insecticide	45% SC, 2.5% SC
190. Spiromesifen	Insecticide	22.9% SC
191. Streptomycin + Tetracycline	Bactericide	90: 10 SP
192. Sulfosulfuron	Herbicide	75% WG
193. Sulphur	Fungicide	85% DP, 80% WP, 40% SC, 80% WG/WDG, 55.16 SC (800 gm / L)
194. Tebuconazole	Fungicide	2.5% DS, 2% DS, 25.9% EW
195. Temephos	Insecticide	50% EC, 1% Sand Granules
196. Tetraconazole	Fungicide	3.8% EC (FI)
197. Thiobencarb (Benthiocarb)	Fungicide	50% EC, 10% GR
198. Thiodicarb	Insecticide	75% WP
199. Thiamethoxam	Insecticide	25% WG, 70% WS, 30% FS
200. Thiometon	Insecticide	25% EC
201. Thiophanate-methyl	Insecticide	70% WP
202. Thiacloprid	Insecticide	21.7% SC
203. Thiram	Fungicide	80% WP
204. Thifluzamide	Fungicide	24% SC

Name of the Pesticides	Type of pesticides	Formulation*registered
205. Transfluthrin	Insecticide	0.88% Liquid Vaporiser, 0.03% Mos. Coil, 20% MV Gel(30 days mat tray)
206. Triadimefon	Fungicide	25% WP
207. *Trichoderma viride*	Biopesticide	1% WP (CFU 2x10^6 gm/min), 0.5% WP, 5% WP
208. Triallate	Insecticide	50% EC
209. Triazophos	Insecticide	40% EC, 20% EC
210. Trichlorfon	Insecticide	5% DP, 50% EC, 5% GR
211. Tricontanol	Plant Growth Regulator	0.05% EC, 0.1% EW, 0.05% GR
212. *Tricoderma harzianum*	Biopesticide	0.5% WS
213. Tricyclazole	Fungicide	75% WP
214. Tridemorph	Fungicide	80% EC
215. Trifluralin	Herbicide	48% EC
216. Validamycin	Fungicide	3% L
217. Zinc Phosphide	Fumigant	2% RB
218. Zineb	Fungicide	80% WP, 27% Colloidal Suspension
219. Ziram	Fungicide	80 WP, 27% CS

(Source: CIB & RC)

***Formulation**

Solids

BB: Block Bait
CB: Bait Concentrate
CG: Encapsulated Granule
CS: Capsule Suspension
DP: Dispersible Powder
DS: Powder of Dry Seed
GB: Granular Bait
GR: Granule
RB: Bait (ready for use)
SG: Water Soluble Granule
WP: Wettable Powder
SP: Water Soluble Powder
WG:Water Dispersible Granules
WS: Water Dispersible Powder for Slurry Treatment

Liquids

DC: Dispersible Concentrate
EC: Emulsifiable Concentrate
ES: Emulsion for Seed Treatment
EW: Emulsion, Oil in Water
FS: Flowable Concentrate for Seed Treatment
OD: Oil Dispersion
SC: Suspension Concentrate
SE: Suspension Emulsion
SL: Soluble Concentrate

Others

AE: Aerosol dispenser

**R= Restricted

(E) Insecticides and combination products approved for insect control in vegetable crops

Sl No	Common name	Strength and Formulation	Target Pests	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
Insecticides					
1	Acetamiprid	20% SP	Aphids	15	75
			Thrips	10-20	50-100
2	Azadirachtin	1% (10000 ppm)	Fruit Borer, FSB*	-	1000-1500
3	Azadirachtin	0.03 % (300 ppm)	Fruit Borers, Whiteflies, Leaf Hoppers, Beetles, Aphids, DBM**	-	2500-5000
4	Azadirachtin	5%	Fruit Borers, Whiteflies, Leaf Hoppers, Aphids, DBM, *Spodoptera*	-	200
5	*Bacillus thuringiensis var. krustaki*	5% WP	DBM	25-50	500-1000
6	Buprofezin	25 % SC	Yellow mite	75-150	300-600
7	Carbaryl	5% DP	Jassid	1000	20000
			Borers	600	12000
		10 % DP	Fruit borer, jassids, DBM, Armyworm	2500	25000
8	Carbofuran	3 % G	Aphids	1000	33300
			Nematodes	1000	50000
			Shoot fly	1000	33.10/plant
			Thrips	500	16600
			Whitefly	1200	40000
			Jassids	1000	33300
9	Carbosulfan	25 % EC	Whitefly, Aphids	200-250	800-1000
10	Chlorantranil-prole	18.5% SC	DBM	10	50
			Fruit borer	30	150
			FSB	40	200

Sl No	Common name	Strength and Formulation	Target Pests	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
11	Chlorfenpyre	10 % SC	DBM	75-100	750-1000
			Yellow mite	75-100	750-1000
12	Chlorpyrifos	20% EC	FSB	200	1000
			DBM	400	2000
			Pod borer/ Pod bugs	600	3000
			Root grub	1000	5000
13	Cypermethrin	0.25 % DP	FSB	50-60	20000-24000
		10 % EC	DBM	60-70	650-760
			Fruit borer, FSB	50-70	550-760
		25 % EC	FSB, Jassids	37-50	150-200
			Epilachna beetle	37-50	150-200
14	Deltamethrin	2.8 % EC	FSB, Jassids	10-15	400-600
			Fruit borer	10-12.5	400-600
15	Dichlorvos	76% EC	Red pumpkin beetle	500	627
16	Dicofol	18..5 % EC	Red spider mite	250-500	1350-2700
17	Difenthiuron	50 % WP	DBM	300	600
			Mites	300	600
			Whitefly	300	600
18	Dimethoate	30% EC	Aphid, Leafhopper	700 600	2310 1980
			Bugs	200	660
			Mites Thrips	300 200	990 660
			Whitefly	300	990
19	Emamectin benzoate	5 % SG	FSB	6.75-10	135-200
			DBM	7.5-10.0	150-200
			Fruit borer, Thrips, Mite	10	200
20	Endosulfan	35 % EC	Aphids	140	400
21	Ethion	50 % EC	Mite, Thrips	750-1000	1500-2000
22	Fenazaquin	10 % EC	Yellow mite	125	1250

Sl No	Common name	Strength and Formulation	Target Pests	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
23	Fenpropathrin	30 % EC	FSB, Thrips, Whitefly, Mites	75-100	250-340
24	Fenpyroximate	5 % EC	Yellow Mite	15-30	300-600
25	Fenvalerate	20 % EC	DBM, Borers	60-75	300-375
			FSB	75-100	375-500
26	Fipronil	5 % SC	DBM	40-50	800-100
			Fruitborer, Thrips, Aphids	40-50	800-100
27	Flubendamide	39.35 % SC	Fruit borer	48-60	100-125
28	Flufenoxuron	10 % DC	DBM	40	400
29	Flumite/ Flufenzine	20 % SC	Mites	80-100	400-500
30	Hexythiazox	5.45 % EC	Yellow mite	15-25	300-500
31	Imidacloprid	70 % WG	Jassids, Aphids, Thrips	21-24.5	30-35
		48 % FS	Jassids, Aphids	300-540 (per 100 kg seed)	500-900
		70 % WS	Jassids, Aphids	350-700 (per 100 kg seed)	500-1000
			Jassids, Aphids, Thrips	700-1050 (per 100 kg seed)	500-1000
		17.8 % SL	Jassid, Aphid, Thrips	25-20	125-250
			Whitefly	30-35	150-175
32	Indoxacarb	14.5% SC	DBM	30-40	200-266
			Fruit borer	50-75	333-500
		15.8 % SC	DBM	40	266
33	Lambda-cyhalothrin	5 % EC	FSB,Fruit borer	15	300
			Thrips, Mite, Jassids	15	300
34	Lufenuron	5.4% EC	DBM, Fruit borer	30	600
35	Malathion	50% EC	Fruit borer Jassids	750 625	1500 1250

Sl No	Common name	Strength and Formulation	Target Pests	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
			Mites, Aphids, Head borer Whitefly, Stem Borer, Pod borer	750	1500
36	Metaflumizone	22 % SC	DBM	165-220	150-1000
37	Methomyl	40 % SP	Pod borer, Thrips	300-450	750-1125
38	Milbemectin	1 % EC	Mites	3.25	325
39	Novaluron	10% EC	DBM	75	750
			Fruit borer	75	750
			Tobacco caterpillar	33.5	375
40	NPV of	0.43 % AS	*Helicoverpa armigera*	-	1500
	H armigera	2.0 % AS	*Helicoverpa armigera*	-	250-500
41	Oxydemeton methyl	25% EC	Whitefly, Aphids, Jassid Leaf beetles	250 400	1000 1600
			Mites Thrips	500 250	2000 1000
42	Permethrin	25 % EC	Fruit borer, Aphids, Jassids	100-125	400-500
			DBM	50-125	200-500
43	Phorate	10% G	Aphids, Jassids Mites, Thrips	1000-1500	15000-20000
			Whitefly	1500	15000
44	Phosalone	35 % EC	Fruit borer	450-525	1500
			FSB	500	1285-1428
			Aphids	500	1428
			Aphid Mite Thrips	700 450 700	2000 1285 2000
45	Phosphomidon	40% SL	Jassids, Aphid Whitefly	250-300	625-750
46	Propargite	57% EC	Mite	850	1500
47	Pyridalyl	10% EC	Fruit borers, DBM	50-75	500-750

Sl No	Common name	Strength and Formulation	Target Pests	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
48	Quinalphos	25% Gel	Aphids	250	100
		20% AF	Fruit borer	250-300	1250-1500
			FSB, Jassids, Epilachana beetle	300-350	1500-1750
		25% EC	Fruit borer, Leaf hopper, Mite	250	1000
			FSB	375	1500
			Leaf hopper	250	1000
			Aphid	250	1000
			Head borer	500	2000
			Mite	375	1500
			Fruit borer	250	1000
			Stemfly	250	1000
			Thrips	3000	1200
49	Spinosad	2.5% SC	DBM	15.0-17.5	600-700
		45% SC	Fruit borer	73	160
50	Spiromesifen	22.9% SC	Red spider mite	96	400
			Yellow mite	96-120	400-500
51	Thiacloprid	21.7% SC	Thrips	54-72	225-300
51	Thiodicarb	75% WP	FSB, Fruitborer	470-750	625-500
53	Thiamethoxam	25% WG	Jassid, aphid,	25	100
			Whitefly	50	200
		70% WDG	Aphids	200	286
54	Thiameton	25% EC	Aphids, Jassids FSB	250	100
55	Trichloforon	5% GR	FSB, DBM Red pumpkin beetle	500-750	
		5% D	FSB, DBM Red pumpkin beetle	500-750	
		50% EC	FSB, DBM Red pumpkin beetle	500-750	
56	Triazophos	40% EC	FSB Epilachana bettle	500	1250

Sl No	Common name	Strength and Formulation	Target Pests	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
Combination Insecticides					
1	Betacyfluthrin + Imidacloprid	8.49% + 19.81% OD	Aphids, Jassids, FSB	15.75+36.75 to 18 + 42	175-200
2	Cypermethrin + Quinalphos	3% + 20% EC	FSB	350-400	500-600
3	Deltamethrin + Triazophos	1% + 35% EC	FSB, Jassids Aphid, Epilachna beetle	10+350-12.5+ 450	1000-1250
4	Indoxacarb + Acetamiprid	14.5 %+ 7.7 % SC	Thrips Fruit borer	88.8-111	400-500
5	Novaluron + Indoxacarb	5.25% + 4.5% SC	Fruit borer & Leaf eating caterpillar	43.31+ 37.13 to 45.94 + 39.38	825-875
6	Pyriproxyfen + Fenpropathrin	5% +15% EC	Whitefly, FSB	25+75 – 37.5 +112.5	500-750

(Source: CIB & RC)
FSB: Fruit & Shoot borer; DBM: Diamond Back Moth

(F) Fungicides and combination products approved for disease control in vegetable crops

Sl No	Common name	Strength and Formulation	Target Disease	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
Fungicides					
1	Azoxystrobin	23% SC	Fruit rot, Powdery mildew	125	500
			Early & Late blight Powdery mildew	125	500
2	Benomyl	50% WP	Powdery mildew, Anthracnose, Fruit rot, Leaf spot	100	200
3	Carbendazim	50% WP	Powdery mildew	125-175	250-350
			Leaf spot, Fruit rot	150	300

Sl No	Common name	Strength and Formulation	Target Disease	Dosage /Ha	
				a.i (g)	Formulation (g/ml)
4	Copper Sulphate	2.62% SC	Early & Late blight, Fruit rot, anthracnose	-	1.0 l
5	Captan	50% WG	Fruit rot & Anthracnose, Early & Late blight	750	1500
		75% WP	Damping off (Nursery)	0.25%	2500
			Early & Late blight	1250	1667
			Fruit rot	1500	2000
		75% WS	Damping off (soil drench)	15-25 per kg seed	20-30 per kg seed
		50% WP	Early & Late blight	1250	2.5 kg
6	Copper Hydroxide	77% WP	Anthracnose, leaf spot Cercospora	625	1250
7	Chlorothalonil	75% WP	Early & Late blight	0.66-0.937	0.875-1.250
			Fruit rot	600	800
8	Difenoconazole	25% EC	Die-back Fruit rot	0.0125% or 12.5g/100 l. water	0.05% or 50 ml/ 100 l. water
9	Dinocap	48% EC	Powdery mildew	108	225
10	Dimethomorph	50% WP	Late blight	500	1000
11	Fenarimol	12% EC	Powdery mildew	0.005% (5g/100 l of water)	0.04 ml% (40 ml/100 l of water)
12	Flusilazole	40% EC	Powdery Mildew	40-60	100-150
13	Hexaconazole	2% SC	Powdery mildew & Fruit rot	60	3.0 l
			Early & Late blight	60	3.0 l
14	Iprodione	50% WP	Early blight	0.75 kg	1.5 kg
15	Kresoxim-methyl	44.3% SC	Early blight	30-37.5 ml 0.03- 0.037%	1000-1250
16	Kitazin	48% EC	Fruit rot dieback	0.10% or 100 in 100 l. of water	0.20% or 200 ml in 200 l. of water

