

Technical Bulletin

Handbook on Pesticide Uses in Pulses



ICAR-Indian Institute of Pulses Research
Kanpur-208 024

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Preface

Pulses are rich sources of dietary protein, fiber, vitamins, minerals, antioxidants, phytochemicals and are important for food and nutritional security of the country. Area under pulse crops is expanding and contributing to increase in per capita income of the farmers and health benefits to the society. Presently, India produces about 25 million tonnes of pulses from an area of 28 million hectares with an average productivity of 9.14 q/ha. The pulse requirement in the country is projected at 32 million tonnes by 2030 and 47 million tonnes by 2047 A.D at an annual growth rate of 2.70 per cent.

Pulse crops are affected by wide range of biotic stresses such as insect pests, diseases, weeds, nematodes and storage pests from sowing to storage which together causes significant crop losses to the tune of 15-25%. To prevent these losses, chemical pesticides are most commonly used. They play a key role in improving pulses productivity and increasing farmers income. Per hectare consumption of pesticide in India is around 300 g/ha⁻¹, which is much less compared to the world average of 2.37 kg/ha⁻¹. In pulses, around 10-12 per cent of total pesticides used in the country are applied mostly in pigeonpea, chickpea and *Vigna* crops. In India, 359 pesticides and more than 350 combination products are registered for use in agriculture. Out of these only 31 insecticides, 8 insecticide mixtures, 28 fungicides, 25 herbicides, 3 plant growth regulators, 18 bio-insecticide, 7 bio-fungicide formulation and 1 fumigant are approved for uses in pulses.

Most of the times, plant protection workers at KVKs, State Departments and farmers lack information and knowledge on correct uses of approved and recommended pesticides for pulses. Comprehensive information on selection of pesticide, label claims and safe use of pesticides in field and storage for pulses is not available at a single place leading to non-judicious, indiscriminate use of non-label claim pesticides resulting to several pesticide hazards including harmful residues.

Keeping this in view, the authors have attempted to bring out a technical bulletin on “**Handbook on Pesticide Uses in Pulses.**” This bulletin is inspired by the discussions 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 pulses for pest management. Bulletin contains useful information on the different groups/classes of pesticides, their mode of action, registered and banned pesticides in India, correct doses of approved pesticides and biopesticides for pulses, target pests, label claims, permitted MRL values and their safe use. The publication will be very useful and ready reckoner to the agricultural extension officers, plant protections officers at KVKs, state departments, students, researchers, farmers, policy makers and all the stakeholders for correct and safe use of approved pesticides for control of insect pest, diseases and weeds in pulses. The authors would like to express deep sense of gratitude to the Director, ICAR- Indian Institute of Pulses Research, Kanpur for his constant encouragement, guidance and support in bringing out this publication.

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Status of Pesticide Uses in Pulses

Pulses are the dried seeds of leguminous crops such as chickpea, pigeonpea, greengram, blackgram, cowpea, lentil and peas. They play a pivotal role in global agriculture, nutrition and sustainable farming systems. As pulses are rich in protein (19–25 per cent), fibres, vitamins and minerals, they are foundational to diets in many regions, particularly where meat and dairy are less accessible. Furthermore, these leguminous crops contribute to soil health by fixing atmospheric nitrogen, enabling crop rotations that reduce dependence on synthetic fertilisers and improve soil biodiversity thereby aligning with sustainable development goals.

Major global producers of pulses are India (361.11 lakh ha), Canada (32.75 lakh ha) and China (26.14 lakh ha) as in Fig 1. Globally, chickpea and dry beans dominate pulse production, together contributing nearly 48 per cent of the world's total, while lentils account for about 7 per cent, and peas for around 15 per cent as in Fig 2. Pulses such as chickpea, dry beans and cowpea together occupies nearly 69 per cent of the global area (FAOSTAT, 2022).

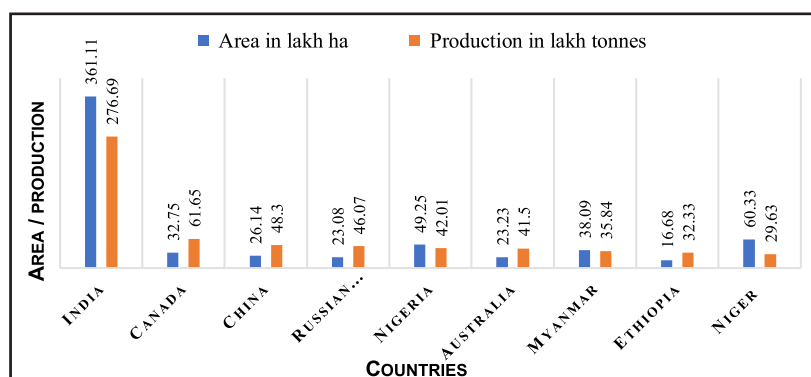


Fig 1. Area and production of pulses in different countries

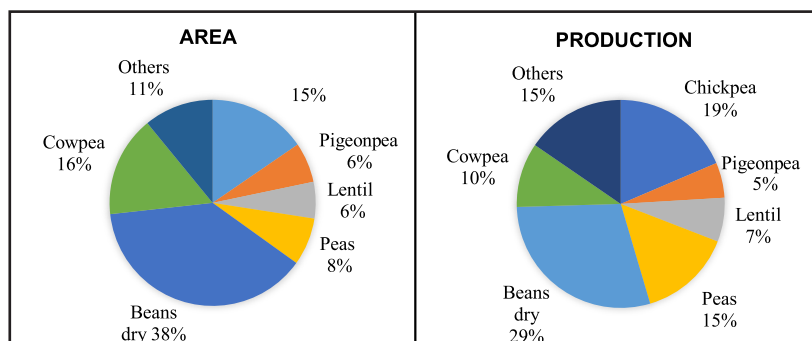


Fig 2. Share of different pulses in area and production in the world

India is the largest producer and consumer of pulses globally, supplying about 28 per cent of global production, consuming around 27 per cent of world consumption and 14 per cent importer (DPD, 2023). Among different pulses grown in India, chickpea occupies the largest share around 35 per cent of total pulse area and nearly 47 per cent of total production, pigeonpea occupies about 15 per cent of area and 16 per cent of production, followed by greengram with 17 per cent area and 11 per cent production and blackgram with 16 per cent area and 11 per cent production, and lentil around 5 per cent area and production (Fig.3). Regionally, the top three states for pulse cultivation in area include Madhya Pradesh (60.74 lakh ha), Rajasthan (57.99 lakh ha) and Maharashtra (42.58 lakh ha) as shown in Fig 4. Despite being the largest in area, Madhya Pradesh achieves a moderate yield of 983 kg ha⁻¹,

while Gujarat (1,099 kg ha⁻¹) and Jharkhand (1,030 kg ha⁻¹) record the highest state-level productivities (DPD, 2023).

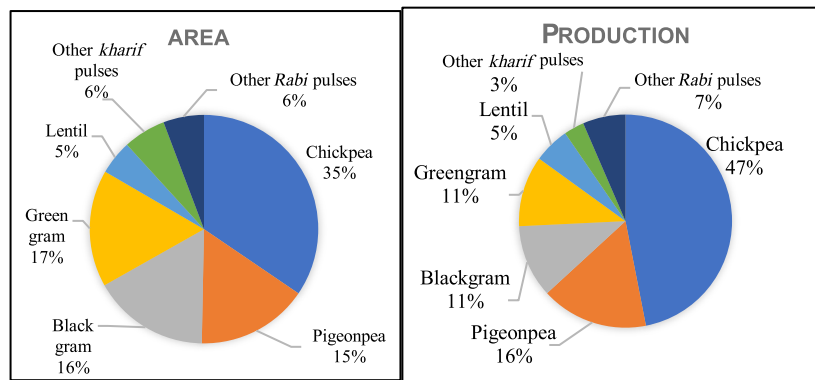


Fig 3. Share of different pulses in area and production in India

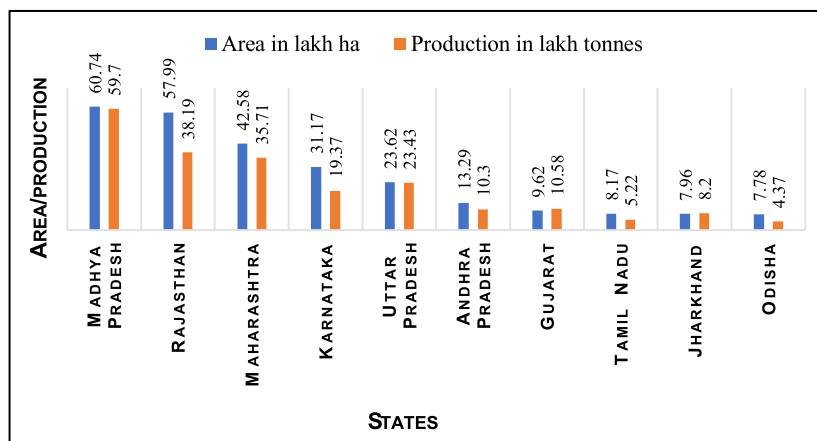


Fig 4. Area and production of pulses in different States of India

Losses by different biotic factors

Pulse crops are primarily grown under rainfed conditions across semi-arid tropics, where climatic fluctuations, water scarcity, and pest incidence strongly influence their productivity. These crops are subject to a wide range of biotic stresses that adversely affect the productivity and seed quality from sowing to storage. The most significant biotic constraints include insect pests, diseases, weeds, nematodes and storage pests, which together undermine both yield and seed viability. These biotic stresses vary by crop species, region and season, but their combined impact remains a persistent challenge in pulse production systems. Under severe infestations sometimes the biotic stress cause complete crop failure in some localized pockets. Each year up to 40 per cent of global crop production is lost due to pests and diseases (FAO, 2025). India loses approximately 15–25 per cent of its total pulse production annually due to a combination of insect pests, diseases, weeds and post-harvest storage losses. Based on the national average production of about 26 million tonnes, this translates to an estimated 3.9–6.5 million tonnes of avoidable loss each year, equivalent to an economic value of ₹ 15,000–18,000 crore at prevailing farm-gate prices (ICAR–IIPR 2023; ICRISAT 2022; FAO 2020). The most destructive pest of pulses is the pod borer complex, while sucking pests like pod bugs, aphids, thrips, whitefly, wilt and foliar diseases add further stress. Losses during storage are primarily caused by bruchids, which infest stored pulses and cause internal seed damage. The presence of storage pest leads to weight loss, reduced germination, and contamination, thereby affecting the marketability and nutritional quality of pulses. Thus, pest induced damage remains one of the

major biotic constraints limiting productivity in pulses. To prevent the losses chemical pesticides are employed to protect crops and food commodities from insect pests, diseases and weeds. Pesticides have played a key role in improving pulses productivity by preventing large crop losses, enhanced the output and income of farmers.

Pesticide consumption in World and India

Globally, pesticide consumption is approximately 3.7 million tonnes of active ingredients per year. The average global consumption of chemical pesticides has increased from 1.23 kg ha⁻¹ of cropland in 1990 to over 2.37 kg ha⁻¹ (Statista, 2025). China is the world's largest pesticide user, accounting for nearly 47 per cent of global consumption, with an intensity of 13.1 kg ha⁻¹ more than five times the global mean. The United States of America, Brazil, and Argentina are next highest pesticide consuming countries, with use intensities between 2.5 and 6.0 kg ha⁻¹, respectively. Japan with minimum pesticide consumption has the highest pesticide use intensity of 11.8 kg ha⁻¹ after China (FAOSTAT, 2022). In contrast, India accounts for only one per cent of global pesticide consumption, with a much lower average intensity of 0.3 kg ha⁻¹, in the world reflecting the country's lower per-hectare intensity of application as shown in Fig 5 (FAOSTAT, 2022). The relatively low intensity of pesticide consumption in India can be attributed to its predominance of rainfed agriculture and small farm holdings, low level of irrigation and less awareness among farmers about the benefits of usage of pesticides etc.

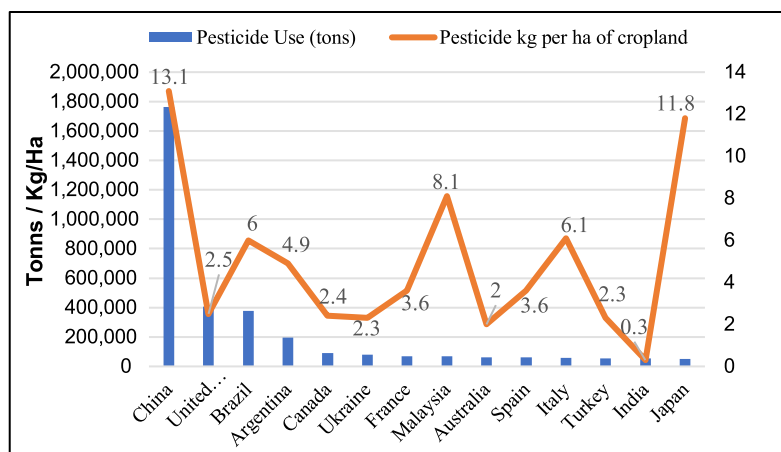


Fig 5. Pesticide consumption in different countries

Among different group of pesticides, herbicides account 55 per cent of global use, followed by fungicides and bactericides (23 per cent) and insecticides (21 per cent). Whereas in India, the consumption pattern is

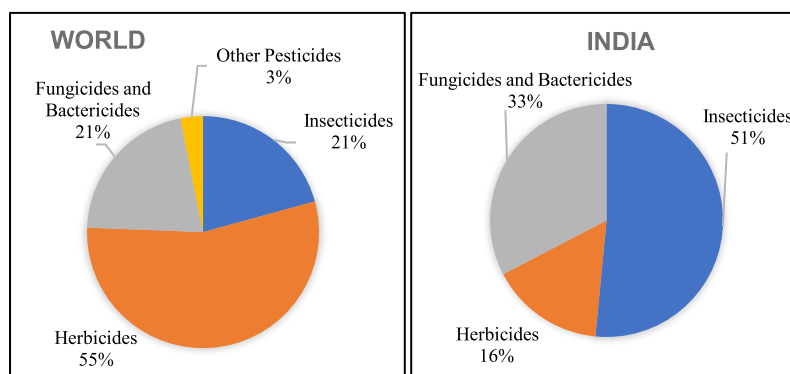


Fig 6. Share of different types of pesticides used in world and India

dominated by insecticides (51 per cent), followed by fungicides & bactericides (33 per cent) and herbicides (16 per cent) as shown in Fig 6 (FAOSTAT, 2022).

In last one decade (2012-13 to 2023-24), average pesticide consumption in India was 58,818.12 tonnes. The highest total chemical pesticide consumption was recorded in year 2020–21 (62,193 tonnes) and the lowest consumption was in 2022–23 (53,630 tonnes). After peaking in 2020–21, chemical pesticide use showed a gradual declining trend, indicating policy shifts, use of biopesticides, improved IPM practices, and increased awareness among farmers.

Among different states of India, Uttar Pradesh and Maharashtra are the largest consumers of chemical pesticides in year 2023-24, together accounting for over 37 per cent of the national total. In contrast, West Bengal (1,575 MT), Tamil Nadu (957 MT), Kerala (609.9 MT), Gujarat (578 MT), Karnataka (470 MT), and Telangana (462 MT) lead in biopesticide consumption as shown in Fig 7 (DPPQ&S, 2023). This reflects successful promotion of Integrated Pest Management (IPM) and organic farming initiatives in these states. Low consumption of biopesticides in high-input using states like Punjab, Maharashtra, and Uttar Pradesh indicate that despite awareness, adoption remains limited due to large-scale commercial farming. In North Eastern states such as Assam, Nagaland, Sikkim and hilly state like Uttarakhand report higher biopesticide use than chemical pesticides due to government-supported organic cultivation and state organic missions.



Fig 7. Consumption of chemical and bio-pesticides in different states of India

Cropped area under pesticide uses in india

In India, the chemical pesticide consumption on cropped area during year 2019–20 and 2023–24, fluctuated between 96,042 to 118,110 ha. showing an overall marginal increase of about 5 per cent over the five-year period. Despite year-to-year fluctuations, the average area under chemical pesticide consumption remained around 109,000 ha per annum. Annual area in biopesticide use ranged from 12,833 ha to 16,868 ha, averaging 14,446 ha during five-year period. The highest area of 16,868 ha was recorded under use of biopesticides in 2021–22 as shown in Fig 8. This corresponds to extensive promotion of microbial-based formulations under national schemes. Although the cropped area under biopesticide use declined slightly in 2023–24, the share of biological control agents in total pesticide use has risen gradually from 11–12 per cent in 2019–20 to nearly 15–17 per cent in 2023–24, marking a transition toward eco-friendly pest management systems. Biopesticide area, though relatively smaller in quantity but there is a steady institutional push toward sustainable crop protection using biopesticides. The area under combined usage of chemical and biopesticides showed downward trend from 37,874 ha. to 20,154 ha. due to use of improved pest resistant varieties and altered climatic pest pressure (DDPQ&S; DES, 2024).

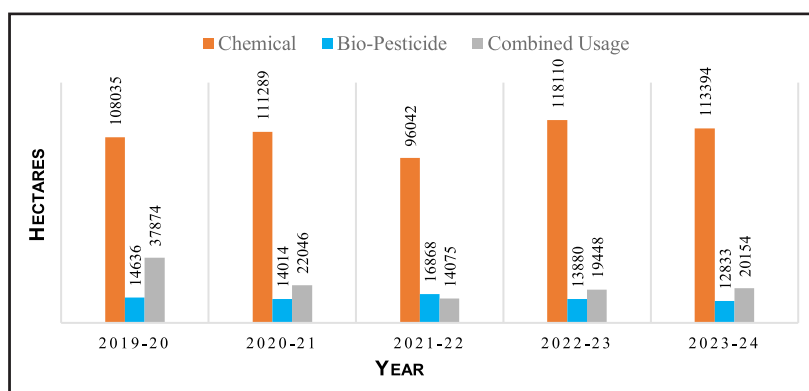


Fig 8. Cropped area under chemical, bio-pesticide and combined use of pesticides in India

In 2020–21, the cropped area (1,11,289 ha) under chemical pesticides dropped by nearly 8 per cent, but total chemical consumption increased (62,193 tonnes), indicating localized pest outbreaks requiring higher chemical use intensity per hectare. Conversely, in 2021–22, both area (96,042 ha) and consumption (59,198 tonnes) declined, reflecting favourable control options of pest populations. The highest chemical consumption does not always coincide with maximum treated area, suggesting variability in pesticide use intensity per hectare (DDPQ&S; DES, 2024).

Pesticide consumption in different agricultural commodities in india

Pesticide consumption differs across agricultural commodities based on pest pressure and value of crop. Cereals, vegetables, and cash crops use higher quantities of chemical pesticides due to intensive cultivation practices and frequent pest attacks, while in pulses and oilseeds comparatively less chemical pesticide input is used. Cereals consistently account for the largest share of 42 per cent, cash crops and fibre crop together contributed 22 per cent. Pulses and oilseeds, combinedly account for about 20 per cent of total chemical pesticide use. Horticultural crops (vegetable, fruits and others) have total share of 15 per cent chemical pesticide consumption as shown in Fig 9 (DPPQ&S, 2023).

Total biopesticide use is driven by Integrated Pest Management (IPM) modules and microbial seed treatments. Cereals and vegetables are the largest users of biopesticides together accounting for 52 per cent of the total share. Pulses and oilseeds also record relatively higher adoption of biopesticides with 9 and 5 per cent share, respectively, despite eco-friendly pest management potential. Horticultural crops such as fruits and vegetables

exhibit strong growth in biopesticide adoption, reflecting the influence of export certification standards and organic market demand (Fig 9).