Sl No	Common name	Strength and Formulation	Target Disease	Dosage /Ha	
				a.i (g)	Formulation (g/ml)
			Early blight	0.10% or 100 gram in 100 l. of water	0.20% or 200 ml in 200 l. of water
17	Lime Sulphur	22% SC	Rust	The liquid is used at one per cent in conventional sprayers (Doses 2-5 l/ha)	
18	Mancozeb	75% WG	Early Blight	750	1000
			Late Blight	750	1000
		35% SC	Early & Late blight	0.175% or 175 gm/100 l. water	0.5% or 500 gm/100 l water
		75% WP	Early & Late blight, Buck eye Rot, Leaf spot	1.125-1.5 kg	1.5-2 kg
			Damping off	2.25	3 g (soil drench)
			Fruit rot, Leaf spot	1.125 kg	1.5-2 kg
			Collar rot	2.25	3
19	Mandi-propamid	23.4% SC	Late blight	0.02%	0.08%
20	Metriam	70% WG	Alternaria blight	1750	2500
21	M.E.M.C.	6% FS	Tuber	0.025 /kg seed	0.415 /kg seed
22	Myclobutanil	10% WP	Leaf spot & Die back	0.004%	0.04%
23	Propineb	70% WP	Early & Late blight	0.21% or 210g/100 l. water	0.30% or 300/ 100 l. water
			Dieback	0.35% or 350 g/100 l. water	0.5% or 500 gram/ 100 lwater
			Buck eye rot	0.21% or 210 /100 l.water	0.30% or 300/ 100 l.water
24	Pyraclostrobin	20% WG	Early blight	75-100	375-500

Sl No	Common name	Strength and Formulation	Target Disease	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
25	Sulphur	80% WP	Powdery mildew,	2.5 kg	3.13 kg
			Rust	2.5 kg	3.13 kg
		80% WG	Powdery mildew	1.50-2.00 kg	1.875-250 kg
		40% WP	Powdery mildew	2.25-3.00 kg	5.65 kg
		52% SC	Powdery mildew	1.04 kg	2.00 l.
		85% DP	Powdery mildew	12.75-17 kg	15-20 kg
			Rust, Powdery mildew	12.75-17 kg	15-20 kg
26	Streptomycin Sulphate + Tetracylin Hydrocloride	9%+1% SP	Halo blight	Spray Streptocycline @ 100 to 150 ppm solution thrice at interval of 7 days. For prevention apply first spray 10 days after emergence of leaf.	
			Bacterial leaf spot	Spray seedlings with streptocycline 40 to 100 ppm solution in seed beds and fields after the appearance of first true leaves. Two sprays of streptocycline, one before transplanting and another after, are effective for controlling the disease.	
27	Triadimefon	25% WP	Rust	0.025%	0.100%
			Powdery mildew	38	0.150 kg
28	Thiophanate Methyl	70% WP	Ring rot	500	715
			Anthracnose	1000	1430
			Powdery mildew	1000	1430

Sl No	Common name	Strength and Formulation	Target Disease	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
29	Tebuconazole	25.9% m/m EC	Fruit rot Powdery mildew	0.125-0.1875 kg	0.50-0.75 kg
30	Ziram	80% WP	Early blight	1.2-1.6 kg	1.5-2.0 kg
31	Zineb	75% WP	Early & Late blight, Grey leaf mould	1.125- 1.5 kg	1.5-2 kg
			Fruit rot & Leaf spot	1.125- 1.5 kg	1.5-2 kg
			Blight	1.125- 1.5 kg	1.5-2 kg
			Downy mildew Anthracnose	1.125- 1.5 kg	1.5-2 kg
			Leaf spot	1.125-1.5 kg	1.5-2 kg
Combination Fungicides					
32	Carboxin 37.5% + Thiram 37.5%	DS	Black scurf	1.87 gm/ kg seed	2.5 gm/kg seed
33	Metalaxy l 8% + Mancozeb 64%	WP	Late blight	1800 or 0.18%	2500 or 0.25%
34	Captan 70% + Hexaconazole 5%	WP	Fruit rot, Anthracnose Early & Late blight	375-750	500-1000
35	Cymoxanil 8% + Mancozeb 64%	WP	Late blight Downy mildew	1080	1500
36	Metalaxyl M 4% + Mancozeb 64%	WP	Late blight	0.17 % or1700	0.25% or 2500
37	Famoxadone 16.6% + Cymoxanil 2.1%	SC	Early and Late Blight	210	500
38	Fenamidone 10% + Mancozeb 50%	WDG	Late blight	125 + 625-150 + 750	1250-1500

Sl No	Common name	Strength and Formulation	Target Disease	Dosage /Ha	
				a.i (g)	Formu-lation (g/ml)
39	Carbendazim 25% + Mancozeb 50%	WS	Late blight Black scurf	(1.5 + 3.0) to (1.75 + 3.5) For 10 kg of seed	6 - 7
40	Metiram 55% + Pyraclostrobin 5%	WG	Late blight	900-1050	1500 - 1750

(Source: CIB & RC)

(G) Herbicides approved for use in agriculture

	Name of Herbicide	Strength and Formulation	Approved crop	Dosage /ha			Waiting Period (days)
				a.i	Formulation	Dilution in water (Litre)	
1	Alachlor	50% EC	Cotton	2-2.5 kg	4-5 l	250-500	210-240
			Maize	2.5 kg	5 l	250-500	90
			Groundnut	2.5 kg	5 l	250-500	120-150
			Soybean	2.5 kg	5 l	250-500	90
		10% GR	Cotton	2.0-2.5 kg	20-25 kg	-	-
			Maize / Groundnut / Soybean	1.5-2.5 kg	15-25 kg	-	-
2	Anilofos	30% EC	Soybean	1.25-1.5 kg	4.20-5.0 l	500	100-120
		18% EC	-	0.30-0.45 kg	1.66-2.5 kg	500-600	-
		2 % G	-	0.4-0.5 kg	20-25 kg	-	30
		24%+ 2,4-D ethyl Ester 32% EC	-	(0.24+ 0.32)	1-1.5 l	300	90
3	Atrazine	50% WP	Maize	0.5-1.0 kg	1-2 kg	500-700	-
			Sugarcane	0.5-2.0kg	1-4 kg	500-700	-
4	Carfentrazone- ethyl	40% DF	Wheat	20 g	50 g	400	80
5	Chlorimuron- ethyl	25% WP	Soybean	9 g	36 g	300 l. + Surfactant 0.2 % (Iso-octylhenoxyl-poloxethanol 12.5 %)	45

	Name of Herbicide	Strength and Formulation	Approved crop	Dosage /ha			Waiting Period (days)
				a.i	Formulation	Dilution in water (Litre)	
6	Clodinafop-propargyl	15% WP	Wheat	60g	400 g	375-400	110
7	Clomazone	50%EC	Soybean	0.75-1.00 kg	1.5-2.0 l	500-600	90
8	2,4-D Dimethyl-	58% WSC	Maize	0.5 kg	2.6 l	400-500	50-60
	amine salt		Wheat	0.5-0.75 kg	1.25-1.87 l	500-600	-
			Sorghum	1.8 kg	2.5 l	500-600	-
			Potato	2.0 kg	4.0 l	400	-
			Sugarcane	3.5	5.0 l	500	-
			Non crop area	2.65 kg	6.0 l	300-400	15-20
9	2,4-D Sodium salt Technical	(80% minimum) (Earlier Registered as 80% WP)	Citrus	1.00-2.5 kg	1.25-2.05 kg	600	> 6 months
			Grapes	2.0	2.5 kg	500	> 90 days
			Maize	1.00 kg.	1.25 kg	500	120(Pre-em) 90(post-em)
			Sugarcane	2.0-2.6	2.5-3.25 ks	600-900	300
			Wheat	0.5-0.84 kg.	0.625-1.0 kg	500	90
			Non crop land	2.5-6.0 kg.	3.2-7.5 kg	600-1000	-
10	2,4-D EthylEster 38 %	(having 2,4-D	Maize	0.9 kg	2.65 l	400-450	50-60
		acid 34 %	Sorghum	1.0 kg	2.94 l	425	-
		w/w) EC	Wheat	0.45-0.75 kg	1.32-2.2 l	450-500	-
			Sugarcane	1.2 to 1.8	3.53- 5.29 l	500	300-330
11	Diclofop methyl	28% EC	Wheat	0.7-1.0 kg	2.5-3.5 l	500	90

	Name of Herbicide	Strength and Formulation	Approved crop	Dosage /ha			Waiting Period (days)
				a.i	Formulation	Dilution in water (Litre)	
12	Diuron	80% WP	Cotton	0.75-1.5 kg	1-2.2 kg.	625	-
			Banana	1.60 kg	2 kg.	625	-
			Rubber	1.6-3.2 kg	2-4 kg.	625	-
			Maize	0.8 kg	1.0 kg.	600	-
			Citrus	2-4.0 kg	2.5-5.0 kg	600	-
			Sugarcane	1.6-3.2kg	2.0-4.0 kg.	600	-
			Grapes	1.6 kg	2.0 kg.	625	-
13	Fluchloralin	45% EC	Cotton	0.9-1.2 kg	2.0-2.68 l	500-800	180
			Soybean	1.0-1.5kg.	2.22-3.33 l	500-800	120-150
14	Fenoxaprop-p-ethyl	9.3% w/w EC (9% w/v)	Soybean	100 g	1.11 l	250-300	100
		10% EC	Wheat	100-120 g	1.0-1.20 kg	250-300	110
15	Glyphosate	20.2% SL IPA salt	Non Crop area	0.82-1.23 kg	4.1-6.15 l	400-500	N/A
		41% SL IPASalt	Tea	0.820-1.230 kg	2.0-3.0 l	450	21
		54% SL (IPASalt)	Non Crop Area	1.8 kg	3.33 l	400-500	-
16	Glyphosate Ammonium Salt	5% SL	Tea	1.5 kg.	30 l	500	7 days
			Non Crop area	2 kg.	40 l	500	-
		71% SG	Tea & Non Crop area	2.13 kg	3.0 kg.	500	7

	Name of Herbicide	Strength and Formulation	Approved crop	Dosage /ha			Waiting Period (days)
				a.i	Formulation	Dilution in water (Litre)	
17	Gulfosinate Ammonium	13.5% SL (15% w/v)	Tea	0.375-0.500 kg	2.5-3.3 l	375-500	15
18	Hexazinone	13.2% +Diuron 46.8 % WP	Sugarcane	1200 g (264 + 936)	2 kg	500	282-306
19	Isoproturon	50% WP	Wheat	1.0 kg	2.0 kg	750	-
		75% WP	Wheat	1.0 kg	1.33 kg.	750	60 days
20	Imazethapyr	10% SL	Soybean	100 gm	1.0 l	500-600	75
			Groundnut	100-150 gm	1.0-1.5 l	500-700	90
21	Linuron	50% WP	Pea	0.625-1.0 kg	1.25-2.0 kg	500	80-90
22	MCPA, Amine salt	40% WSC	Wheat	1.0 kg	2.5 kg	300-600	-
23	Metolachlor	50% EC	Soybean	1.0 kg	2.0 l	600-750	-
24	Mesosulfuron Methyl	3% + Iodosulfuron Methyl Sodium 0.6% WG	Wheat	(12+2.4 g)	400 ml.	400-500 + Surfactant (Genopol LRO fluid) @ 500 ml/ha	96
		20% WP	Wheat	4 g	20 g	500-600 + Surfactant (Iso-Octyl Phenoxyl-Poloxethanol 12.5%) @ 500 ml/ha	80

	Name of Herbicide	Strength and Formulation	Approved crop	Dosage /ha			Waiting Period (days)
				a.i	Formulation	Dilution in water (Litre)	
		20% WG	Wheat	4 g	20 g	500-600+ Surfactant (Iso-Octyl Phenoxyl-Poloxethanol 12.5%) @ 0.2%	76
25	Methabenzthiazuron	70% WP	Wheat (PE – 2 DAS)	1.05-1.4 kg	1.5-2.0 kg.	700-1000	100
			Wheat (Post – EM 30 DAS)	1.05-1.75 kg	2.0-2.5 kg.	700-1000	100
			Wheat (Early POE. 16-18 DAS)	0.7-0.87 kg	1.0-1.25 kg	700-1000	100
26	Metribuzin	70% WP	Soybean	0.35-0.525 kg	0.5-0.75 kg.	750-1000	30
			Wheat	0.175- 0.21 kg	0.25-0.30 kg	500-750	120
27	Oxyflorfen	23.5% EC	Tea	150-250 g	650-1000g	500-750	15 days
			Onion	100-200 g	425-850 g	500-750	-
			Potato	100-200 g	425-850 g	500-750	-
			Groundnut	100-200 g	425-850 g	500-750	-
28	Oxadiargyl	6 % EC	Cumin	60-75g	1.0-1.25 l	500	87
29	Pendimethalin	30% EC	Wheat	Light soil-1.0 kg	3.3 l	500 -700	-
			Cotton	0.75-1.25kg	2.5-4.165 l	500-700	150