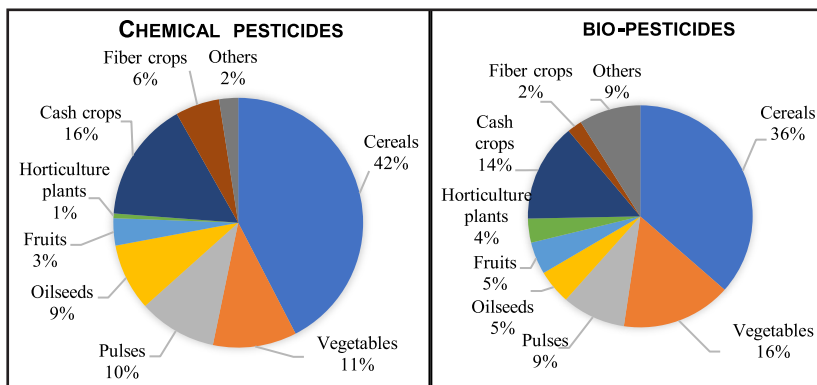


Fig 9. Consumption of chemical and bio-pesticides in different agricultural commodities

Trends in chemical and biopesticide use pattern in pulses in India

The pattern of pesticide use in pulses is highly heterogeneous, driven by variations in pest pressure, farmer awareness, and input access. Roughly one-fifth to one-fourth (20–25 per cent) of the total pulse area in India receives pesticide treatment each year. The five-year average (2019-20 to 2023-24) of chemical pesticide use in pulses was approximately 4,639 MT, representing about 10–12 per cent of total pesticide consumption across major crops. The total pesticide uses in pulses during last 5-year period fluctuated between 4,084 and 6,062 metric tonnes, showing a moderate decline of 30 per cent from the peak year 2021–22 (Fig. 10). Use of chemical pesticide in pulses peaked in year 2021–22 (6,062 MT) nearly 38 per cent higher than the preceding year due to widespread insect pest infestations in pigeonpea and chickpea belts of Karnataka, Maharashtra, and Madhya Pradesh. In some of the regional hotspots such as Kalaburagi (Karnataka), Akola and Latur (Maharashtra), and Nalgonda (Telangana) reported multiple sprays of pesticides per season, mainly insecticides targeting pod borers and sucking pests. Subsequently, the reduction in pesticide use was observed in year 2022–23 and 2023–24 indicating better pest management efficiency and greater farmer awareness toward balanced use of chemical pesticides. This variation corresponds closely with changes in pest pressure, particularly the incidence of pod borer like *Helicoverpa armigera*, *Maruca vitrata* and sterility mosaic disease, which fluctuates according to seasonal rainfall and temperature patterns (DPPQ&S, DES, 2023).

During five-year period (2019-20 to 2023-24), the share of biopesticides in total pesticide use increased from 6.7 to 7.4 per cent. The biopesticide consumption in pulses was within the narrow range of 317–768 MT, with the highest use in year 2020–21 (768 MT) a 142 per cent increase over 2019–20, later years, its usage was stabilized around 325–372 MT (Fig 10). This peak was due to national initiatives taken for promotion of microbial-based IPM modules. Also, adoption and promotion of biopesticide based pest control practices particularly in organic pulse clusters of Karnataka, Gujarat, Maharashtra and Madhya Pradesh led to incremental usage of biopesticides in pulses. This could significantly reduce production losses and environmental impact, contributing to India's long-term pulse self-sufficiency and ecological sustainability. Though chemical pesticides use continues to dominate due to their immediate efficacy, but the trend analysis indicates gains in biopesticide uses with a slow and steady shift toward biopesticides based sustainable pest management in pulses. To enhance adoption of biopesticides in pulses, strengthening of supply-chain, quality control of microbial formulations and development of location-specific eco-friendly IPM packages are essential.

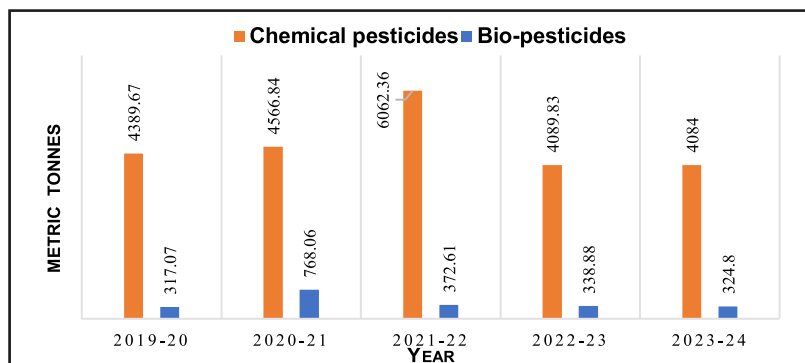


Fig 10. Consumption of chemical and bio-pesticides in pulses from 2019-2020 to 2023-2024

Microbial based biopesticides in pest management

The annual national consumption of biopesticides is estimated at 7,800 tonnes of formulations, dominated by a few key microbial formulations such as fungal antagonists, bacterial biocontrol agents, and entomopathogenic microbes which accounts for more than 90 per cent of marketed volume (Fig 11). In India around 50 microbial formulations of biopesticides are registered under Central Insecticides Board and Registration Committee (CIBRC). Over 270 biopesticide manufacturers are currently registered and most of them are in Tamil Nadu, Karnataka, Maharashtra, and West Bengal (FICCI, 2024).

Among fungal antagonists, *Trichoderma* species (*T. harzianum* and *T. viride*) together account for nearly 45–50 per cent of the national biopesticide market share followed by *Pseudomonas fluorescens* which contributes around 16 per cent share (Fig 11). This is mainly due to their broad-spectrum efficacy against soil and seed-borne fungal pathogens and their inclusion in most seed treatment and nursery management protocols. These fungal antagonists are widely used in rice, pulses and vegetable systems for managing soil and air borne diseases.

Among entomopathogenic microbes, *Bacillus thuringiensis* (*Bt*) holds a significant share of 11 per cent. It is most commonly used in crops like cotton, pigeonpea, and chickpea, mainly targeting lepidopteran pests. *Beauveria bassiana* and *Metarhizium anisopliae* together account for about 16 per cent of the biopesticide volume. These entomopathogens gaining popularity in vegetables, pulses, and plantation crops under organic programmes and IPM programmes. *Verticillium lecanii*, holds a 5 per cent share and mainly used against sucking pests in greenhouse horticulture. *Nuclear Polyhedrosis Viruses* (NPVs) for *Helicoverpa* and *Spodoptera* represent around 4 per cent of total biopesticide consumption (Fig 11). Although NPVs are limited in volume but are critical biocontrol components in pulses, cotton, and vegetable IPM programmes (NCIPM Annual Report, 2023).

Programmes like the National Mission on Sustainable Agriculture (NMSA), Organic Farming Mission, and National Project on Organic Farming (NPOF) are further driving force in adoption of biopesticides in pest management. In addition, the ban on 27 hazardous chemical insecticides in year 2020 and the rising export demand for residue-free produce have accelerated the shift toward use of microbial pest management. The pattern of microbial biopesticide use suggests India is transitioning from a chemically dependent pest management regime toward a biological-based integrated pest management system, emphasizing on environmental safety and long-term pest resistance management strategies (Kiran & Sharma, 2023). However, issues like product shelf-life, strains, quality control, temperature sensitivity, and mass production scaling-up mechanisms for liquid formulations are some of the major challenges in the adoption of biopesticides.

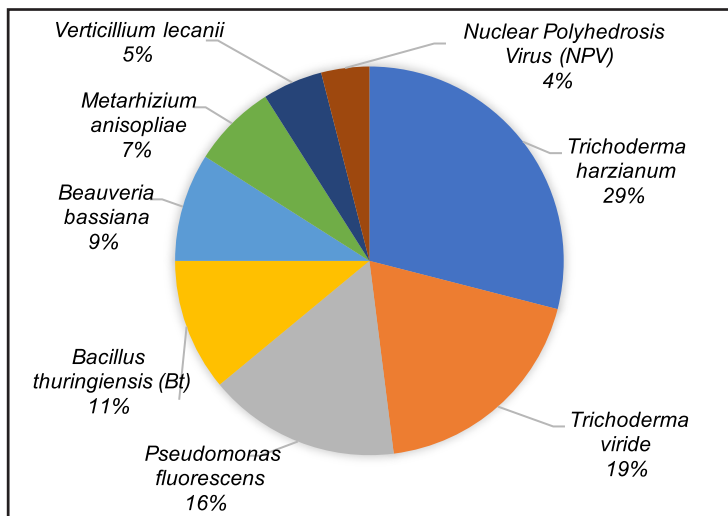


Fig 11. Share of microbial based biopesticides formulations in Indian market

Classification of Pesticides

The most commonly used pesticides like insecticide and fungicides in the agricultural crops are generally classified based on their chemical group/class and their mode of action/target site action. Knowledge on the classification of pesticides is very important to plant protection workers for selection of appropriate pesticides to be used in the field for control of target pest and diseases. Also, this information will aid in judicious use of pesticides, slowing down the development or resistance among insect pest and for better and longer efficacy of the novel molecules under field conditions. Classification of most commonly used insecticides and fungicides based on their chemical group and mode of action is given below :

A. Classification of Insecticides

i) Based on chemistry

Sl. No	Insecticide Group	IRAC mode of action class	Name of Insecticides
I	Synthetic Insecticides		
1	Organochlorines	2A	Dicofol
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, Lamd a cyhalothrin, Fenvalrate, Fenpropathrin etc.,
5	Neonicotinoids	4A	Imidacloprid, Acetamiprid, Thiamethoxam, Thiachloprid, Clothianidin, Dinotefuran, Nitenpyram
6	Sulfoximines	4C	Sulfoxaflor
7	Butenolides	4D	Flupyradifurone
8	Mesoionics	4E	Dicloromezotiaz, Fenmezoditiaz, Triflumezopyrim
9	Pyridylidenes	4F	Flupyrimin
10	Pyridine azomethine derivatives	9B	Pymetrozine, Pyrifluquinazon
11	Pyropenes	9D	Afidopyropen
12	Phenylpyrazoles	2B	Fipronil, Ethiprole
13	Oxadiazines	22A	Indoxacarb
14	Semicarbazones	22B	Metaflumizone
15	Ketoenols (Tetronic and Tetramic acid derivatives)	23A	Spirodiclofen, Spiromesifen, Spirotetramat

16	Phosphides	24A	Aluminium phosphide, Calcium phosphide, Phosphine, Zinc phosphide
17	Cyanides	24B	Calcium cyanide, Potassium cyanide, Sodium cyanide
18	Beta-ketonitrile derivatives	25A	Cyenopyrafen, Cyflumetofen
19	Carboxanilides	25B	Pyflubumide
20	Diamides	28A	Chlorantraniliprole, Cyantraniliprole, Cyclaniliprole, Flubendiamide, Tetraniliprole
21	Pyridazionone		Pyridaben
22	Nereistoxin	14A	Bensultap, Thiocyclam, Thiosultap sodium
23	Formamidines	19A	Chlordimeform and Amitraz
24	Pyridinecarboxamide	29	Flonicamid
25	Isoxazolines	30	Isocycloseram
26	Meta-diamides	30	Broflanilide, Cyproflanilide, Fluxametamide
II	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
III.	Insect Growth Regulators		
1	Benzoylureas (Chitin Synthesis Inhibitors for lepidoptera)	15A	Bistrifluron, Chlorfluazuron, Diflubenzuron, Flucyclozuron, Flufenoxuron, Hexaflumuron, Lufenuron, Novaluron, Noviflumuron, Teflubenzuron, Triflumuron
2	Chitin Synthesis Inhibitors (for Homoptera)	16A	Buprofezin
3	Moulting disruptors (for dipterans)	17A	Cryomazine
4	Ecdysone Agonists and Diacylhrazines	18A	Methoxyfenozide, Tebufenozide, Halofenozide, Methofenozide
5	Juvenile Hormone Mimics	17A	Pyriproxifen, Fenoxycarb, Diofenolan, Hydroprene, Methoprene and Kinoprene.
6	Mite growth inhibitors	10A	Clofentezine, Diflovidazin, Hexythiazox
		10B	Etoxazole
7	Juvenile hormone analogues/receptor modulators	7A	Hydroprene, Kinoprene, Methoprene
		7B	Fenoxycarb
		7C	Pyriproxifen

ii) Based on Insecticide Resistance Action Committee (IRAC) Mode of Action

Main Group and Primary Site of Action	Chemical Sub-group or exemplifying Active Ingredient	Major Active Ingredients
<p>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</p>	<p>1A Carbamates</p>	Alanycarb, Aldicarb, Bendiocarb, Benfuracarb, Butocarboxim, Butoxycarboxim, Carbaryl, Carbofuran, Carbosulfan, Ethiofencarb, Fenobucarb, Formetanate, Furathiocarb, Isoprocarb, Methiocarb, Methomyl, Oxamyl, Pirimicarb, Propoxur, Thiodicarb, Thiofanox, Triazamate, Trimethacarb, XMC, Xyllylcarb
	<p>1B Organophosphates</p>	Acephate, Azinphos-ethyl, Azinphos-methyl, Chlorpyrifos, Chlorpyrifos-methyl, Demeton-S-methyl, Diazinon, Dichlorvos/ DDVP, Dimethoate, Ethion, Fenitrothion, Fenthion, Malathion, Methamidophos, Monocrotophos, Naled, Oxydemeton-methyl, Parathion, Phenthoate, Phorate, Phosalone, Phosmet, Phosphamidon, Profenofos, Quinalphos, Tebupirimfos, Temephos, Thiometon, Triazophos, Trichlorfon, Vamidothion
<p>Group 2 GABA-gated chloride channel blockers Nerve action Block the GABA-activated chloride channel, causing hyperexcitation and convulsions. GABA is the major inhibitory neurotransmitter in insects. inhibitory neurotransmitter in insects</p>	<p>2A Cyclodiene organochlorines</p>	Chlordane, Endosulfan
	<p>2B Phenylpyrazoles</p>	Ethiprole, Fipronil
<p>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</p>	<p>3A Pyrethroids Pyrethrins</p>	Acrinathrin, Bifenthrin, Bioresmethrin, Cycloprothrin, Cyfluthrin, <i>beta</i> -Cyfluthrin, Cyhalothrin, <i>lambda</i> -Cyhalothrin, Cyphenothrin, Deltamethrin, Esfenvalerate, Etofenprox, Fenpropathrin, Fenvalerate, Flucythrinate, Flumethrin, <i>tau</i> -Fluvalinate, Halfenprox,

potentials along nerve axons.		Imiprothrin, , Permethrin, Phenothrin, Prallethrin, Pyrethrins (pyrethrum), Resmethrin, Silafluofen, Tefluthrin, Tetramethrin, Tralomethrin, Transfluthrin,
<p>Group 4. Nicotinic acetylcholine receptor (nAChR) competitive modulators Nerve action Bind to the acetylcholine site on nAChRs, causing a range of symptoms from hyperexcitation to lethargy and paralysis. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.</p>	<p>3B DDT Methoxychlor</p> <p>4A Neonicotinoids</p> <p>4B Nicotine</p> <p>4C Sulfoximines</p> <p>4D Butenolides</p> <p>4E Mesoionics</p> <p>4F Pyridylidenes</p>	<p>DDT Methoxychlor</p> <p>Acetamiprid, Clothianidin, Dinotefuran, Imidacloprid, Nitenpyram, Thiacloprid, Thiamethoxam,</p> <p>Nicotine</p> <p>Sulfoxaflor</p> <p>Flupyradifurone</p> <p>Dicloromezotiaz, Fenmezoditiaz, Triflumezopyrim</p> <p>Flupyrimin</p>
<p>Group 5. Nicotinic acetylcholine receptor (nAChR) allosteric modulators – Site I Nerve action Allosterically activate nAChRs (at a site distinct from Group 32 - Site II), causing hyperexcitation of the nervous system. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.</p>	<p>5 Spinosyns</p>	<p>Spinetoram, Spinosad</p>
<p>Group 6. Glutamate-gated chloride channel (GluCl) allosteric modulators Nerve and muscle action Allosterically activate glutamate-gated chloride channels (GluCl), causing paralysis. Glutamate is an important inhibitory neurotransmitter in insect.</p>	<p>6 Avermectins, Milbemycins</p>	<p>Abamectin, Emamectin benzoate, Lepimectin, Milbemectin</p>

Group 7 Juvenile hormone receptor modulators 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	1,3-Dichloropropene, Methyl bromide and other alkyl halides
	8B Chloropicrin	Chloropicrin
	8C Sulfuryl fluoride	Cryolite (Sodium aluminum fluoride), Sulfuryl fluoride
	8D Borax	Borax, Boric acid, Disodium octaborate, Sodium borate, Sodium metaborate
	8E Tartar emetic	Tartar emetic
	8F Methyl isothiocyanate generators	Dazomet, Metam, Methyl isothiocyanate
Group 9. Chordotonal organ TRPV channel modulators Bind to and disrupt the gating of Nan-Iav TRPV (Transient Receptor Potential Vanilloid) channel complexes in chordotonal stretch receptor organs, which are critical for the senses of hearing, gravity, balance, acceleration, proprioception and kinesthesia. This disrupts feeding and other behaviors in target insects.	9B Pyridine azomethine derivatives	Pymetrozine, Pyriproxyfen
	9D Pyropenes	Afidopyropen
Group 10. Mite growth inhibitors affecting CHS1 Growth regulation Inhibit the enzyme that catalyzes the polymerization of chitin	10A Clofentezine Hexythiazox, Diflovidazin	Clofentezine, Hexythiazox, Diflovidazin
	10B Etoxazole	Etoxazole

<p>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.</p>	<p>11A <i>Bacillus thuringiensis</i> and the insecticidal proteins they produce</p>	<p><i>Bacillus thuringiensis</i> subsp. <i>israelensis</i> <i>Bacillus thuringiensis</i> subsp. <i>aizawai</i> <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i> <i>Bacillus thuringiensis</i> subsp. <i>tenebrionis</i> <i>B.t. crop proteins: Cry1Ab, Cry1Ac, Cry1Fa, Cry1A.105, Cry2Ab, Vip3A, mCry3A, Cry3Ab, Cry3Bb, Cry34Ab1/Cry35Ab1</i></p>
	<p>11B <i>Bacillus sphaericus</i></p>	<p><i>Bacillus sphaericus</i></p>
<p>Group 12. Inhibitors of mitochondrial ATP synthase Energy metabolism Inhibit the enzyme that synthesizes ATP.</p>	<p>12A Diafenthiuron</p>	<p>Diafenthiuron</p>
	<p>12B Organotin miticides</p>	<p>Azocyclotin, Cyhexatin, Fenbutatin oxide</p>
	<p>12C Propargite</p>	<p>Propargite</p>
	<p>12D Tetradifon</p>	<p>Tetradifon</p>
<p>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 cannot be synthesized.</p>	<p>Pyrroles Dinitrophenols Sulfluramid</p>	<p>Chlorfenapyr DNOC Sulfluramid</p>
<p>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.</p>	<p>Nereistoxin analogues</p>	<p>Bensultap, Cartap hydrochloride, Thiocyclam, Thiosultap-sodium</p>