	Name of Herbicide	Strength and Formulation	Approved crop	Dosage /ha			Waiting Period (days)
				a.i	Formulation	Dilution in water (Litre)	
			Soybean	0.75-1.0 kg	2.5-3.3 l	500-700	100
			Groundnut	0.75-1.5 kg	2.5-5.0 l	500-700	120
			Chillies	1.0-1.25 kg	2.5-4.16 l	500-700	15
			Onion	0.75-1.0	2.5-3.3 l	500-700	15
		38.7% CS	Soybean	580.5- 677.25 g	1500-1750 ml	500	40
		30%+ Imazethapyr 2% EC	Soybean	(750+50) to (900+60) g	2.5-3.0 l	500-600	90
30	Paraquatdichloride	24% SL	Tea	0.2-1.0 kg	1.0-5.0 l	200-400	90-120
			Potato	0.5 kg	2.5 l	500	40-60
			Cotton	0.3-0.5 kg	1.5-2.5 l	500	150-180
			Rubber	0.3-0.5 kg	1.5-2.5 l	670	40-60
			Wheat	1.0 kg	5.0 l	500	120-150
			Maize	0.2-0.5 kg	1.0-2.5 l	500	90-120
			Grape	0.5 kg.	2.5 l	500	20-30
			Apple	0.75 kg	3.75 l	700-1000	60-90
31	Pyrithiobac Sodium	10% EC	Cotton	62.5-75 g	625-750 ml	500	160
32	Quizalofop ethyl	5% EC	Soybean	37.5-50 g	0.75-1.0 l	500-600	95
		4.41% EC	Soybean	30-40 g	750-1000 ml	400	30

	Name of Herbicide	Strength and Formulation	Approved crop	Dosage /ha			Waiting Period (days)
				a.i	Formulation	Dilution in water (Litre)	
33	Sulfosulfuron	75% WG	Wheat	25 g	33.3 kg	200-250 gm + cationic surfactant 500 ml/ha	110
		75%+ Metsulfuron Methyl 5%WG	Wheat	(30+2 g)	40 g	250-500 + surfactant 1250 ml/ha	110
34	Triallate	50% EC	Wheat	1.25 kg	2.5 kg.	250-500	150

(Source: CIB &RC)

(H) Plant growth regulators (PGR) approved for use in vegetable crops

	Name of PGR	Approved crop	Time of application	Dose		
				a.i (ppm/g)	Formulation (g/ml)	Dilution in water (Litre)
1	Alpha Naphthyl Acetic Acid 4.5% SL	Tomato	At the time of flowering. Two spray.	45ppm	-	-
		Chillies	Ist spray during flowering & 2nd spray 20 -30 days later	10 ppm	-	-
2	Chlormequat Chloride 50% SL	Brinjal	Before sowing, seed soaking for 24 hours.	50 ppm	-	-
3	Ethephon 39% SL	Tomato	For uniform ripening post harvest dip treatment on fruits	2500 ppm	-	-
4	Gibberellic Acid (Technical)	Brinjal	a) seed treatment (dipping) b) When 4 weeks old - weekly spray	10 ppm 50 ppm	-	-
5	Gibberellic Acid 0.001% L	Tomato / Cabbage/ Cauliflower	a) First spray 45 DAS b) Second spray 65 DAS	0.018g	180 ml.	450-500
		Brinjal, Bhindi	a)First spray 34 DAP b)Second spray 70 DAP c)Third spary 105 DAP	0.045 g	450 ml.	450-500
6	Triacontano l0.05% EC	Chilli	Three sprays at 25, 45 and 65 days after planting	0.125 g	0.25 l	400-500
		Tomato	Three sprays at 25, 45 and 65 days after planting	0.125 g	0.25 l	400-500

	Name of PGR	Approved crop	Time of application	Dose		
				a.i (ppm/g)	Formulation (g/ml)	Dilution in water (Litre)
7	Triacontanol 0.05%w/w min. GR	Chilli	Broadcast & mix the desired quantity of granules in soil 2-3 days before sowing.	12.5 g	25 kg.	-
		Tomato	Broadcast & mix the desired quantity of granules in soil 2-3 days before sowing.	12.5 g	25 kg.	-
8	Triacontanol 0.1% EW.	Chilli	Three sprays at 25, 45 and 65 days after planting	025 g	0.25 l	400-500
		Tomato	Three sprays at 25, 45 and 65 days after planting	025 g	0.25 l	400-500

(Source: CIB & RC)

(I) Biopesticides for use in vegetable pest control

(i) Microbial biopesticides currently used in vegetable pest management in India

Biopesticides	Target Insects / Diseases	Crops
Microbial Insecticides		
Bacillus thuringiensis	*Plutella xylostella*	Cruciferous crops
	Helicoverpa armigera	Tomato, Pulses
	Leucinodes orbonalis	Brinjal
	Earias vitella	Okra
	Diaphania indica	Gherkins
Nuclear polyhedrosis virus	*H. armigera*	Legumes, Tomato, Cole crops, Okra
	Spodoptera litura	Tobacco, Cabbage, Soybean, Tomato
Nomuraea rileyi	*Helicoverpa armigera*	Tomato, Cole crops
	Spodoptera litura	
	Trichoplusia ni	
Verticillium lecanii	Whiteflies, Mealybugs	Vegetables
Paecilomyces lilacinus	Nematodes	Vegetables
Metarhizium anisopliae	Root Grubs	Vegetables
Beauveria bassiana	White grubs, *P. xylostella*	Cole crops
Antagonist		
T. viride	Root rots	Cowpea, Black gram, Green gram
T. viride *T. harzianum* *P. fluorescens*	Damping off, Wilts, Root rots	Tomato, Brinjal, Beans, Chillies, Cabbage, Carrot
T. harzianum, T. viride	Root rot	Soybean

(Source: Rabindra, R.J., 2005)

(ii) Biopesticides and their formulations registered for use in India

	Common name	Formulations
Microbial Pesticides		
1.	*Bacillus thuringiensis var. kurstaki*	2% WP, 2.5% AS
	a) Serotype H-3a, strain A-97	35 WP
	b) Serotype (3a,3b,3c) Strain DOR Bt-1,	0.5% *WP*
	c) Serotype (3a,3b) Strain HD-1,	3.5% ES
	d) Serotype (3a,3b) Strain Z-52	
2.	*Bacillus thuringiensis var. galleriae, Serotype 3a,3b, strain R1539m*	1.3% FC
3.	*Bacillus thuringiensis var. israelensis*	
	a) *Serotype H-14, strain 164*	
	b) *Serotype H-14, strain VCRC B-17*	Slow release granules
	c) *Serotype H-14, strain VCRC B-17*	WP
	d) *Serotype H-14, 12*	AS
	e) *Serotype H-14, strain VCRC B-17*	5 AS
4.	*Bacillus sphaericus* Serotype 5a, 5b, Strain 1593 m	1.3% FC
5.	*Beauveria bassiana*	1% WP, 1.15% WP, 2.15% WP, 10% SC, 1.5% WP, 5% WP
6.	*Trichoderma viride*	1% WP, 0.5% WS, 1.5% WP, 0.5% WP
7.	*Trichoderma harzianum*	1% WP, 2% WP, 0.5% WS
8.	*Pseudomonas fluoresens*	0.5% WP, 1.0% WP, 1.25% WP, 1.5% WP, 1.25% WP
9.	*Verticillum lecanii*	1.15% WP
10.	NPV of *Helicoverpa armigera*	0.43% AS, 0.5% AS, 0.64% AS, 1.0% AS, 2% AS
11.	NPV of *Spodoptera litura*	0.5% AS
12.	*Metarrhizium anisopliae*	1.0% WP, 1.15% WP
13.	*Verticillium chlamydosporium*	1% WP
14.	*Paecilomyces lilacinus*	0.5% WP, 1.15% WP, 1.0% WP
15	*Ampelomyces quisqalis*	2% WP
16.	*Bacillus subtilis*	1.5% AS

Common name	Formulations
Botanical Pesticides	
17. Azadirachtin	0.03% EC, 0.3%, 0.1% EC, 0.15% EC, 1% EC, 1%, 2.5%, 25%
18. Pyrethrum/Pyrethrin	0.2% Aerosol, 0.4% Mat, 0.3% Agarbatti, 0.2% Coil, 0.05% Spray, 25% Extract, 0.2% DP, 0.2% PH, 2% EC & 2.5% EC

(Source: CIB &RC)

(iii) List of biopesticides included in the schedule of the Insecticide Act, 1968

Microbial Insecticides

1. *Bacillus* species
2. *Bacillus subtilis*
3. *Gliocadium* species
4. *Pseudomonas* species
5. *Trichoderma* species
6. *Beauveria bassiana*
7. *Metarrhizium anisopliae*
8. *Nomuraea rileyi*
9. *Verticileum lecani*
10. *Granulosis viruses* (GV)
11. *Nuclear polyhedrosis viruses* (NPV)
12. *Verticillium chlamydosporium*
13. *Streptomyces griseoviridis*
14. *Streptomyces lydicus*
15. *Ampelomyces quisqualis*
16. *Candida oleophila*

17. *Fusarium oxysporum* (non pathogenic)
18. *Burkholderia cepacia*
19. *Coniotyrium minitans*
20. *Agrobacterium radiobacter* strain 84
21. *Agrobacterium tumefaciens*
22. *Pythium oligandrum*
23. *Erwinia amylovora* (hairpin protein)
24. *Phlebia gigantean*
25. *Paecilomyces lilacinus*
26. *Penicillium islanidicum* (for groundnut)
27. *Alcaligenes* sp.
28. *Chaetomium globosum*
29. *Aspergillus niger* – strain AN27
30. VAM – *Vesicular arbuscular mycorrihiza*
31. *Myrothecium verrucaria*
32. *Photorhabdus luminescences akhurustii* strain K-1
33. *Serratia marcescens* GPS 5 (Bacteria)
34. *Hirsutella* sp

Botanical Insecticides

35. *Piriformospora indica*
36. Pyrethrins (Pyrethrum)
37. Neem products
38. Karanjin
39. Extracts of Cymbopogan species
40. Oxymatrine

41. Reduced Azadirachtin (s)
42. Triptericium of wilfordii Hook GTW – Plant extract
43. Bitterbarkomycin
44. Squamocin
45. Eucalyptus leaf extract

(iv) Field recommendations of Neem based insecticides for vegetable crops

	Name	Crop	Target Pests	Formulation (Dose/ha.)
1.	Azadirachtin	Cow pea	Pod Borer	1.6-2.0 l
	0.03% (300 ppm)	Okra	Fruit & Shoot Borer, Jassids, Aphids, Leaf Folder	1.25-4.5 l
		Cauliflower	Diamond back moth (DBM)	1.25-2.0 l
		Cabbage	DBM, Aphids	0.80-2.5 l
		Tomato	Whitefly	2.5 l
		Field bean	Pod borer, Aphids	0.8-1.5 l
2.	Azadirachtin	Okra	Aphids, Jassids	1-2 l
	0.15% (1500 ppm)	Cabbage	Aphids, DBM	2-2.5 l
		Tomato	Fruit borer and Whitefly	3.25 l
		Field bean	Pod borer	2 l
3.	Azadirachtin 0.3% (3000 ppm)	Cabbage	DBM	1.67 – 3.34 l
4.	Azadirachtin 5% (50000 ppm)	Cauliflower	DBM, Aphids, *Spodoptera litura*	0.2 l
		Okra	Whitefly, Jassids, Aphids and Shoot and Fruit borer	0.2 l

(Source: Pawar, 2001)

(v) Field recommendations of *Bacillus* based bio pesticides

	Name	Crop	Target Pests	Formulation (Dose/ha.)
1.	*Bacillus thuringiensis var. kurstaki, 3a, 3b, SA-II* WG	Cabbage & Cauliflower	Diamond back moth (DBM)	0.5 kg/ha.
2.	*Bacillus thuringiensis var. kurstaki, BMPn 123 (2x)* WDG, *3a, 3b*	Brinjal	Shoot and fruit borer	0.25-0.5 kg/ha
3.	*Bacillus thuringiensis var. kurstaki, HPWP*	Cabbage, Cauliflower	DBM	300-500 g/ha
4.	*Bacillus thuringiensis var. galleriae Serotype, 3a, 3b,*	Cabbage, Cauliflower	DBM	0.60- 1.0 l/ha
		Tomato	Fruit borer	1 – 1.5 l/ha
		Okra	Fruit and shoot borer	1 – 1.5 l/ha
5.	*Bacillus thuringiensis var. kurstaki, strain Z-523, serotype H3a, 3b*	Okra	Fruit and shoot borer	0.4-1.0 kg
6.	*Bacillus thuringiensis var. kurstaki,* WP	Soybean	*Spodoptera litura, Spilosoma,* Semilooper, leaf miner	0.75-1.0 kg/ha
		Legumes	Pod borer	0.75-1.0 kg/ha

(Source: Pawar, 2001)

(J) Approved pesticides for controlling termites, storage insect pests and rodents

(i) Insecticides for protecting buildings from termites

S.N	Insecticides	Dosage
1	Chlorpyriphos 50% EC	50 ml in 5 litre water
2	Ethion 50% EC	50 ml in 5 litre water
3	Imidacloprid 30.50% SC	10.5 ml in 5 litre water
4	Lindane 20% EC	250 ml in 5 litre water

(ii) Insecticides to control termites in agricultural crops

S.N.	Insecticide	Formulations
1.	Chlorpyriphos	20% EC
2.	Endosulfan	35% EC, 4% DP
3.	Imidacloprid	17.8% SL