<p>Group 15. Inhibitors of chitin biosynthesis affecting CHS1 Growth regulation Inhibit the enzyme that catalyzes the polymerization of chitin.</p>	<p>15 A Benzoylureas</p>	Bistrifluron, Chlorfluazuron, Diflubenzuron, Flucycloxuron, Flufenoxuron, Hexaflumuron, Lufenuron, Novaluron, Noviflumuron, Teflubenzuron, Triflumuron
<p>Group 16. Inhibitors of chitin biosynthesis, type 1 Incompletely defined MoA leading to inhibition of chitin biosynthesis in a number of insect species, including whiteflies.</p>	Buprofezin	Buprofezin
<p>Group 17. Moulting disruptors, Dipteran Growth regulation Incompletely defined MoA that leads to moult disruption.</p>	Cyromazine	Cyromazine
<p>Group 18. Ecdysone receptor agonists Growth regulation Mimic the moulting hormone, ecdysone, inducing a precocious moult.</p>	Diacylhydrazines	Chromafenozide, Halofenozide, Methoxyfenozide, Tebufenozide
<p>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</p>	Amitraz	Amitraz
<p>Group 20. Mitochondrial complex III electron transport inhibitors - Qo site Energy metabolism Inhibit electron transport complex III, preventing the utilization of energy by cells by binding to the Qo site.</p>	<p>20A Hydramethylnon</p>	Hydramethylnon
	<p>20B Acequinocyl</p>	Acequinocyl
	<p>20C Fluacrypyrim</p>	Fluacrypyrim
	<p>20D Bifenazate</p>	Bifenazate

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	Fenazaquin, Fenpyroximate, Pyrimidifen, Pyridaben, Tebufenpyrad, Tolfenpyrad
	21B Rotenone	Rotenone (Derris)
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 Oxadiazines	Indoxacarb
	22B Semicarbazones	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.	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	Aluminium phosphide, Calcium Phosphide, Phosphine, Zinc phosphide
	24B Cyanide	Calcium cyanide, Potassium cyanide, Sodium cyanide
Group 25. Mitochondrial complex II electron transport inhibitors Energy metabolism Inhibit electron transport complex II, preventing utilization of energy by cells.	25A Beta-ketonitrile derivatives	Cyenopyrafen, Cyflumetofen
	25B Carboxanilides	Pyflubumide
Group 28 Ryanodine receptor modulators Nerve and muscle action Activate muscle ryanodine	Diamides	Chlorantranilprole, Cyantranilprole, Cyclanilprole Flubendiamide, Tetranilprole

receptors, leading to contraction and paralysis. Ryanodine receptors mediate calcium release into the cytoplasm from intracellular stores.		
<p>Group 29 Chordotonal organ nicotinamidase inhibitors Nerve action Disrupt the function of chordotonal stretch receptor organs, which are critical for the senses of hearing, gravity, balance, acceleration, proprioception and kinesthesia. This disrupts feeding and other behaviors in target insects. Group 29 insecticides inhibit the enzyme nicotinamidase, which degrades the endogenous TRPV modulator nicotinamide.</p>	Flonicamid	Flonicamid
<p>Group 30 GABA-gated chloride channel allosteric modulators Nerve action Allosterically inhibit the GABA-activated chloride channel, causing hyperexcitation and convulsions. GABA is the major inhibitory neurotransmitter in insects.</p>	<p>Isoxazolines</p> <p>Meta-diamides</p>	<p>Isocycloseram</p> <p>Broflanilide, Cyproflanilide, Fluxametamide</p>
<p>Group 31 Baculoviruses Host-specific occluded pathogenic viruses A baculovirus-unique Per os Infectivity Factor (PIF) protein complex on the virus promotes host-specific infection by binding to PIF targets on midgut cells that are unknown but believed to be unique for each baculovirus type. Infection is ultimately lethal.</p>	<p>Granuloviruses (GVs)</p> <p>Nucleo Polyhedron Viruses (NPVs)</p>	<p><i>Cydia pomonella</i> GV <i>Thaumatotibia leucotreta</i> GV</p> <p><i>Anticarsia gemmatalis</i> MNPV <i>Helicoverpa armigera</i> NPV <i>Spodoptera litura</i> NPV</p>

<p>Group 32 Nicotinic Acetylcholine Receptor (nAChR) Allosteric Modulators - Site II Nerve action Allosterically activate nAChRs (at a site distinct from Group 5 - Site I), causing hyperexcitation of the nervous system. Acetylcholine is the major excitatory neurotransmitter in the insect central nervous system.</p>	GS-omega/kappa HXTX-Hv1a peptide	GS-omega/kappa HXTX-Hv1a peptide
<p>Group 33 Calcium-activated potassium channel (KCa2) modulators Nerve action Negative modulation of KCa2 causes hyperexcitation and convulsions. KCa2 channels are activated by increase of the intracellular calcium concentration and are involved in the regulation of action potentials.</p>	Acynonapyr	Acynonapyr
<p>Group 34 Mitochondrial complex III electron transport inhibitors – Qi site Energy metabolism Inhibit electron transport complex III, preventing the utilization of energy by cells. In contrast to Group 20, Group 34 insecticides bind to the Qi site.</p>	Flometoquin	Flometoquin
<p>Group 35. RNA Interference mediated target suppressors Activation of the RNAi mechanism which specifically reduces abundance of the target messenger RNA (mRNA) resulting in the reduction of the protein encoded by the mRNA.</p>	Ledprona	Ledprona

<p>Group 36. Chordotonal organ modulators – undefined target site Nerve action Disrupt the function of chordotonal stretch receptor organs, which are critical for the senses of hearing, gravity, balance, acceleration, proprioception and kinesthesia. This disrupts feeding and other behaviors in target insects. Group 36 insecticides act at a site different from Group 9 and Group 29 insecticides and are neither affecting TRPV channels nor nicotinamidase.</p>	Pyridazine pyrazolecarboxamides	Dimpropyridaz
<p>Group 37. Vesicular acetylcholine transporter (VAChT) inhibitor Nerve action Bind to VAChTs, causing cholinergic synaptic transmission block resulting in nervous system shutdown and paralysis. VAChTs are involved in loading acetylcholine into synaptic vesicles</p>	Oxazosulfyl	Oxazosulfyl
<p>Group UN: Compounds of unknown or uncertain MoA (Target protein responsible for biological activity is unknown, or uncharacterized)</p>	Azadirachtin	Azadirachtin
	Benzoximate	Benzoximate
	Benzpyrimoxan	Benzpyrimoxan
	Bromopropylate	Bromopropylate
	Chinomethionat	Chinomethionat
	Dicofol	Dicofol
	Lime sulfur	Lime sulfur
	Mancozeb	Mancozeb
<p>Group UNB: Bacterial agents (non-Bt) of unknown or uncertain MoA</p>	Pyridalyl	Pyridalyl
	Sulfur	Sulfur <i>Burkholderia</i> spp <i>Wolbachia pipientis</i> (Zap)

Group UNE: Botanical essence including synthetic, extracts and unrefined oils with unknown or uncertain MoA		<i>Chenopodium ambrosioides</i> near ambrosioides extract, Fatty acid monoesters with glycerol or propanediol, Neem oil, Nonanoic acid, Sabadilla extract
Group UNF: Fungal agents of unknown or uncertain MoA		<i>Akanthomyces muscarius</i> <i>Beauveria bassiana</i> strains <i>Metarhizium brunneum</i> strains <i>Paecilomyces fumosoroseus</i> Apopka strain 97
Group UNM: Non-specific mechanical and physical disruptors		Diatomaceous earth Mineral oil Polydimethylsiloxane (PDMS)
Group UNP: Peptides of unknown or uncertain MoA		
Group UNV: Viral agents of unknown or uncertain MoA		

Source: IRAC (2025)

B. Classification of Fungicides

i). Based on Chemistry

Chemical group	Sub group	FRAC Code	Fungicides
Aliphatic nitrogen fungicides	Quinones (anthrax-quinones)	M9	Cymoxanil
Amide Fungicides	Thiophene-carboxamides	38	Silthiofam, carpropamid, fenoxanil, mandipropamid, metominostrobin, prochloraz
	Acylamino acid fungicides	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	Benthiavdicarb, iprovalicarb	

Antibiotic fungicides	Hexopyranosyl antibiotic	24	Kasugamycin
	Glucopyranosyl antibiotic	25	Streptomycin
	Glucopyranosyl antibiotic	26	Validamycin
Strobilurin fungicides	Methoxyacrylate	11	Azoxystrobin
	Methoxycarbanilate	11	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
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		11	Famoxadone
	Phthalimide fungicides	M4	Captan
Dinitrophenol fungicides			Dinocap
Dithio carbamate fungicides		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 bth	P	Acibenzolar-s-methyl

ii). **Based on Mode of Action**

MOA	Target Site and Code	Group Name	Chemical or Biological Group	Common Name
A: Nucleic acids metabolism 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 Furalaxyl, Metalaxyl Metalaxyl-M
			Oxazolidinones	Oxadixyl
			Butyrolactones	Ofurace
	A2 Adenosin-deaminase	hydroxy- (2-amino-) pyrimidines	Hydroxy- (2-amino-) pyrimidines	Bupirimate Dimethirimol Ethirimol
	A3 DNA/RNA synthesis (proposed)	heteroaromatics	Isoxazoles Isothiazolones	Hymexazole Isothiazolones
A4 DNA topoisomerase type II (gyrase)		Carboxylic acids	Carboxylic acids	Oxolinic Acid

	A5 Inhibition of dihydroorotate dehydrogenase within <i>de novo</i> pyrimidine biosynthesis	DHODHI-fungicides	Phenyl-Propanol Dihydro-isoquinoline	Ipflufenoquin Quinofumelin
B: Cytoskeleton and motor protein Inhibits β -tubulin assembly in mitosis. Causes several target site mutations, mostly E198A E198/G/K, F200Y in β -tubulin gene. Also causes delocalisation of spectrin-like proteins	B1 Tubulin polymerization	MBC-fungicides (Methyl Benzimidazole Carbamates)	Benzimidazoles	Benomyl, Carbendazim, Fuberidazole, Thiabendazole.
			Thiophanates	Thiophanate Thiophanate-Methyl
	B2 Tubulin polymerization	N-phenyl carbamates	N-phenyl carbamates	Diethofencarb
	B3 Tubulin polymerization	Benzamides	Toluamides	Zoxamide
		Thiazole Carboxamide	Ethylamino-Thiazole-Carboxamide	Ethaboxam
	B4 Cell division (unknown site)	Phenylureas	Phenylureas	Pencycuron
	B5 Delocalisation of spectrin-like proteins	Benzamides	Pyridinylmethyl-Benzamides	Fluopicolide Fluopimomide
	B6 Actin/myosin/fimbrin function	Cyanoacrylates	Amino cyanoacrylates	Phenamacril
Aryl-Phenyl-Ketones		Benzophenone Benzoylpyridine	Metrafenone Pyriofenone	
B7 Tubulin dynamics modulator	Pyridazine	Pyridazine	Pyridachlometyl	