(iii) Insecticides for the control of stored grain pests

S.N.	Insecticides
1	Aluminium Phosphide 56% m/m*
2	Aluminium Phosphide 15% Tablet*
3	Deltamethrin 2.5% WP
4	Lindane 6.5% WP
5	Methyl Bromide Technical*
6	Methyl Bromide 98% + Chloropicrin 2% w/w Fumigant

*To be used by Govt. approved agencies under expert supervision only

(iv) Rodenticides for rodent control in field and house/ godown

S.N	Rodenticides	Formulations
1	Bromadiolone	0.005% RB
2	Bromadiolone	0.25% CB
3	Coumatetralyl	0.0375% Bait
4	Warfarin	0.5% (HH)
5	Warfarin	0.025% w/w
6	Zinc Phosphide	Technical
7	Zinc Phosphide	2% RB

(Source: CIB & RC)

4. Label Claim of Pesticides in Different Vegetable Crops

Tomato

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
Insecticides							
1	Azadirachtin	1%	Fruit borer	-	1000-1500	500	3
2	Azadirachtin	5%	Aphids Whitefly Fruit borer	-	200	400	5
3	Carbofuran	3 % G	Whitefly	1200	40000	-	-
4	Chlorantranilprole	18.5% SC	Fruit borer	30	150	500	3
5	Dimethoate	30% EC	Whitefly	300	990	500-1000	
6	Imidacloprid	17.8 % SL	Whitefly	30-35	150-175	500	3
7	Indoxacarb	14.5% SC	Fruit borer	60-75	400-500	300-600	5
8	Lambda Cyhalothrin	5 % EC	Fruit borer	15	300	400-600	4
9	Malathion	50% EC	Whitefly	750	1500	500-1000	
10	Methomyl	40 % SP	Pod borer	300-450	750-1125	500-1000	5-6
11	Novaluron	10% EC	Fruit borer	75	750	500-100	1-3
12	NPV of *H armigera*	0.43 % AS	*Helicoverpa armigera*		1500	400-600	-
		2.0 % AS	*H.armigera*		250-500	500	-

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
13	Oxydemeton methyl	25% EC	Whitefly	250	1000	500-1000	-
14	Phorate	10% G	Whitefly	1500	15000	-	-
15	Phosalone	35 % EC	Fruit borer	450	1285	500-1000	-
16	Quinalphos	20 % AF	Fruit borer	300-350	1500-1750-	750-1000	7
		25 % EC	Fruit borer	250	1000	500-1000	-
17	Thiamethoxam	25% WG	Whitefly	50	200	500	5
18	Trichloforon	5% GR	Fruit borer	500-750	-	-	-
		5% Dust	Fruit borer	500-750	-	-	-
		50% EC	Fruit borer	500-750	-	-	-
Fungicides							
19.	Azoxystrobin	23% SC	Early/ Late Powdery mildew	125 g	500 g	500	3
20.	Copper Sulphate	2.62% SC	Early/Late blight		1.0 l	500	3 days
		75% WP	Damping off (Nursery)	0.25%	2500 g	1000 Soil drenching the nursery	NA
			Early & Late blight	1250 g	1667 g	1000	6
		75% WS	Damping off (soil drench)	15-25 gm per kg seed	20-30 g per kg seed	1	-
		50% WP	Early & Late blight	1250 g	2.5 kg	750-1000	

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
21.	Iprodione	50% WP	Early blight	0.75 kg	1.5 kg	500	15
22.	Kresoxim-methyl	44.3% SC	Early blight	30- 37.5 ml 0.03- 0.037%	1000-1250 g	500-600	03
23.	Kitazin	48% EC	Early blight	0.10% or 100 gram in 100 l. of water	0.20% or 200 ml in 200 l. of water	As required depending upon crop stage and plant protection equipment used	5
24.	Mancozeb	75% WG	Early Blight	750 gm	1000 gm	500 l	5-6
		35% SC	Early & Late blight	0.175% or 175gm/100 l water	0.5% or 500 gm/100 lwater	500 l water or as required depending upon crop stage	10
		75% WP	Late blight, Buck eye Rot, Leaf spot	1.125-1.5 kg	1.5-2 kg	750 l	-
25.	Metarim	70% WG	Alternaria blight	1750 g	2500 g	500-750 l	6

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
26.	Propineb	70% WP	Buck eye rot	0.21% or 210 g/100 l water	0.30% or 300 g/100 l water	As required depending upon crop stage and plant protection equipment used	10
27.	Pyraclostrobin	20% WG	Early blight	75-100 g	375-500 g	500	3
28.	Streptomycin Sulphate + Tetracylin Hydrocloride	9%+1% SP	Bacterial leaf spot	-	Spray seedlings with streptocycline 40 to 100 ppm solution in seed beds and fields after the appearance of first true leaves. Two sprays of streptocycline, one before transplanting and another after, are effective for controlling the disease.		
29.	Thiophenate Methyl	70% WP	Ring rot	500 g	715 g	750-1000	7
30.	Ziram	80% WP	Early blight	1.2-1.6 kg	1.5-2.0 kg	750-1000	3
31.	Zineb	75% WP	Early & Late blight Grey leaf mould	1.125- 1.5 kg	1.5-2 kg	750-1000 l	
32.	Cymoxanil 8% + Mancozeb 64%	WP	Late blight	1080 g	1500 g	500-750 l	10 days
33.	Famoxadone 16.6% + Cymoxanil 22.1%	SC	Early and Late Blight	210	500	500	3

(Source: CIB& RC) * PHI: Pre-Harvest Interval

Brinjal

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
Insecticides							
1	Azadirachtin	1%	FSB**	-	1000-1500	500	3
2	Azadirachtin	0.03%	FSB, Beetles	-	2500-5000	500	7
3	Carbofuran	3 % G	Nematodes	2000	66600	-	-
4	Chlorantranilprole	18.5% SC	FSB	40	200	500-750	22
5	Chloropyrifos	20% EC	FSB	200	1000	500-1000	-
6	Cypermethrin	0.25 % DP	FSB	50-60	2000-2400	500-750	3
		10 % EC	FSB	50-70	550-760	150-400	3
		25 % EC	FSB, Epilachna beetle	37-50	150-200	500	1
7	Dicofol	18..5 % EC	Mite	250-500	1350-2700	500-1000	15-20
8	Difenthiuron	50 % WP	Whitefly	300	600	500-750	3
9	Dimethoate	30% EC	Jassids	600	1980		
			FSB	200	660	500-100	-
10	Emamectin benzoate	5 % SG	FSB	10	200	500	3
11	Fenzaquin	10 % EC	Mites	125	1250	500	7
12	Fenpropathrin	30 % EC	Whitefly, FSB,Mites	75-100	250-340	750-1000	10

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
13	Fenvalerate	20 %EC	FSB	75-100	375-500	500-750	5
14	Flumite/ Flufenzine	20 % SC	Mites	80-100	400-500	500-1000	5
15	Lambda-Cyhalothrin	5 % EC	FSB	15	300	500	4
		4.9 % CS	FSB	15	300	500	5
16	Malathion	50% EC	Mites	750	1500	500-1000	-
17	Phorate	10% G	Jassids Aphids Mites Thrips	1500	15000	-	-
18	Phosalone	35 % EC	FSB	500	1428	500-1000	-
19	Phosphomidon	40% SL	Jassids Aphid Whitefly	250-30	625-750	500	10
20	Quinalphos	20 % AF	FSB, Jassids, Epilachnna beetle	300-350	1500-1750	750-100	7
		25 % EC	FSB, Leaf hopper	250 375	1500 1000	500-1000	-
21	Spiromesifen	22.9% SC	Red spider mite	96	400	500	5
22	Thiodicarb	75% WP	FSB	470-750	625-1000	500	6
23	Thiamethoxam	25% WG	Whiteflies	50	200	500	3

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
24	Thiameton	25 % EC	Aphids, Jassids, FSB	250	1000	750-1000	-
25	Trichloforon	5% G, 5% Dust 50% EC	FSB	-	500-750 500 500	-	-
26	Triazophos	40% EC	FSB, Epilachna beetle	500	1250	500	5
27	Deltamethrin + Triazopphos	1 % + 35 % EC	FSB, Epilachana beettle	-	1000-1250	-	21
Fungicides							
29.	Benomyl	50% WP	Powdery mildew	100 g	200 g	600	-
30.	Carbendazim	50% WP	Leaf spot, Fruit rot	150 g	300 g	600	-
31.	Captan	75% WP	Damping off in Nursery	0.25%	2500 g	1000 Soil drench in the nursery	-
32.	Zineb	75% WP	Blight	1.125-1.5 kg	1.5-2 kg	750-1000	-

(Source: CIB& RC) * PHI: Pre Harvest Interval; **FSB-Fruit & shoot borer

Chilli

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
Insecticides							
1	Acetamiprid	20% SC	Thrips	10-20	50-100	500-600	3
2	Buprofezin	25 % SC	Yellow mite	75-150	300-600	500-750	5
3	Carbofuran	3 % G	Thrips	1000	33300	-	-
4	Carbosulfan	25 % EC	Whitefly, Aphids	200-250	800-1000	500-1000	8
5	Chlorfenpyre	10 % SC	Yellow mite	75-100	750-1000	500	5
6	Deltamethrin	2.8 % EC	Fruit borer	10-12.5	400-600	400-600	5
7	Difenthiuron	50 % WP	Mites	300	600	500-750	3
8	Dimethoate	30% EC	Mites, Thrips	300200	990660	500-1000	-
9	Emamectin benzoate	5 % SG	Fruit borer, Thrips, mite	10	200	500	3
10	Endosulfan	35 % EC	Aphids	140	400	500-1000	21
11	Ethion	50 % EC	Mite, Thrips	750-1000	1500-2000	500-1000	05
12	Fenazaquin	10 % EC	Yellow mite	125	1250	400-600	10
13	Fenpropathrin	30 % EC	Thrips, Whitefly, Mites	75-100	250-340	750-1000	7
14	Fenpyroximate	5 % EC	Yellow mite	15-30	300-600	300-500	7
15	Fipronil	5 % SC	Fruit borer, Thrips, Aphids	40-50	800-100	500	7

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water (Litre)	
16	Flubendamide	39.35 % SC	Fruit borer	48-60	100-125	500	7
17	Hexythiazox	5.45 % EC	Yellow mite	15-25	300-500	625	3
18	Imidacloprid	70 % WS	Jassids, Aphids, Thrips	700-1050 (per 100 kg seed)	500-1000	-	-
		17.8 % SL	Jassid, Aphid, Thrips	25-20	125-250	500-700	40
19	Indoxacarb	14.5% SC	Fruit borer	50-60	333-400	300-600	5
20	Lambda Cyhalothrin	5 % EC	Thrips, Mite, Pod borer	15	300	400-600	5
21	Methomyl	40 % SP	Pod borer, Thrips	300-450	750-1125	500-1000	5-6
22	Milebemectin	1 % EC	Mites	3.25	325	500	7
23	Novaluron	10% EC	Fruit borer, Tobacco caterpillar	33.5	375	500	3
24	Oxydemeton methyl	25% EC	Aphids Mites Thrips	400 500 250	1600 2000 1000	500-1000	-
25	Phorate	10% GR	Aphids, Mites, Thrips	1000	10000	-	-
26	Phosalone	35 % EC	Aphid, Mite, Thrips	700 450 700	2000 1285 2000	500-1000	-
27	Propargite	57%EC	Mite	850	1500	500-625	7
28	Quinalphos	25% Gel	Aphids	250	100	500-1000	-

	Common Name	Strength and formulation	Target Pests	Dose /Ha a.i (g)	Dose /Ha Formulation (g/ml)	Dose /Ha Dilution in water	Waiting Period / PHI* (days)
		25% EC	Aphid, Mite	250 375	1000 1500	500-1000	-
29	Spinosad	45% SC	Fruit borer	73	160	500	3
30	Spiromesifen	22.9% SC	Yellow mite	96	400	500-750	7
31	Thiacloprid	21.7% SC	Thrips	54-72	225-300	500	5
32	Thiodicarb	75% WP	Fruitbore	470-750	625-500	500	6
33	Indoxacarb + Acetamiprid	14.5 % + 7.7 % SC	Thrips,Fruit borer	88.8-111	400-500	500	5
Fungicides							
34	Azoxystrobin	23% SC	Fruit rot, Powdery mildew	125 g	500 g	500 - 750	5
35	Benomyl	50% WP	Powdery mildew Fruit rot, Leaf spot	100 g	200 g	600	-
36	Copper Sulphate	2.62% SC	Fruit rot, anthracnose		1.0 l	500	3
37	Captan	50% WG	Fruit rot & anthracnose	750 g	1500 g	500	5
		75% WP	Damping off in nursery	0.25%	2500 g	1000 Soil drench	-
			Early blight	1250 g	1667 g	1000	8
		75% WS	Damping off (soil drench)	15-25 gm per kg seed	20-30 g per kg seed	1	

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water	
38	Copper Hydroxide	77% WP	Anthraconse, Cercospora leaf spot	625 g	1250 g	500	-
39	Chlorothalonil	75% WP	Fruit rot	600 g	800 g	750	10
40	Difenoconazole	25% EC	Die-back Fruit rot	0.0125% or 12.5g/ 100 l water	0.05% or 50ml/100 l water	500	15
41	Dinocap	48% EC	Powdery mildew	108 g	225 g	750	—
42	Fenarimol	12%EC	Powdery Mildew	0.005% (5g/100 l of water)	0.04ml (40 ml/100 l of water)	As required depending on stage of crop	15
43	Flusilazole	40% EC	Powdery Mildew	40-60g a.i/ ha	100-150 ml/ha	500	5
44	Hexaconazole	2% SC	Powdery mildew & Fruit rot	60 g	3.0 l	500	7
45	Kitazin	48% EC	Fruit rot dieback	0.10% or 100 g in 100 l of water	0.20% or 200 ml in 200 l of water	As required depending upon crops tage	3
46	Mancozeb	75% WP	Damping off	2.25 g	3 g (soildrench)	1	-
			Fruit rot, Leaf spot	1.125 kg	1.5-2 kg	750	-
47	Myclobutanil	10% WP	Leaf spot & die back	0.004%	0.04%	500	03

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water	
48	Propineb	70% WP	Die back	0.35% or 350 g/100 l water	0.5% or 500 gram/ 100 l water	As required depending upon crop stage	10
49	Sulphur	80% WP	Powdery mildew	2.5 kg	3.13 kg	750-1000	-
		52% SC	Powdery mildew	1.04 kg	2.00 l	400.00	-
50	Streptomycin Sulphate + Tetracyline Hydrocloride	9%+1% SP	Bacterial leaf spot	-	Spray seedlings with streptocycline 40 to 100 ppm solution in seed beds and fields after the appearance of first true leaves two sprays of streptocycline, one before transplanting and another after are effective for controlling the disease.		
51	Triadimefon	25% WP	Powdery mildew	38 g	0.150 kg	750	15
52	Tebuconazole	25.9% m/m EC	Fruit rot, Powdery mildew	0.125-0.1875 kg	0.50-0.75 kg	500	5
53	Zineb	75% WP	Fruit rot & Leaf spot	1.125- 1.5 kg	1.5-2 kg	750-1000	-
54	Captan + Hexaconazole	70%+5% WP	Fruit rot Anthracnose	375-750 g	500-1000 g	500	. 5

(Source: CIB& RC) * PHI: Pre Harvest Interval

Okra

	Common Name	Strength and formulation	Target Pests	Dose /Ha a.i (g)	Dose /Ha Formulation (g/ml)	Dose /Ha Dilution in water	Waiting Period / PHI* (days)
Insecticides							
1	Azadirachtin	0.03 %	FSB**, whiteflies, Jassids	-	2500-5000	500-1000	7
2	Azadirachtin	5%	FSB, Whiteflies Jassids, Aphids	-	200	400	5
3	Carbaryl	5% DP	Jassid	1000	20000	-	8
		10 % DP	FSB, Jassids	2500	25000	-	-
4	Carbofuran	3 % G	Aphids	1000	33300	-	-
5	Chlorantranilprole	18.5% SC	FSB	25	125	500	5
6	Cypermethrin	10 % EC	FSB	50-70	550-760	150-400	3
		25 % EC	FSB, Jassids	37-50	150-200	500	3
7	Deltamethrin	2.8 % EC	FSB, Jassids	10-15	400-600	400-600	1
8	Dicofol	18..5 % EC	Red spider mite	250-500	1350-2700	500-100	15-20
9	Dimethoate	30% EC	Aphid, Jassids	700 600	2310 1980	500-1000	-
10	Emamectin benzoate	5 % SG	FSB	6.75-8.5	135-170	500	5
11	Endosulfan	35 % EC	Aphids	140	400	500-1000	21
12	Fenpropathrin	30 % EC	Whitefly, FSB, Mites	75-100	250-340	750-1000	7
13	Fenvalerate	20 %EC	FSB	60-75	300-375	600-750	7
14	Imidacloprid	70% WG	Jassids, Aphids, Thrips	21-24.5	30-35	375-500	3

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water	
		48% FS	Jassids, Aphids	300-540 (per 100 kg seed)	500-900	-	-
		70% WS	Jassids, Aphids	350-700 (per 100 kg seed)	500-1000	-	-
		17.8 SL	Jassid, Aphid, Thrips	20	100	500	3
15	Lambda-Cyhalothrin	5% EC	Jassids, FSB	15	300	300-400	4
16	Malathion	50% EC	FSB, Aphid, Jassids	750 500 625	1500 1000 1250	500-1000	-
17	Oxydemeton-methyl	25% EC	Whitefly Jassids	250 400	1000 1600	500-1000	-
18	Permethrin	25 % EC	FSB, Aphids, Jassids	100-125	400-500	750-1000	-
19	Phosalone	35 % EC	FSB	525	1500	500-1000	-
20	Pyridalyl	10%EC	FSB	50-75	500-750	500-750	3
21	Quinalphos	20 % AF	FSB	250-300	1250-1500	750-1000	7
		25 % EC	FSB Jassids,Mite	250	1000	500-1000	-
22	Spiromesifen	22.9% SC	Red spider mite	96-120	400-500	500	3
23	Thiamethoxam	25% WG	Jassid, Aphid, Whitefly	25	100	500-1000	5
		70% WDG	Aphids	200	286	-	-
Fungicides							
24	Dinocap	48% EC	Powdery mildew	108 g	225 g	750	-
25	Sulphur	80% WP	Powdery mildew	2.5 kg	3.13 kg	750-1000 l	-

(Source: CIB& RC) * PHI: Pre Harvest Interval, **FSB- Fruit and shoot borer

Cucurbits

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water	
Insecticides							
1	Chlorantranilprole	18.5% SC	Fruit borers, Caterpillars	20-25	100-125	500	7
2	Dichlorvos	76% EC	Red pumpkin beetle	500	627	500-100	-
3	Dicofol	18..5 % EC	Red spider mite	250-500	1350-2700	500-100	15-20
4	Imidacloprid	70 % WG	Jassids, Aphids	24.5	35	500	5
5	Trichloforon	5% Gr	Red pumpkin beetle	500-750	-	-	-
		5% Dust	Red pumpkin beetle	500-750	-	-	-
		50% EC	Red pumpkin beetle	500-750	-	-	
Fungicides							
6	Benomyl	50% WP	Powdery Mildew, Anthracnose	100 g	200 g	600	-
7	Carbendazim	50% WP	Powdery mildew	150 g	300 g	600	
8	Thiophanate Methyl	70% WP	Powdery mildew, Anthracnose	1000 g	1430 g	750-1000	1
9	Zineb	75% WP	Downy mildew, Anthracnose, Leaf spot	1.125- 1.5 kg	1.5-2 kg	750-1000	-
10	Cymoxanil 8% + Mancozeb 64%	WP	Downy mildew	1080 g	1500 g	500-600	10

(Source: CIB& RC) * PHI: Pre Harvest Interval

Cruciferous vegetables (Cabbage & Cauliflower)

	Common Name	Strength and formulation	Target Pests	Dose /Ha a.i (g)	Dose /Ha Formulation (g/ml)	Dilution in water	Waiting Period / PHI* (days)
Insecticides							
1.	Acetamiprid	20 % SC	Aphids	15	75	500-600	7
2.	Azadirachtin	0.03 %	Aphids, DBM**	-	2500-5000	500-100	7
3.	Azadirachtin	5%	DBM, *Spodoptera*, Aphids	-	200	400	5
4.	*Bacillus thuringiensis* var. *kurstaki*	5% WP	DBM	25-50	500-1000	500-1000	-
5.	Carbaryl	5% DP	Borers	600	12000	-	8
		10 % DP	DBM,Armyworm	2500	25000	-	-
6.	Carbofuran	3 % G	Nematodes	1000	50000	-	-
7.	Chlorantranilprole	18.5% SC	DBM	10	50	500	3
8.	Chlorfenpyre	10 % SC	DBM	75-100	750-1000	500	7
9.	Chlorpyrifos	20% EC	DBM	400	2000	500-1000	
10.	Cypermethrin	10 % EC	DBM	60-70	650-760	100-400	7
11.	Difenthiuron	50 % WP	DBM	300	600	500-750	7
12.	Dimethoate	30% EC	Aphids, Bugs	200	660	500-1000	-
13.	Emamectin benzoate	5 % SG	DBM	7.5-10.0	150-200	500	3
14.	Fenvalerate	20 %EC	DBM, borer	60-75	300-375	600-750	7
15.	Fipronil	5 % SC	DBM	40-50	800-100	500	7
16.	Flufenoxuron	10 % DC	DBM	40	400	500-1000	7
17.	Indoxacarb	14.5% SC	DBM	30-40	200-266	400-750	7
		15.8 % SC	DBM	40	266	500-1000	5

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water	
18.	Lufenuron	5.4% EC	DBM	30	600	500	14
			DBM	30	600	500	5
19.	Malathion	50% EC	Aphids	750	1500	500-1000	-
			Head borer	750	1500	500-1000	-
20.	Metaflumizone	22 % SC	DBM	165-220	150-1000	500	3
21.	Novaluron	10% EC	DBM	75	750	500-1000	5
22.	Permethrin	25 %EC	DBM	50-125	200-500	750-1000	-
23.	Phorate	10% G	Aphids	2000	20000		
24.	Phosalone	35 % EC	Aphids	500	1428	500-1000	-
25.	Pyridalyl	10%EC	DBM	50-75	500-750	500-750	3
26.	Quinalphos	25 % EC	Aphid	250	1000	500-1000	-
			Head borer	500	2000		
27.	Spinosad	2.5% SC	DBM	15-17.5	600-700	500	3
28.	Trichloforon	5% G	DBM	500-750	-	-	-
		5% Dust	DBM	500-750	-	-	-
		50% EC	DBM	500-750	-	-	-
Fungicides							
29.	Captan	75% WP	Damping off (Nursery)	0.25%	2500 g	1000 Soil drench in nursery	-
		75% WS	Damping off (soil drench)	15-25 gm per kg seed	20-30 g per kg seed	-	-
30.	Mancozeb	75% WP	Collar rot	2.25 g	3 g	-	-
			Leaf spot	1.125 kg	1.5-2 kg	750	-
31.	Zineb	75% WP	Leaf spot	1.125-1.5 kg	1.5-2 kg	750-1000	-

(Source: CIB& RC) * PHI: Pre Harvest Interval, **DBM: Diamond back moth

Pea

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water	
1.	Benomyl	50% WP	Powdery mildew	100 g	200 g	600	2
2.	Carbendazim	50% WP	Powderymildew	125 g	250 g	600	-
3.	Fenarimol	12%EC	Powdery Mildew	0.005% (5g/100 l of water)	0.04ml% (40 ml/100 l of water)	As required depending on stage of crop	15
4.	Sulphur	80% WP	Rust	2.5 kg	3.13 kg	750-1000 l	-
		80% WG	Powdery mildew	1.50-2.00 kg	1.875-250 kg	750-1000 l	-
		40% WP	Powdery mildew	2.25-3.00 kg	5.65 kg	750-1000 l	-
		52% SC	Powdery mildew	1.04 kg	2.00 l	400.00 l	-
		85% DP	Rust, Powdery mildew	12.75-17 kg	15-20 kg	-	-
5.	Triadimefon	25% WP	Rust,Powdery mildew	0.025%	0.100%	750	25

(Source: CIB& RC) * PHI: Pre Harvest Interval

Legume vegetables

	Common Name	Strength and formulation	Target Pests	Dose /Ha			Waiting Period / PHI* (days)
				a.i (g)	Formulation (g/ml)	Dilution in water	
1.	Benomyl	50% WP	Powdery mildew	100 g	200 g	600	-
2.	Carbendazim	50% WP	Powdery mildew	175 g	350 g	750	-
3.	Captan	75% WP	Damping off in nursery	0.25%	2500 g	1000 for Soil drench	NA
4.	Dinocap	48% EC	Powdery mildew	108 g	225 g	750	-
5.	Lime Sulphur	22% SC	Rust	The Liquid is used at one per cent in conventional sprayers (Doses 2-5 l/ha)			-
6.	Sulphur	80% WP	Powdery mildew	2.5 kg	3.13 kg	750-1000 l	-
		80% WG	Powdery mildew	1.50-2.00 kg	1.875-250 kg	750-1000 l	-
		40% WP	Powdery mildew	2.25-3.00 kg	5.65 kg	750-1000 l	-
		85% DP	Powdery mildew	12.75-17 kg	15-20 kg	-	-
			Rust	12.75-17 kg	15-20 kg	-	-
7.	Streptomycin Sulphate + Tetracylin Hydrocloride	9%+1% SP	Halo blight	Spray Streptocycline 100 to 150 ppm solution thrice at interval of 7 days. For prevention apply first spray 10 days after emergence of leaf.			