<p>C: Respiration Inhibits several enzymes involved in pathogen respiration <i>e.g.</i> I NADH Oxido-reductase (pyrimidinamines); succinate-dehydrogenase SDHI (Succinate Dehydrogenas inhibitors)with target site mutations in <i>sdh</i> gene, <i>e.g.</i> H/Y (or H/L) at 257, 267, 272 or P225L, dependent on fungal species; cytochrome <i>bc1</i> (ubiquinol oxidase) at Qo site (<i>cyt b</i> gene) with target site mutations in <i>cyt b</i> gene (G143A, F129L); cytochrome <i>bc1 t</i> Qi site. also inhibits oxidative phos-phorylation and ATP synthase</p>	C1 Complex I NADH oxido-reductase	Pyrimidin Amines	Pyrimidin Amines	Diflumetorim	
		Pyrazole-MET1	Pyrazole-5-Carboxamides	Tolfenpyrad	
		Quinazoline	Quinazoline	Fenazaquin	
	C2 complex II: succinate-dehydro- genase	SDHI-fungicides (Succinate-dehydrogenase inhibitors)	Phenyl-Benzamides	Phenyl-Benzamides	Benodanil Flutolanil Mepronil
			Phenyl-Oxo-Ethyl Thiopheneamide	Phenyl-Oxo-Ethyl Thiopheneamide	Isofetamid
			Pyridinyl-Ethyl-Benzamides	Pyridinyl-Ethyl-Benzamides	Fluopyram
			Phenyl-Cyclobutyl-Pyridineamide	Phenyl-Cyclobutyl-Pyridineamide	Cyclobutrifluram
			Furan-Carboxamides	Furan-Carboxamides	Fenfuram
			Oxathiin-Carboxamides	Oxathiin-Carboxamides	Carboxin Oxycarboxin
			Thiazole-Carboxamides	Thiazole-Carboxamides	Thifluzamide
			Pyrazole-4-Carboxamides	Pyrazole-4-Carboxamides	Benzovindiflupyr Bixafen Fluindapyr Luxapyroxad Furametpyr Inpyrfluxam Isopyrazam Penflufen Penthiopyrad Sedaxane
			N-cyclopropyl-N-benzyl-pyrazole-carboxamides	N-cyclopropyl-N-benzyl-pyrazole-carboxamides	Isoflucypram
			N-methoxy-(phenyl-ethyl)-pyrazole-carboxamides	N-methoxy-(phenyl-ethyl)-pyrazole-carboxamides	Pydiflumetofen
			Pyridine-carboxamides	Pyridine-carboxamides	Boscalid
			Pyrazine-carboxamides	Pyrazine-carboxamides	Pyraziflumid

C3 complex III: cytochrome bc1 (ubiquinoloxidase) at Qo site (<i>cyt b</i> <i>gene</i>)	QoI-fungicides (Quinone outside Inhibitors)	Methoxy- acrylates	Azoxystrobin Coumoxystrobin Enoxastrobin Flufenoxystrobin Picoxystrobin Pyraoxystrobin
		Methoxy- Acetamide	Mandestrobin
		Methoxy- Carbamates	Pyraclostrobin Pyrametostrobin Triclopyricarb
		Oximino- Acetates	Kresoxim-Methyl Trifloxystrobin
		Oximino- Acetamides	Dimoxystrobin Fenaminstrobin Metominostrobin Orysastrobin
		Oxazolidine- Diones	Famoxadone
		Dihydro- Dioxazines	Fluoxastrobin
		Imidazolinones	Fenamidone
		Benzyl- Carbamates	Pyribencarb
			QoI-fungicides (Quinone outside Inhibitors; Subgroup A)
C4 complex III: cytochrome bc1 (ubiquinone reductase) at Qi site	QiI-fungicides (Quinone insie Inhibitors)	Cyano-Imidazole	Cyazofamid
		Sulfamoyl- Triazole	Amisulbrom
		Picolinamides	Fenpicoxamid Florylpicoxamid
C5 uncouplers of oxidative phosphorylation		Dinitrophenyl- Crotonates	Binapacryl Meptyldinocap Dinocap
		2,6-dinitro- anilines	Fluazinam
		(pyr.hydrazones)	Ferimzone
C6 Inhibitors of oxid. phosphorylation, ATP synthase	Organotin compounds	Tri-phenyltin compounds	Fentinacetate Fentinchloride Fentinhydroxide
C7 ATP transport (proposed)	Thiophene- carboxamides	Thiophene- carboxamides	Silthiofam

	C8 complex III: cytochromebc1 (ubiq. reductase) at Qi and Qo site (stigmatellin)	QioSI fungicide (Quinone inside and outside inhibitor, stigmatellin binding mode)	Triazolo-pyrimidylamine	Ametoctradin
D: Amino acids and protein synthesis Inhibits methionine biosynthesis (cgs gene) and protein synthesis	D2 Protein synthesis (ribosome, termination step)	Enopyranuronic acidantibiotic	Enopyranuronic acid antibiotic	Blasticidin-S
	D3 Protein synthesis (ribosome, initiation step)	Hexopyranosyl antibiotic	Hexopyranosyl antibiotic	Kasugamycin
	D4 Protein synthesis (ribosome, initiation step)	Glucopyranosyl antibiotic	Glucopyranosyl antibiotic	Streptomycin
	D5 Protein synthesis (ribosome, elongation step)	Tetracycline antibiotic	Tetracycline antibiotic	Oxytetracycline
	D6 Leucyl-tRNA synthetase (LeuRS)	Benzoxaboroles	Benzoxaboroles	Tavaborole
E: Signal transduction Inhibits G-proteins in early cell signalling. Histidine-Kinase in osmotic signal transduction	E1 Signal transduction (mechanism unknown)	Aza-naphthalenes	Aryloxyquinoline Quinazolinone	Quinoxyfen Proquinazid
	E2 MAP/Histidine-Kinase in osmotic signal transduction (<i>os-2, HOG1</i>)	PP-fungicides (Phenyl Pyrroles)	Phenylpyrroles	Fenpiclonil Fludioxonil
	E2 MAP/Histidine-Kinase in osmotic signal transduction (<i>os-2, HOG1</i>)	PP-fungicides (Phenyl Pyrroles)	Phenylpyrroles	Fenpiclonil Fludioxonil

	E3 MAP/Histidine-Kinase in osmotic signal transduction (<i>os-1, Daf1</i>)	Dicarboximides	Dicarboximides	Chlozolate Dimethachlone Iprodione Procymidone Vinclozolin
F: Lipid synthesis or transport/ membrane integrity or function Inhibits phospho lipid biosynthesis, by inactivating methyl transferase enzymes or lipid peroxidation. Hampers the cell membrane permeability and disrupts cell wall deposition	F1	Formerly dicarboximides		
	F2 Phospholipid biosynthesis, Methyl transferase	Phosphorothiolates	Phosphorothiolates	Edifenphos Iprobenfos(ibp) pyrazophos
		Dithiolanes	Dithiolanes	Isoprothiolane
	F3 Cell peroxidation (proposed)	AH-fungicides (Aromatic Hydrocarbons) (chlorophenyls, nitroanilines)	Aromatic hydrocarbons	Biphenyl Chloroneb Dicloran Quintozene (PCNB) Tecnazene (TCNB) Tolclofos-methyl
		Heteroaromatics	1,2,4-thiadiazoles	Etridiazole
	F4 Cell membrane permeability, fatty acids (proposed)	Carbamates	Carbamates	Iodocarb Propamocarb Prothiocarb
	F5	Formerly CAA-fungicides		
	F6 Microbial disrupters of pathogen cell membranes	Formerly <i>Bacillus amyloliquefaciens</i> strains (FRAC Code 44), reclassified to BM02 in 2020		
	F7 Cell membrane disruption	Formerly extract from <i>Melaleuca alternifolia</i> (tea tree oil) and plant oils (eugenol, geraniol, thymol) FRAC Code 46, reclassified to BM01 in 2021		
F8 Ergosterol binding	Polyene	Amphoteric macrolide antifungal antibiotic from <i>Streptomyces natalensis</i> or <i>S. chattanoogensis</i>	Natamycin (pimaricin)	

	F9 Lipid homeostasis and transfer/storage	OSBPI-fungicides oxysterol binding protein homologue inhibition	Piperidinyl-thiazole-isoxazolines	Oxathiapiprolin fluoxapiprolin
	F10 Interaction with lipid fraction of the cell membrane, with multiple effects on cell membrane integrity	Protein fragment	Polypeptide	Polypeptide ASFBI0F01-02
G: Sterol biosynthesis in membranes Inhibits C14-demethylase in sterol biosynthesis (<i>erg11/cyp51</i>) (De Methylation Inhibitors) or A14Reductase and 48-47 Isomerase in sterol biosynthesis or 3-keto reductase, or squalene-epoxidase	G1 C14-demethylase in sterol biosynthesis (<i>erg11/cyp51</i>)	DMI-fungicides (DeMethylation Inhibitors) (SBI: ClassI)	Piperazines	Triforine
			Pyridines	Fenarimol Nuarimol
			Imidazoles	Imazalil Oxpoconazole Pefurazoate Prochloraz Triflumizole
			Triazoles, triazolinthiones	Azaconazole, Bitertanol, Bromuconazole, Cyproconazole, Difenoconazole, Diniconazole, Epoconazole, Etaconazole, Fenbuconazole, Fluquinconazole, Flusilazole , Flutriafol, Hexaconazole, Imibenconazole, Ipconazole, Mefentrifluconazole, Metconazole, Myclobutanil, Penconazole, Propiconazole, Simeconazole, Tebuconazole,