(Source: CIB& RC), * PHI- Pre Harvest Interval

Approved alternatives for endosulfan in different vegetable crops

Crop	Insect pest	Alternate insecticides
Endosulfan 35% EC		
Okra	Aphid	Azadirachtin 5%, Carbofuran 3%CG, Dimethoate 30% EC, Imidacloprid 70% WG, 48% FS, 70% WS & 17.8% SL, Malathion 50% EC, Permethrin 25% EC, Thiamethoxam 70% WS
Chillies	Aphid	Carbosulfan 25% EC, Fipronil 5% SC, Imidacloprid 70% WS & 17.8% SL, Lambda cyhalothrin 5% EC, Oxydemeton methyl 25% EC, Phorate 10% CG, Phosalone 35% EC, Quinalphos 25% Gel, 25% EC & 1.5% DP
Endosulfan 4% DP		
Okra	Aphid, Jassid	Azadirachtin 5% Neem extract concentrate, Carbofuran 3% CG, Dimethoate 30% EC, Imidacloprid 70% WG, 48% FS, 70%WS & 17.8% SL, Lambda-cyhalothrin 5% EC, Malathion 50% EC, Permethrin 25% EC, Thiamethoxam 70% WS
Chillies	Aphid, Jassid	Imidacloprid 70%WS, Oxydemeton methyl 25%EC, Phorate 10%CG, Phosalone 35% EC, Quinalphos 25%EC & Gel
Endosulfan 2% DP		
Okra	Fruit and shoot borer	Azadirachtin 5% Neem ext, Carbaryl 10% DP, Cypermethrin 0.25 DP, 10% EC & 25% EC, Deltamethrin 2.8% EC, Emamectin benzoate 5% SG, Fenpropathrin 30% EC, Fenvalerate 20% EC, Malathion 50% EC, Permethrin 25% EC, Phosalone 35% EC, Pyridalyl 10% EC, Quinalphos 20% AF & 25% EC
Brinjal	Fruit and shoot borer	Azadirachtin 1% EC & 0.03% WSP, Chlorantraniliprole 18.5% SC, Chlorpyriphos 25% EC, Cypermethrin 0.25% DP & 25% EC, Dimethoate 30% EC Emamectin benzoate 5% SG, Fenpropathrin 30% EC, Fenvalerate 20% EC, Lambdacyhalothrin 5% EC, Phosalone 35% EC, Quinalphos 20% AF & 25% EC, Thiodicarb 75% WP, Thiometon 25% EC, Triazophos 40% EC, Trichlorofon 5% GR, Dust & 50% EC, Deltamethrin 1% + Triazophos 35% EC

(Source: CIB&RC)

5. Maximum Residue Limits (MRL) for Vegetable Crops

Pesticide residues are a major concern in fresh vegetables and their products for domestic consumption and export. Technically, pesticide residue in food is regulated using a set of quantitative standards called maximum residue limits (MRL). The MRL specifies the amount of pesticide residue that is allowed in food products. In India, The Ministry of Health and Family Welfare regulates MRLs of pesticides and agrochemicals in food products through the amended Prevention of Food Adulteration Act (PFA), 1955. However, with the implementation of Food Safety and Standards Act (FSSA), 2006, the PFA rules are being integrtaed into the Food Safety and Standards Regulations, 2010. The new act authorizes the Food Safety and Standards Authority of India (FSSAI) to specify the limits for use of food additives, crop contaminants, pesticide residues, residues of veterinary drugs, heavy metals, processing aids, mycotoxins, antibiotics, pharmacological active substances and irradiation of food. The existing MRLs on pesticides and agrochemicals specified in the PFA are incorporated in the Food Safety and Standards Regulations, 2010. MRLs are listed by chemical product for specific food item / commodity. In the absence of an established MRL, the Ministry of Health authorities generally reffer to FAO/WHO's Codex Alimentarius Commissions (CAC) MRLs, as long as the pesticide in question has not been banned. The Codex MRLs serve as the reference standards in international trade, but many industrialized countries use their own set of MRLs for import and domestic food products. The European Union (EU) MRLs are generally lower than USA MRLs, and often lower than Codex MRLs. For certain crops or pesticides, the differences between Codex MRL and the MRL from an industrialized country, as well as the MRL among industrialized countries can be substantially different. For easy reference the MRL values (Indian and Codex) of registered insecticides and fungicides as per CIB & RC for different vegetable crops are given in the tables 2 and 3.

Table 2. MRL for insecticides recommended for insect control in vegetables

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
1	Acetamiprid	20% SC	0.1 (Cabbage) 0.01(Chilli)	-
2	Buprofezin	25 % SC	0.01(Chilli)	0.7(Cucurbits) 1.0(Tomato) 10 (Peppers Chilli) 2 (Peppers)
3	Carbaryl	5% DP 10 % DP	10.0 (Okra & Leafy Vegetables) 5.0 (Chilli) 5.0 (Other Vegetables)	5.0(Tomatoes) 0.5(Pepper/Chilli)
4	Carbofuran	3 % G	0.10 (Fruits & Vegtables)	-
5	Carbosulfan	25 % EC	0.2 (Chilli)	0.6 (Fruiting Vegetables) 0.3 (Cucurbits) 20.0 (Leafy Vegetables)
6	Chlorantranilprole	18.5% SC	0.03 (Cabbage)	2 (Cole or Cabbage, Brassicas Vegetables) 0.6 (Fruiting vegetables other than cucurbits) 0.3 (Fruiting vegetables, Cucurbits) 20 (Leafy vegetables) 0.02 (Root and tuber vegetables)
7	Chlorfenpyre	10 % SC	0.05 (Cabbage) 0.05 (Chilli)	- -

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
8	Chlorfluazoron	5.4% EC		
9	Chlorpyrifos	20% EC	0.01(Cabbage) 0.2 (Other Vegetables)	1.0(Cabbage) 0.05(Cauliflower) 2.0 (Broccoli) 2.0(Peppers) 0.1(Carrot)
10	Cypermethrin	0.25 % DP 10 % EC 25 % EC	0.20(Brinjal) 2.0(Cabbage) 0.20(Okra)	0.03 (Brinjal) 1.0(Cabbage) 0.07(Fruiting cucurbit vegetables) 0.7 (Leafy Vegetables) 0.7(Legume Vegetables) 0.5 (Okra) 0.2 (Tomato) 2 (Peppers Chilli) 0.01 (Root and tuber vegetables)
11	Dazomet Technical	-	-	-
12	Deltamethrin	2.8 % EC	0.05 (Okra) 0.05(Tomato)	0.1 (Broccoli, Cabbage and Cauliflower) 0.2 (Fruiting vegetables, Cucurbits) 2 (Leafy vegetables) 0.2(Legume vegetables) 0.3 (Tomato)
13	Dichlorvos	76% EC	0.15(Cucurbits/Vegetables)	-

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
14	Dicofol	18..5 % EC	5.0 (Vegetables) 1.0(Chilli)	0.5 (Cucumber) 1.0 (Pepper and Chilli) 2 (Bean pods) 0.2 (Melons, except watermelon) 1 (Squash, summer)
15	Difenthiuron	50 % WP	1.0(Cabbage) 0.05 (Chilli) 1.0 (Brinjal)	-
16	Dimethoate	30% EC	0.5(Chilli) 2.0 (Fruits & Vegetables)	0.2(Cauliflower) 0.5(Sweet Pepper) 0.05 (Cabbage, Savoy) 1.0 (Peas - pods and succulent)
17	Emamectin benzoate	5 % SG	0.05 (Okra)	-
18	Endosulfan	2 % DP 35 % EC	2.0 (Fruits & Vegetables) 1.0 (Chilli)	1.0 (Cucumber) 0.1(Egg Plant) 0.5 (Tomato) 2 (Melons except watermelon) 0.5(Squash, summer)
19	Ethion	50 % EC	0.5 (Cucmber and squash) 1.0 (Other vegetables)	-
20	Fenazaquin	10 % EC	0.5(Chilli)	-
21	Fenpropathrin	30 % EC	0.2(Brinjal) 0.5(Okra) 0.2(Chilli)	0.2 (Egg plant) 0.2 (Gherkin) 1.0 (Tomato)

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
22	Fenpyroximate	5 % EC	1.0 (Chilli)	0.03 (Cucumber) 0.2 (Fruiting vegetables other than cucurbits) 0.05 (Melons, except watermelon)
23	Fenvalerate	20 %EC	2.0 (Cauliflower) 2.0 (Brinjal) 2.0 (Okra)	3.0 (Cabbage) 2.0(Cauliflower) 0.2(Cucumber) 0.5(Sweet Pepper) 1.0(Tomato) 2 (Broccoli) 0.2 (Melons, except watermelon) 0.05 (Root and tuber vegetables) 0.5 (Squash, summer) 0.5 (Winter squash)
24	Fipronil	5 % SC	0.001(Cabbage) 0.001(Chilli)	0.02 (Cabbage, Cauliflower and Brocooli)
25	Flubendamide	20 % WG 39.35 % SC	-	4 (Cabbage, Cole Vegetables) 0.2 (Fruiting vegetables, Cucurbits) 2 (Legume vegetables) 0.7 (Peppers) 2 (Tomato)
26	Flufenoxuron	10 % DC	-	-
27	Flumite/ Flufenzine	20 % SC	0.5 (Brinjal)	-

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
28	Hexythiazox	5.45 % EC	0.01 (Chilli)	0.1 (Egg plant) 0.05 (Fruiting vegetables, Cucurbits) 0.1 (Tomato)
29	Imidacloprid	48 % FS 70 % WS 17.8 % SL 70 % WG	-	2.0(Beans) 0.5(Cabbage/cauliflower/Brocoli) 1.0(Cucumber) 0.2(Brinjal) 0.2(Melons) 5.0(Pea Pods) 1.0 (Chilli/peppers) 0.5 (Tomato) 0.5 (Root and tuber vegetables) 1.0 (Squash, summer)
30	Indoxacarb	14.5% SC 15.8 % SC	0.1(Cabbage) 0.01(Chilli) 0.05(Tomato)	3 (Cabbage) 0.2(Cauliflower/Brocoli) 0.1(Cowpea) 0.5(Egg Plant) 0.5(cucumber) 0.5(Tomato) 0.3 (Peppers)
31	Lambda Cyhalothrin	5 % EC 4.9 % CS	0.2 (Brinjal) 0.1 (Tomato) 0.05 (Chilli) 2.0 (Okra)	-

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
32	Lufenuron	5.4% EC	0.3 (Cabbage) 0.1 (Cauliflower)	-
33	Malathion	50% EC	3.0 (Fruits & Vegetables)	1.0 (Beans) 0.2 (Cucumber) 0.1 (Pepper) 0.5 (Tomato) 3.0 (Spinach)
34	Metaflumizone	22 % SC	-	0.6 (Egg plant) 0.6 (Peppers) 0.6 (Tomato)
35	Metaldehyde	2.5 % Dust (Ready to use)	-	-
36	Methomyl	40 % SP	0.05(Tomato) 0.05(Chilli)	1.0 (Tomato) 1.0 (Beans) 0.7 (Chilli) 0.1 (Cucurbits) 5 (Peas- pods and succulent seeds)
37	Milebemectin	1 % EC	0.01(Chilli)	-
38	Novaluron	10% EC	0.01(Chilli) 0.01 (Tomato) 0.01 (Cabbage)	0.7 (Cabbage and other cole crops) 0.2 (Cucurbits) 0.7 (Fruiting vegetables other than cucurbits)
39	Oxydemeton methyl	25% EC	-	0.01 (Cauliflower)

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
40	Permethrin	25 %EC	0.5 (Cucumber)	2.0 (Broccoli) 5.0 (Cabbages, Head) 0.1 (Carrot) 0.5 (Cauliflower) 1.0 (Common bean -pods and/or immature seeds) 0.5 (Cucumber) 1.0 (Egg plant) 0.5 (Gherkin) 0.1 (Melons) 1.0 (Peppers) 2.0 (Spinach) 0.5 (Squash, summer) 1.0 (Tomato)
41	Phorate	10% G	0.10(Tomato) 0.05 (Other Vegetables)	0.05 (Common bean -pods and/or immature seeds)
42	Phosalone	35 % EC	1.0 (Vegetables)	-
43	Phosphomidon	40% SL	0.2(Vegetables)	-
44	Propargite	57%EC	2.0(Chilli)	2.0 (Tomato)
45	Pyridalyl	10%EC	0.02((Okra) 0.02(Cabbage)	-
46	Quinalphos	25 % EC 25% Gel 20 % AF 1.5 % DP	0.2(Chilli)	-

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
47	Spinosad	2.5% SC 45% SC	0.02(Cabbage/Cauliflower) 0.001(Chilli)	2.0(Cole crop) 0.2(Cucurbits) 10(Leafy Vegetables) 0.3(Legume Vegetables) 0.3(Peppers) 0.3(Tomato)
48	Spiromesifen	22.9% SC	-	-
49	Thiacloprid	21.7% SC	0.02(Chilli)	0.3(Cucumber) 0.7(Egg Plant) 0.2(Melons) 0.3(Summer Squash) 0.5(Tomato) 1.0(Sweet Pepper)
50	Thiodicarb	75% WP	0.01(Chilli)	-
51	Thiamethoxam	30% FS 25% WG 70% WS	0.5(Okra) 0.01(Tomato) 0.30(Brinjal)	5.0 (Cabbage and cole crops) 0.5 (Cucurbits) 0.7 (Fruiting vegetables other than cucurbits) 3.0 (Leafy vegetables) 0.01 (Legume vegetables) 0.3 (Root and tuber vegetables)
52	Thiameton	25% EC	0.1 (Vegetables)	-
53	Trichloforon	5% G 5% Dust 50% EC	0.1 (Fruits and vegetables)	-
54	Triazophos	40% EC	0.2 (Chilli)	-

[Source: Food Safety and Standards Regulations, 2010 and FAO/WHO's Codex Alimentarius Commissions (CAC)]

Table 3. MRL for fungicides recommended for disease control in vegetables

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
1	Azoxystrobin	23% SC	-	-
2	Benomyl	50% WP	0.50 (Vegetable)	2.0 (Okra, Green chillies)
3	Carbendazim	50% WP	0.50 (Vegetable)	0.05 (Tomato), 2.0 (Okra, Green chillies)
4	Copper Sulphate	2.62% SC	-	-
5	Captan	50% WG 75% WP 75% WS 50% WP	15 (Vegetable)	15 (Tomato)
6	Copper Hydroxide	77% WP	-	-
7	Chlorothalonil	75% WP	-	5.0 (Tomato)
8	Difenoconazole	25% EC	0.002 (Chilli)	
9	Dinocap	48% EC	-	0.03 (Tomato)
10	Dimethomorph	50% WP	2.0	-
11	Fenarimol	12% EC	-	-
12	Flusilazole	40% EC	0.01 (Chilli)	-
13	Hexaconazole	2% SC	-	-
14	Iprodione	50% WP	5.0 (Tomato)	5.0 (Tomato, Okra)
15	Kresoxim-methyl	44.3% SC	-	-
16	Kitazin	48% EC	-	-

	Common Name	Strength and Formulations	MRL or Tolerance Limit in mg/kg (ppm)	
			PFA(Indian)	Codex(CAC)
17	Lime Sulphur	22% SC	-	-
18	Mancozeb	75% WG 35% SC 75% WP	3.0 (Tomato), 1.0 (Chilli), 0.02 (Cauliflower)	1.0 (Green chillies), 2.0 (Tomato)
19	Mandipropamid	23.4% SC	-	-
20	Metiram	70% WG	5.0 (Tomato)	5.0 (Okra)
21	M.E.M.C.	6% FS	-	-
22	Myclobutanil	10% WP	-	0.30 (Tomato)
23	Propineb	70% WP	2.0 (Green chilli)	-
24	Pyraclostrobin	20% WG	-	0.03 (Tomato)
25	Sulphur	80% WP 80% WG 40% WP 52% SC 85% DP	-	-
26	Streptomycin Sulphate + Tetracyline Hydrocloride	9%+1% SP	-	-
27	Triadimefon	25% WP	0.1 (Pea)	-
28	Thiophanate Methyl	70% WP	-	-
29	Tebuconazole	25.9% m/m EC	-	0.20 (Tomato)
30	Ziram	80% WP	-	-
31	Zineb	75% WP	3.0 (Tomato)	-

[Source: Food Safety and Standards Regulations, 2010 and FAO/WHO's Codex Alimentarius Commissions (CAC)]

6. Selection of Eco-Friendly Pesticides for Protecting Honey Bees/ Pollinators

Pesticides are one of the main agents of poisoning honeybees and other pollinators in the vegetable ecosystem. Honeybees are very much susceptible to different groups of pesticides. Selective use of insecticides is one of the pre-requisites for integrated pest management (IPM). In this context, selection of insecticides which are effective against target pests but less toxic to pollinators is essential and will definitely minimize the losses of bees. In recent years many insecticides have been screened for their efficacy to target pests and their toxicity to honeybees.

The causes of bee poisoning are:

- Use of broad spectrum insecticides (chlorinated hydrocarbons, synthetic pyrethroids).
- Pesticide application during the blooming period of crop.
- Application of pesticides directly on/ to bees foraging on the crop.
- Collecting contaminated nectar and/or pollen from the treated plants by the bees.
- Bee feeding on contaminated food and water sources.
- Contamination of flowering cover crops during spraying.
- Transportation of pesticide dusts and contaminated pollen/ nector to beehive by worker bees.
- Drift of toxic chemicals from the point of application on to flower, pollen and nectar or across apiaries.
- Use of insecticide formulations like Dust, EC which are more harmful than WP and granules.
- Use of insect growth regulators may inhibit brood production.
- Use of diesel oil as a carrier in insecticide formulations.

Symptoms of bee poisoning

Specific symptoms are caused by poisoning by different groups of pesticides in bees. The general and most common symptoms of bee poisoning are:

- Appearance of large number of dead bees near the entrance or in and around of bee-hives or colonies and in fields.
- Dead bees on the top of frames or bottom board.
- Paralysed bees crawling on nearby objects.
- Bees lose power of orientation and may perform abnormal communication dances on the horizontal landing board at hive entrance.
- Legs, wing and digestive systems of bees stop functioning.
- Bees are irritated and become aggressive, they sting heavily and they also lack recognition of guard bees.
- Queen may behave abnormally and lay eggs in poor pattern.
- Fighting among bees.
- Sudden decline in food storage and brood rearing.
- Abdomen become distended and regurgitation of stomach contents.
- Dead and deserted brood in the hive.
- Poor recognition of pollen and nectar by bees.
- Lack of foraging bees.
- Depleted population of bees in the colony.
- Longevity of adult bee is reduced.

Guidelines to assess the extent of bee poisoning by pesticides

The mortality data given below can be used as guidelines to assess the extent of bee poisoning by pesticides

No of dead bees /day at entrance of bee box	Level of poisoning
100	Normal death rate
200-400	Low
500-1000	Medium
More than 1000	High

(Source: Hameed and Singh, 2002)

Effects of bee/pollinator poisoning

Three types of harmful effects are evident in agriculture. These are:

- Reduction in the yield of cross pollinated crops
- Loss in production of honey
- Contamination of bee products

Categories of pesticides on the basis of their toxicity to honeybees

Pesticides are also grouped under different categories depending upon their relative toxicities to bees. This can help in choosing and selection of appropriate pesticides. There are three main categories of pesticides based on their toxicities to bees.

Category I: Highly toxic pesticides

These pesticides are highly toxic and cause severe damage to bees. They should not be applied on blooming crops or weeds. Their residual toxicity is usually high even after 10 hours of spray. The list of commonly used highy toxic insecticides is given below.

Carbaryl
Carbofuran
Carbophenothion
Chlorpyriphos
Clothianidin
Cypermethrin
Deltamethrin
Dichlorvos (DDVP)
Dicrotophos
Dimethoate
Fenvalerate
Imidacloprid
Monocrotophos
Oxydemeton-methyl
Parathion
Permethrin
Phorate
Phosphamidon
Quinalphos
Thiometon
Thiamethoxam

Category II: Moderately toxic pesticides

These insecticides are moderately toxic to bees and should be applied during late evening, night or early morning hours when

bees are not actively foraging. Their residual toxicity is usually low upto 3 hours of spray. These insecticides/fungicides are as under.

Moderately toxic pesticides

Acetamiprid
Bavistin
Carbendazim
Diazinon
Difolatan
Ediphenphos
Ethyl parathion
Fenitrothion
Fenthion
Foltaf
Formothion
Heptachlor
Malathion
Mancozeb
Metasystox
Methyl demeton
Methyl parathion
Mevinphos
Monocrotophos
Trichlorphon
Thiacloprid

Category III: Relatively non toxic pesticides

Pesticides under this category are least toxic to bees and can be applied at any time with reasonable safety to honeybees. Their toxicity is usually low with direct application. The list of commonly used highy toxic insecticides are given below.

Relatively non toxic pesticides

Anilazine
Bacillus thuringiensis
Benomyl
Bordeaux mixture
Captan
Catafol
Chlorobenzilate
Cuprous oxide
Dicofol
Dimite
Dinocap
Dodine
Endosulfan
Folcid
Ethion
Menazon
Methoxychlor
Morestan
Nicotine
Nuclear polyhedrosis virus
Phosalone
Polyram
Pyrethrum
Sabadilla
Thiram
Ziram

Relatively non toxic herbicides, defoliants and desiccants

Amitrole
Ammate
Atrazine
Bromocil
Cynazine
Diuron
Methazole
Nitrofen
Oil sprays

(Source: Abrol, 1997)

7. Guidelines for Pest Management in Organic Vegetable Production

(A) National standards for pest management during organic vegetable production

General Principles

Organic farming systems should be carried out in a way which ensures that losses from pests, diseases and weeds are minimised. Emphasis is placed on the use of a balanced fertilising programme, use of crops and varieties well-adapted to the environment, fertile soils of high biological activity, adapted rotations, companion planting, green manures, etc. Growth and development should take place in a natural manner.

Recommendations

- Weeds, pests and diseases should be controlled by a number of preventive cultural techniques which limit their growth and development, e.g. suitable rotations, green manures, a balanced fertilising programme, early and predrilling seedbed preparations, mulching, mechanical control and the disturbance of pest development cycles.
- The natural enemies of pests and diseases should be protected and encouraged through proper habitat management of hedges, nesting sites etc.
- Pest management should be regulated by understanding and disrupting the ecological needs of the pests.
- An ecological equilibrium should be created to bring about a balance in the pest predator cycle.

Standards

- Products used for pest, disease and weed management, prepared at the farm from local plants, animals and micro-organisms, are allowed.

- Branded products must always be evaluated.
- Thermic weed control and physical methods for insect pest, disease and weed management are permitted.
- Thermic sterilization of soils to combat pests and diseases is restricted to circumstances where a proper rotation or renewal of soil cannot take place. Permission may be given by the certification programme only on a case by case basis.
- All equipment from conventional farming systems shall be properly cleaned and free from residues before being used on organically managed areas.
- The use of synthetic herbicides, fungicides, insecticides and other pesticides is prohibited. Permitted products for plant pest and disease control is listed in below table.
- Do not use synthetic growth regulators, synthetic dyes and genetically engineered organisms or products.
- Accredited certification programmes shall ensure that measures are in place to prevent transmission of pests, parasites and infectious agents.

(B) National standards for pest management during food storage, processing and handling

General Principles

Pests should be avoided by following good handling practices. This includes general cleanliness and hygiene.

Recommendations

- Recommended treatments are physical barriers, sound, ultra-sound, light, and UV-light, traps (including pheromone traps and static bait traps), temperature control, controlled atmosphere and diatomaceous earth.
- Develop a plan for pest prevention and pest control

Standards

1. For pest management and control the following measures should be used in order of priority.

- Preventive methods such as disruption, elimination of habitat and access to facilities.
- Mechanical, physical and biological methods.
- Approved pesticidal substances of the national standards.

2. Irradiation is prohibited.
3. There shall never be direct or indirect contact between organic products and prohibited substances. (e.g. pesticides). In case of doubt, it shall be ensured that no residues are present in the organic product.
4. Persistent or carcinogenic pesticides and disinfectants are not permitted.
5. The certification programme shall set up rules to determine which protection agents and disinfectants may be used.

Permitted /approved products for insect pest and disease control

Certain products are safe and allowed for use in the control of pests and diseases in plants. However, some of them are restricted for use in organic production (table 4). Such products should only be used when absolutely necessary and should be chosen taking the environmental impact into consideration. In this "restricted" means that the conditions and the procedure for use shall be set by the certification agency.

Table 4. List of products/items permitted for pest control in organic farming

Substances from plant and animal origin		
1.	*Azadirachta indica* (neem preparations /neem oil)	Restricted
2.	Preparation of rotenone from *Derris elliptica, Lonchocarpus, Thephrosia spp.*	Restricted
3.	Gelatine	Permitted
4.	Propolis	Restricted
5.	Plant based extracts (e.g. neem, garlic, pongamia, etc.)	Permitted

6.	Preparation on basis of pyrethrins extracted from *Chrysanthemum cinerariaefolium*, containing possibly a synergist pyrethrum cinerafolium	Restricted
7.	Preparation from *Quassia amara*	Restricted
8.	Release of parasitoids, predators of insect pests	Restricted
9.	Preparation from *Ryania* species	Restricted
10.	Tobacco tea	Not allowed
11.	Lecithin	Restricted
12.	Casein	Permitted
13.	Sea weeds, sea weed meal, sea weed extracts, sea salt and salty water	Restricted
14.	Extract from mushroom (Shiitake fungus)	Permitted
15.	Extract from *Chlorella*	Permitted
16.	Fermented product from *Aspergillus*	Restricted
17.	Natural acids (vinegar)	Restricted
Minerals		
1.	Chloride of lime/soda	Restricted
2.	Clay (e.g. bentonite, perlite, vermiculite, zeolite)	Permitted
3.	Copper salts / inorganic salts (Bordeaux mix, copper hydroxide, copper oxychloride) used as a fungicide, maximum 8 kg per ha per year depending upon the crop and under the supervision of inspection and certification agency	Restricted
4.	Mineral powders (stone meal, silicates)	Not allowed
5.	Diatomaceous earth	Restricted
6.	Light mineral oils	Restricted
7.	Permanganate of potash	Restricted
8.	Lime sulphur (calcium polysulphide	Restricted
9.	Silicates (sodium silicate, quartz)	Restricted
10.	Sodium bicarbonate	Permitted
11.	Sulphur (as a fungicide, acaricide, repellent)	Restricted
Microorganisms / Biocontrol agents		
1.	Viral preparations (e.g., Granulosis viruses, Nuclear polyhedrosis viruses etc.)	Permitted
2.	Fungal preparations (e.g., *Trichoderma* species etc.)	Permitted
3.	Bacterial preparations (e.g., *Bacillus* species etc.)	Permitted
4.	Parasites, predators and sterilized insects.	Permitted

Others		
1.	Carbon dioxide and nitrogen gas	Restricted
2.	Soft soap (potassium soap)	Permitted
3.	Ethyl alcohol	Not allowed
4.	Homeopathic and Ayurvedic preparations	Permitted
5.	Herbal and biodynamic preparations	Permitted
Traps		
1.	Physical methods (e.g., chromatic traps, mechanical traps, light traps, sticky traps and pheromones)	Permitted
2.	Mulches and insect proof nets	Permitted

(Source: APEDA, 2005)

8. Pesticide Dose Calculations

The success of a pesticide spraying in small areas or large fields depends upon accurate control of the application rate. After the equipment is accurately calibrated to apply the desired volume of spray fluid, one must determine how much chemical is required to put into tank to apply the correct dosage recommended.

The calculation and formulae for various formulations of pesticides are given below:

For Emulsifiable Concentrate (EC) and Wettable Powder (WP) Formulations

$C_1 V_1 = C_2 V_2$

C_1 = Concentration of given formulation (%)

V_1 = Volume/amount of formulation required (ml or g)

C_2 = Concentration of spray fluid required (%)

V_2 = Volume/amount of spry fluid required (ml or g)

Example 1. How much spray fluid of 0.1% concentration can be prepared from 125g of carbaryl 50 WP?

C_1 = 50%

C_2 = 0.1%

V_1 = 125 g

V_2 = ?

$V_2 = (C_1V_1)/C_2$

= 62500 ml

= 62.5 liters

Example 2. Calculate the amount of carbaryl 50 WP required to prepare 10 liters of 0.1% sprays material.