				Tetraconazole, Triadimefon, Triadimenol, Triticonazole, Prothioconazole
	G2 Δ 14-reductase and Δ 8 - Δ 7 isomerase in sterol biosynthesis (<i>erg24, erg2</i>)	Amines ("morpholines") (SBI: ClassII)	Morpholines	Aldimorph dodemorph Fenpropimorph tridemorph
			Piperidines	Fenpropidin piperalin
			Spiroketal- amines	Spiroxamine
	G3 3-keto reductase, C4- demethylation (<i>erg27</i>)	KRI-fungicides (Keto Reductase Inhibitors) (SBI: Class III)	Hydroxyanilides	Fenhexamid
			Amino- pyrazolinone	Fenpyrazamine
	G4 squalene- epoxidaseinsterol biosynthesis (<i>erg1</i>)	SBI class IV)	Thiocarbamates	Pyributicarb
			Allylamines	Naftifine terbinafine
H: Cell wall biosynthesis Inhibits trehalase and inositol- biosynthesis	H3	Formerly glucopyranosyl antibiotic (validamycin)		
	H4 Chitin synthase	Polyoxins	Peptidyl pyrimidine nucleoside	Polyoxin
	H5 Cellulose synthase	CAA-fungicides (Carboxylic Acid Amides)	Cinnamic acid amides	Dimethomorph Flumorph Pyrimorph
			Valinamide carbamates	Benthiavalicarb Iprovalicarb Valifenalate
Mandelic acid amides			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	Fthalide
			Pyrrolo- quinolinone	Pyroquilon
			Triazolobenzothiazole	Tricyclazole
	I2 Dehydratase in melanin biosynthesis	MBI-D (Melanin Biosynthesis Inhibitors - Dehydratase)	Cyclopropane- carboxamide	Carpropamid
			Carboxamide	Diclocymet
Propionamide			Fenoxanil	

	I3 Polyketide synthase in melanin biosynthesis	MBI-P (Melanin Biosynthesis Inhibitors - Polyketide synthase)	Trifluoroethyl- carbamate	Tolprocarb	
P: host plant defence induction Plays a role in initiating salicylic acid pathway which induces resistance and also antibacterial and antifungal activity	P01 Salicylate-related	Benzo- thiadiazole (BTH)	Benzo-thiadiazole (BTH)	Acibenzolar-S- methyl	
	P02 Salicylate-related	Benzisothiazole	Benzisothiazole	Probenazole (also antibacterial and Antifungal activity)	
	P03 Salicylate-related	Thiadiazole- carboxamide	Thiadiazole- carboxamide	Tiadinil isotianil	
	P04 Polysaccharide elicitors	Natural compound	Polysaccharides	Laminarin	
	P05 Anthraquinone elicitors	Plant extract	Complex mixture, Ethanol extract (anthraquinones, Resveratrol)	Extract from <i>reynoutria sachalinensis</i> (giant knotweed)	
	P06 Microbial elicitors		Microbial	Bacterial <i>Bacillus</i> spp.	<i>Bacillus mycoides</i> Isolatej
				Fungal <i>Saccharomyces</i> spp.	<i>Cell walls of saccharomyces cerevisiae</i> strain las117
	P07 Phosphonates	Phosphonates	Ethyl phosphonates	Fosetyl-Al Phosphorous acid and salts	
P08 Salicylate-related	Isothiazole	Isothiazolylmethyl ether	Dichlobentiazox		
U: Unknown mode of action (U numbers not appearing in the list derive from reclassified fungicides) The mode of action is under study	Unknown	Cyanoacetamide- oxime	Cyanoacetamide- oxime	Cymoxanil	
	Formerly phosphonates (FRAC code 33), reclassified to P 07 in 2018				
	Unknown	Phthalamic acids	Phthalamic acids	Tecloftalam (bactericide)	
	Unknown	Benzotriazines	Benzotriazines	Triazoxide	
	Unknown	Benzene- sulfonamides	Benzene- sulphonamides	Flusulfamide	
	Unknown	Pyridazinones	Pyridazinones	DiClomezine	
Formerly methasulfocarb (FRAC code 42), reclassified to M 12 in 2018					

	Unknown	Phenyl-acetamide	Phenyl-acetamide	Cyflufenamid
	Cell membrane disruption (proposed)	Guanidines	Guanidines	Dodine
	Unknown	Thiazolidine	Cyano-methylene-thiazolidines	Flutianil
	Unknown	Pyrimidinone-hydrazones	Pyrimidinone-hydrazones	Ferimzone
	Complex III: cytochrome bc1, unknown binding Site (proposed)	4-quinolyl-acetate	4-quinolyl-acetates	Tebufloquin
	Unknown	Tetrazolyloxime	Tetrazolyloximes	Picarbutrazox
	Unknown (inhibition of trehalase)	Glucopyranosyl antibiotic	Glucopyranosyl antibiotics	Validamycin
Not specified	Unknown	Diverse	Diverse	Mineral oils, Organic oils, Inorganic salts, Material of biological origin
M: Chemicals with multi-site activity	Multi-site contact activity	Inorganic (electrophiles)	Inorganic	Copper (different salts)
		Inorganic (electrophiles)	Inorganic	Sulphur
		Dithiocarbamates and relatives (electrophiles)	Dithio-carbamates and relatives	Amobam Ferbam Mancozeb Maneb Metiram Propineb Thiram Zinethiazole Zineb Ziram
		Phthalimides (electrophiles)	Phthalimides	Captan Captafol Folpet
		Chloronitriles (phthalonitriles) (unspecified mechanism)	Chloronitriles (phthalonitriles)	Chlorothalonil
		Sulfamides (electrophiles)	Sulfamides	Dichlofluanid Tolyfluanid
		Bis-guanidines (membrane Disruptors, detergents)	Bis-guanidines	Guazatine Iminoctadine

		Triazines (unspecified mechanism)	Triazines	Anilazine
		Quinones (anthraquinones) (electrophiles)	Quinones (anthraquinones)	Dithianon
		Quinoxalines (electrophiles)	Quinoxalines	Chinomethionat/ Quinomethionate
		Maleimide (electrophiles)	Maleimide	Fluoroimide
		thiocarbamate (electrophiles)	thiocarbamate	Methasulfocarb
BM: Biologicals with multiple modes of action. Plant extracts	Multiple effect son ion membrane transporters; chelating effects	Plant extract	Polypeptide (lectin)	Extract from the cotyledons of lupine plantlets (“BLAD”)
	Affects fungal spores and germ tubes, induced plant defense	Plant extract	Phenols, sesquiterpenes, triterpenoids, coumarins	Extract from <i>Swinglea glutinosa</i>
	Cell membrane disruption, cell wall, Induced plant defense mechanisms	Plant extract	Terpene hydrocarbons, terpene alcohols and terpene phenols	Extract from <i>Melaleuca alternifolia</i> (tea tree oil) Plant Oils (Mixtures): Eugenol, Geraniol, Thymol
BM: Biologicals with multiple modes of action: Microbial (living microbes, or extracts from microbes or metabolites)	multiple effects described (examples, not all apply to all biological groups): competition, mycoparasitism, antibiosis, membrane disruption by fungicidal lipopeptides, lytic enzymes, induced plant defense	Microbial (strains of living microbes or extract, metabolites)	Fungal <i>Trichoderma</i> spp.	<i>T. atroviride</i> Strain I-1237 strain LU132 strain SC1 strain SKT-1 strain 77B
				<i>T. asperellum</i> Strain T34 strainkd
				<i>T. harzianum</i> Strain T-22
				<i>T. virens</i> Strain G-41
		Fungal <i>Clonostachys</i> spp.	<i>C. rosea</i> Strain J1446 strain CR-7	
		Fungal <i>Coniothyrium</i> spp.	<i>C. minitans</i> Strain CON/M/91-08	

			Fungal <i>Hanseniasspora</i> spp.	<i>H. uvarum</i> Strain BC18Y
			Fungal <i>Talaromyces</i> spp.	<i>T. flavus</i> Strain SAY -Y -94- 01
			Fungal <i>Saccharomyces</i> spp.	<i>S. cerevisiae</i> Strain LAS 02 strain DDSF 623
			Bacterial <i>Bacillus</i> spp.	<i>B.</i> <i>amyloliquefaciens</i> Strain QST 713 strain FZB 24 strain MBI 600 strain D 747 Strain F 727 strain AT - 332
				<i>B. subtilis</i> Strain AFS 032321 strain Y1336 strain HAI-0404 strain RTI477
				<i>B. velezensis</i> Strain RTI 301
			Bacterial <i>Erwiniaspp.</i> (peptide)	Phc25279
			Bacterial <i>Gluconobacter</i> spp.	<i>G. Cerinus</i> Strain bc 18b
			Bacterial <i>Pseudomonas</i> spp.	<i>P. Chlororaphis</i> Strain af s009
			Bacterial <i>Streptomyces</i> spp.	<i>S. Griseovirides</i> Strain 61
				<i>S. Lydicus</i> Strain WYEC 108
BM: Purified metabolites from plant or microbial sources, or synthetic versions of these metabolites	Inhibition of beta (1,3) glucan synthase and chitin synthase and resulting cell wall biosynthesis, disruption of membranes and	Purified metabolites from plant or microbial sources, or synthetic versions of these metabolites	Nature-derived or nature-identical single molecules originally derived from plants (or other organisms)	Cinnam aldehyde

	membrane function, destruction of mitochondria and disruption of oxidative processes			
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Source: FRAC (2025)

C). Based on Toxicity/Hazard

WHO Recommended Classification of Pesticides by Hazard

WHO Class		LD ₅₀ for the rat (mg/kg body weight)		Colour of Toxicity Triangle	Symbol in Toxicity Triangle
		Oral	Dermal		
I a	Extremely hazardous	< 5	< 50	Red	Skull +Poison
I b	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)