C_1 = 50%

V_1 = ?

C_2 = 0.1%

V_2 = 10 liters = 10000 ml

V_1 = $(C_2\ V_2)/\ C_1$

= (0.1x 10000)/50

= 20 g.

Example 3. How much quantity of cypermethrin 20 EC is required for spraying 0.025% spray fluid at the rate of 250 liter/ha for controlling the diamondback month on cauliflower over an area of one-twenty-fifth of a hectare?

C_1 = 20%

V_1 = ?

C_2 = 0.025%

Rate of application= 250 liter/ha

For one-twenty-fifth of a hectare = 250 x liter/ha

V_2 = 10 liters = 10000 ml

C_1V_1 = C_2V_2

V_1 = $(C_2V_2)/C_1$

= (0.025 x 10000)/20

= 12.5 ml

Example 4. Chlorpyrifos 20% EC measuring 300 ml is added in 150 liters of water. Determine the percentage concentration of the pesticide in the spray fluid.

C_1 = 20 %

V_1 = 300 ml

C_2 = 150 liters =150,000 ml

C_1V_1 = C_2V_2

C_2 = (20x300)/150000

= 0.04%

For Granules and Dust formulations

C_1V_1 = 100 RA

C_1 = Concentration of formulation availabe (%)

V_1 = Amount of formulation required (g or kg)
R = Recommended rate of pesticide application [g or kg ingredient (a.i.)/ha]
A = Area to be treated (ha)

Example 1. Calculate the amount of 5% carbofuran granules applied @ 0.25 kg a.i. to one ha area.

C1 = 5%
V1 = ?
R = 0.25 kg
A = 1ha
C1V1 = 100 RA
V1 = (100 RA)/C
= (100x 0.25x1)/5
= 5 kg.

Example 2. How many kg of commercial formulation is required to treat 3000 m^2 when the recommended rate is 1 kg a.i./ha and per cent a.i. in the commercial granular formulation is 10%?

C1 = 10%
V1 = ?
R = 1 kg a.i./ha
A = 3000 m^2 = 0.3 ha
C1V1 = 100 RA
V1 = (100 RA)/C_1
= (100 x1x0.3)/10
= 3 kg.

Example 3. How many kg of the commercial formulation is required to treat the 1000 m^2 area at the recommended rate of 0.75 kg/ha? The percentage a.i. in the commercial formulation is 5%.

C1 = 5%
V1 = ?
R = 0.75 kg
A = 1000 m^2 = 0.1 ha

C1V1 = 100 RA

V1 = (100 RA)/C_1

= (100 x 0.75x o.1)/5

= 1.5 kg

Calculation of formulated product requirement

The leaflet supplied with the product will provide details on per cent active ingredient contents and dose of active ingredient required per hectare. Using this information we can work out the quantity of formulated product required for spraying for one hectare of land by using the following formula:

$$\text{Commercial product (g/ha)} = \frac{\text{Does in g.a.i./ha} \times 100}{\text{\% a.i. in the kg/l formulation}}$$

Examples

1. Solid Formulations like WP, Dust – To calculate quantity of Diafenthiuron 50 % WP required to cover 1 hectare of land @ 300 g active ingredient per hectare;

$$= \frac{\text{300 g.a. /ha}}{\text{50\% a.i. in 1 kg}} \times 100$$

= 600 g

2. Liquid Formulations like EC, SC, SL – To calculate quantity of Flubendamide 480 SC required to cover 1 hectare of land @ 48 g active ingredient per hectare;

$$= \frac{\text{48 g.a.i./ ha}}{\text{48\% a.i. in 1 kg}} \times 100$$

= 100 ml

3. Granule Formulation – To calculate quantity of Fipronil 0.3 GR required to cover 1 hectare of land @ 50 g active ingredient per hectare;

$$= \frac{\text{50 g.a.i.}}{\text{0.3\% a.i. in 1 kg}} \times 100$$

= 16667g (16.67 kg)

9. Safe Use of Pesticides and Standard Guidelines for Handling Pesticide Poisoning

(A) Safe use of pesticides in vegetables

(i) Basic principles before use or application of any agrochemicals

- Before using, read and understand the product label.
- Exercise caution at all times when handling a product.
- Maintain application equipment in good working condition.
- Practice good personal hygiene before, during and after using product.
- Use appropriate personal protective equipment or clothings.

(ii) Precautions to be followed for safe use of pesticides

- Do not transport or keep the pesticides along with food stuff.
- Store the pesticides under lock & key.
- Keep out of reach of children.
- Buy pesticides in original packing from authentic plant protection shops.
- Measure correctly and use only recommended quantity/dose of pesticides.
- Use funnel and fill without spillage.
- Mix thoroughly in water using a paddle of stick.
- Do not use empty pesticides containers for food or water storage.
- Do spray along the wind.
- Put up warning board in treatment area.
- Do not blow with your mouth to clean the nozzle.
- Do not smoke, drink or eat while spraying.
- Do not use leaky or damaged sprayer.
- In case of accidental contamination wash thoroughly the clothes and body part.
- Do not allow children to spray.
- Do not keep the food stuff near the site of application.
- Wash hand and mouth before eating, drinking or smoking.

- Give first-aid in case of any accidental poisoning.
- Get immediate treatment from medical experts.
- Show leaflet and container to the treating doctor
- Destroy and bury empty containers.
- Take bath and wash clothes after spraying.
- Avoid environmental contamination.

(B) Guidelines for handling pesticide poisoning

(i) Skin contamination

- Remove clothing
- Drench skin and clothing with water.
- Cleanse skin and hair thoroughly with soap and water.
- Avoid use of ointments, greases, powders, etc. in the first aid treatment of burns.

(ii) Eye contamination

- Wash the eye quickly but as gently as possible. Hold eyelids open and wash eye with a gentle stream of clean running water.
- Continue washing for fifteen minutes or more. It is important to use a large volume of water.
- Cover the eye with a clean piece of cloth and seek medical attention immediately.

(iii) Inhaled poisons (dusts, vapors, gases)

- Carry patient to fresh air immediately.
- Open all doors and windows.
- Loosen all tight clothing.
- Apply artificial respiration if breathing has stopped or is irregular.
- Prevent chilling.

(iv) Swallowed poisons

- Never induce vomiting if the victim is unconscious or having convulsions.

- Never induce vomiting if the victim has swallowed a corrosive poison. A corrosive poison is a strong acid or alkali.

Do not waste a lot of time for inducing vomiting. Use it only as first aid until you can get the victim to a hospital. Make sure the victim is lying face down or kneeling forward while retching or vomiting. Do not let him lie on his back. The detail symptoms of pesticide poisoning in human beings by different groups of pesticides and their antidotes is given in the table 5.

Table 5. Symptoms of pesticide poisoing and antidotes for plant protection chemicals

	Chemical group/ Class	Examples	Symptoms	Treatment/Antidotes
1.	Organochlorine	Aldrin, Dialdrin, Endosulfan, etc.	Headache, Giddiness, Gripping, Nausea, Vomiting, Weakness in arms and legs, Cramps in hands,restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death	No specific antidote. Induce vomiting by tickling the back of throat or gastric lavage with 2-4 L tap water – catharsis with 30 gm (10 oz) sodium sulphate in one cup of water. Normal dose of Barbiturate / Diazepam or Benzodiazepines. Avoid oils, oil laxatives and epinephrine (Adnrenalin). Do not give stimulants. Give calcium gluconate (10% in 10 ml. Ampules) intra-venously every four hours. Consult Doctor immediately
2.	Organophophorus	Fenthion, Quinolphos, Chlorpyriphos, Profenophos, etc.	Tiredness, Weakness, Vomiting, Stomach pain, Shrinkage of eye ball, Vertigo, Blurred vision, Excessive sweating, Salivation In Severe case – Diarrhoea, pinpoint and non-reactive pupils, respiratory difficulty, pulmonary edema, cyanosis, loss of sphincter control, convulsions, coma and heart block.	Ensure clear airway. Intubate the patient & aspirate the secretion. Administer oxygen by mechanically pulmonary ventilation, if respiration is assisted depressed. Improve tissue oxygenation before atropine. Administer Atropine every 10 minute by injection. Give glycopyrolate as alternative to atropine. This is very good in case of respiratory infection. Pralixodime (2PAM) to be used within 48 hour. Relieves nicotinic as well as muscarinic effect. Consult Doctor immediately.

	Chemical group/ Class	Examples	Symptoms	Treatment/Antidotes
3.	Carbamate	Carbofuran, Carbaryl, Methomyl, etc.	Fever, Vomiting, Headache, Giddiness, Gripping in muscles, Stomach pain, Excessive sweating	Remove the contaminated and dirty clothes. Wash the body and clothes. Ensure clear airway. Intubate the patient & aspirate the secretion. Administer oxygen by mechanically assisted pulmonary ventilation, if respiration is depressed. Improve tissue oxygenation before atropine. In case the patient is unconscious then administer Atropine injection. Use glycopyrolate as alternative to atropine. Avoid theophyllin and aminophyllin or barbiturates. 2-PAM and other oximes are harmful and in fact contra indicated for routine usage. Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine. Consult Doctor immediately.
4.	Pyrethrins or Synthetic Pyrethrides	Cypermethrin, Alpha-Cypermethrin, Fenvalerate	Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin, allergic manifestations etc. Parasthesia, sometimes bronchospasm. In severe cases convulsion can occur and anxiety	No specific antidote. Induce vomiting. Treatment is essentially symptomatic.If swallowed then give active Charcol dissolved in water. Vit E oil preparation in parasthesia.Inhalation of water vapour aerosol in case of irritation of upper respiratory tract. Antihistamines can be given in case of allergy with or without steroid. To control convulsion in severe cases Diazepam can be given 5-10 mg/IV. Consult Doctor immediately.

	Chemical group/ Class	Examples	Symptoms	Treatment/Antidotes
5.	Phosphine pesticides	Aluminium phosphide *Zinc phosphide	Stomach pain, Tiredness, Unconsciousness, Gripping in muscles, Muscular pain, Vomiting, Diarrhoea, Shivering, Anxiety	Administer N-acetylcysteine to prevent poisoning. If swallowed, do not induce vomiting. Activated charcoal – slurry with sorbitol – adsorbs phosphine. Diazepam – Give undiluted and monitor BP respiration. Dopamine – 4.6 microgram/kg/min IV. Magnesium sulphate – 3 gm IV.Ranitidine – 50 mg IV every 8 hours. Sodium bicarbonate - 50 mEq/15 min. Gastric lavage is contraindicated as more phosphine is released upon contact with water in the stomach.Take the patient to hospital.
6.	Dithiocarbamates	Mancozeb, Maneb, Thiram, etc.	Inflammation or irritation in eyes, skin and mouth, Problem in respiration.	No specific antidote. Treat, symptomatically. Dissolve active Charcol in water and give to the patient. Induce vomiting and immediately consult Doctor.
7.	Chlorophenoxy	2,4-D (2,4-Dichlorophenoxy Acetic Acid)	Vomiting, Loose motion or loose faeces, Headache, Anxiety.	No specific antidote. Treat symptomatically. Consult Doctor immediately.
8.	Paraquat	Paraquat Dichloride	Nausea, vomiting, diarrhoea, burning pain in mouth, throat and upper abdomen, mouth/throat ulceration, concentrate of product	No specific antidote. Perform gastric lavage. Give Fuller's Earth (an adosrbent) 300 ml of 30% aqueous suspension. Give mannitol 200 ml of 20% solution in 200 ml of water via gastric tube. Fuller's earth should be given as early as possible.If Fuller's earth is not available, give Bentonite 1 litre of 7.5% suspension or

	Chemical group/ Class	Examples	Symptoms	Treatment/Antidotes
			is extremely irritating to skin and eyes. Inhalation of spray must may lead to sore throat, husky voice and epistaxis, as a result of local irritation. Giddiness, headache, fever, diarrhoea and myalgia. Proteinuria, haematuria, pyrexia, azotemia followed by oliguria/anuria	activated charcoal 50 to 100 g dissolved in 200 ml of water.Take patient to Doctor immediately.
9.	Copper Compounds	Copper Oxychloride, Copper Hydrochloride, Copper Sulphate Cuprous oxide	Nausea, vomiting, diarrhoea with blood, Stomach pain and headache are the early features of poisoning. Dehydration can lead to shock. May cause oedema of lids, conjunctivitis and corneal ulceration. In severe poisoning causes coma, convulsions and death	No specific antidote. Advise patient to drink water or milk as early as possible. Treat symptomatically. Take patient to hospital and consult Doctor immediately.

	Chemical group/ Class	Examples	Symptoms	Treatment/Antidotes
10.	Anticoagulant	Bromodiolone Coumachlor Coumatetralyl Warfarin	Bleeding from nose, gums blood in urine and stool, brain hemorrhage. Swelling and pain in joints.	Give Vitamin K1 (Phytonadione) oral or injection. Vit K1 is specifically required. Neither Vit K3 nor Vit K4 is an antidote for these anticoagulants. Transfuse with fresh blood if bleeding is severe or until anemia is corrected. Iron (Ferrous sulfate) by mouth for correction of secondary anemia. Carefully observe for 4-5 days.Consult Doctor immediately.
11.	Urea by-product	Chlorimuron ethyl, Isoproturon	Harmful only when excess quantity is swallowed. Headache, Nauseation, Vomiting and loose motion or diarrhea	No specific antidote. Treat symptomatically.
12.	Sulfonyl Urea	Sulfosulfuron, Metsulfuron Methyl	Inflammation in eyes and skin, To nauseate, Vomiting and loose motion or diarrhea	No specific antidote. Treat symptomatically. Milk or any item material containing fat be avoided.

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