Pesticides Approved for Uses in Pulses

Out of 359 pesticides registered for uses in agriculture, for pulses only 28 insecticides, 8 insecticide mixtures are approved for control of insect pests under field conditions and 3 insecticides and 1 fumigant are approved for use against storage insect pests and 6 pesticides are approved for rodent control. For control of diseases only, 28 fungicides and their combi products, 25 herbicides and their combi-products for weed control, and 3 plant growth regulators (PGRs) have been approved for uses in pulses. Among different biopesticides registered, 18 bio-insecticide formulation (botanicals and microbial based pesticides) and 7 bio-fungicide formulations are approved for uses against insect pest and diseases control in different pulse crops (CIB&RC, 2025 c). The details of insecticides, fungicides, herbicides, PGRs and biopesticides approved for use in pulses is given in below tables.

i). Insecticides Approved for Insect Control in Pulses

Sl. No.	Name of the Insecticide and Formulation	Target Insect Pests	Dosage /ha		
			a.i. (gm)	Formulation (gm/ml)	Dilution in water (Litre)
1	Benfuracarb 40% EC	Pod borers	1,000	2,500	500
2	Broflanilide 300 g/l SC	Pod borers	12.6-18.6	42-62	500
3	Carbofuran 03% CG	White grub	750	23,300	-
		Grey & Stem weevil	1000	33,300	
		Shoot fly & Aphid	1000	33,300	-
4	Chlorantraniliprole 18.50% SC	Pod borers	30	150	500-750
		Pod borers	25	125	500
		Pod borers	20	100	500
		Pod borers	25	125	400-600
5	Chlorantraniliprole 47.85% w/w SC	Pod borers	30	50	500-750
		Pod borers Tobacco caterpillar	25	41.66	500
		Pod borers Tobacco caterpillar semilooper	25	41.67	400-600
6	Chlorfenapyr 240 g/L SC	Pod borers	192-240	800-1,000	500
		Pod borers	192-240	800-1,000	500
7	Chlorpyrifos 20% EC	Pod borers, Black bugs	600	3,000	500 –1,000
		Cut worm	500	2,500	500 –1,000
8	Chlorpyrifos 01.50% DP	Pod borers	375	25,000	-

9	Deltamethrin 02.80% EC	Pod borers and pod fly	12.50	500	500
10	Emamectin benzoate 05% SG	Pod borers	11	220	500-750
		Pod borers	11	220	500
11	Emamectin benzoate 01.90% EC	Pod borers	7.13	375	500
12	Ethion 50% EC	Pod borers	500 –750	1000 –1500	500 – 1000
		Pod borers	500 –750	1000 –1500	500 – 1000
13	Flubendiamide 20% WG	Pod borers	50	250	500
		Pod Borers, <i>Spodoptera litura</i>	60	300	500
		Pod borers	50	250	500
14	Flubendiamide 39.35% w/w SC	Pod borers	48	100	500
		Pod borers	48	100	500
		Pod borers & <i>Spodoptera</i> spp.	48	100	500
15	Fluxametamide 10% w/w EC	Pod borers	40	400	500
16	Imidacloprid 48% FS (dosage per 100 kg of seeds)	Aphids, Jassids	0.12-0.18	0.2-0.3	-
		Termite	0.15	0.25	-
		Aphids, Jassids, Whitefly	0.42	0.7	
17	Indoxacarb 14.50% SC	Pod borers	50-60	333 - 400	500-1,000
		Pod borers	60-75	400-500	500
18	Indoxacarb 15.80% EC	Pod borers & Pod fly	50	333	500-700
		Pod borers	50	333	500
19	Isocycloseram 9.2% W/W Dc (10% W/V) DC	Pod borers	50-60	500-600	500
20	Lambda-cyhalothrin 05% EC	Pod borers, Pod fly	20-25	400-500	400-600
		Pod borers	25	500	300 – 400
21	Lufenuron 05.40% EC	Pod borers, Pod fly	30	600	500-1,000
		Pod borers	30	600	500
22	Novaluron 10% EC	Pod borers	75	750	500
23	Quinalphos 20% AF	Pod borers	500	2,500	750-1,000

24	Quinalphos 25% EC	Pod borers	250	1,000	500-1,000
		Bihar hairy caterpillar	375	1,500	500 – 1,000
		Stem fly	250	1,000	500 – 1,000
		Pod borers, Pod fly	350	1,400	500 – 1,000
25	Quinalphos 01.50% DP	Pod borers	350	23,300	-
		Pod borers	350	23,300	
		Stem fly	30	20,000	-
26	Spinetoram 11.70% SC	Pod borers	45-54	375-450	500-1,000
		Pod Borers	45-54	375-450	500-1,000
27	Spinosad 45% SC	Pod borers	56 – 73	125 – 162	800 – 1,000
28	Thiodicarb 75% WP	Pod borers	468 – 562	625 – 750	375 – 500
		Pod borers	470 – 750	625 – 1,000	500

ii). **Combi Products of Insecticides Approved for Insect Control in Pulse Crops**

Sl. No.	Name of the Insecticide and Formulation	Target Insect Pests	Dosage /ha		
			a.i. (gm)	Formulation (gm/ml)	Dilution in water (litre)
1	Chlorantraniliprole 09.30% + Lambda-cyhalothrin 04.60% ZC	Pod borers	30	200	500
		Pod Borers & <i>Spodoptera litura</i>	28	200	500
2	Chlorantraniliprole 5.2% + Novaluron 8.5% SC	Pod borers	20.8 + 34	400	500
3	Emamectin benzoate 3% + Thiamethoxam 12% WG	Pod borers & Leaf hopper	6 + 24	200	500
4	Methoxyfenozide 20%+ Chlorpyrifos 25% SE	Pod borers	100+500	2,000	500
5	Novaluron 05.25% + Emamectin Benzoate 0.9% SC	Pod borers	45.94 + 7.87	875	500
		Pod borers	45.94 + 7.88	875	500
6	Novaluron 05.25% + Indoxacarb 04.50% SC	Pod borers	43.31 + 37.13- 45.94 + 39.38	825 – 875	500
		Pod borers and Pod fly	43.31 + 37.13- 45.94 + 39.38	825 – 875	500

		Pod borers & <i>Spodoptera litura</i>	43.31 + 37.13-45.94 + 39.38	825 – 875	500
7	Novaluron 9.45% + Lambda-Cyhalothrin 1.9% ZC	Pod borers Leaf hopper	75+15	750	500
8	Pyriproxyfen 10 % + Bifenthrin 10 % w/w EC	Whitefly	100+100	1,000	500

iii). **Insecticides Approved for Control of Storage Insect Pests in Pulses and Godowns**

Sl. No.	Name of the insecticide and formulation	Name of Commodity	Target Insect Pests	Dose	Exposure Period	Aeration Waiting period
1	Aluminum Phosphide 56 % (3 g Tablet, 10 g Pouch)	Stored whole pulses	Pulse beetle	03 tablets (03 gm) per tonne or 150 gm per 100 m ³ or 10 gm pouch per ton of commodity or 150 gm per 100 m ³ .	Minimum 05 days (<i>Sitophilus oryzae</i>) or 07 days	One hour of partial aeration in case of non - polyethylene packed commodities allowed by 6-8 hrs of full aeration. For polyethylene packed commodities, minimum aeration period is 48 hrs. The waiting period for the release of stock is 48 hrs in both the cases. Recommendation for bag stock 15 days.
		Split pulses (<i>Dal</i>)	Long headed floor beetle, Flat grain Beetle, Carpet beetle	03 tablets/10 gm per tonne or 225 gm/100 m ³	05 days	Aeration is waiting Period 07 days to be checked PH3 detector strips.

		Empty godowns & sheds	All storage pests	14 tablets/1,000 m ³ or 150 gm/100 m ³ or 4 pouch 10 gms each/1,000 CFT or 150 gm/100 m ³	72 hrs.	Aeration period 24 hrs detectors trips or 4 hosphine detect tubes should be used in the premises to signal safety of atmosphere.
2	Aluminum Phosphide 15 % (12g Tablet)	Pulses	Grain Beetle	900 g/100 m ³	-	05
		Split Pulses Dals	Saw Toothed Grain, Beetle, Long headed flour beetle & Mites	900 g/100 m ³	48 hrs.	03
		Empty Godowns & Sheds (under air tight condition)	All stored insect pests	14 tablets/ 1000 tons or 600 g/ 1000 m ³	48 hrs. or 24 hrs.	03
3	Deltamethrin 02.50 % WP	Grain and seeds in stacks	All stored insect pests	30 mg/m ²	1.2 g/m ²	Dilution in water: 1 liter for 30 m ²
		Walls, ceilings floors of Godowns		30 mg/m ²	1.2 g/m ²	Dilution in water: 1 liter for 30 m ²

iv). Insecticides Approved for Control of Storage Insect Pests in Pulses and Godowns

Sl. No.	Fumigants	Crop	Pest	Cond.	Weight of volume	Exposure period	Conc. in air (ppm)	Aeration n / Waiting g
1	Ethylene dichloride + Carbon tetrachloride (3:1)	Stored pulses	Pulse beetle	Air tight cover	300 – 400 gm/m ³ (230 – 307 ml)	48 – 72 hr. for cover fumigation	10 ppm	Partial aeration For at least 1 hr. followed by 24 hr. complete aeration

								waiting period of 24 hr.
		Godown fumigation	All storage pests	Air tight	150 gm/m ³	07 days	10 ppm	Partial aeration For cover ppm at least 1 hr. followed by 24 hr. complete aeration waiting period of 24 hr.

v). **Insecticides/Rodenticides Recommended for Control of Rodents in Field and godowns**

Sl. No.	Name of the insecticide and formulation	Name of Commodity	Target insect pests	Dose	Exposure period	Aeration waiting period
1	Aluminum Phosphide 56% (3 g Tablet, 10 g Pouch)	Rodents burrows	Rodents	01 tablet / burrow	-	-
2	Aluminum phosphide 06% Tablet	Crop & non - Crop area	Rodents	One tablet of 12 gm/burrow	-	-
3	Brodifacoum 0.005 %w/w BB	Godowns, warehouse grain mandis, crop store rooms	Rodents	One bait of 0.005% (a block of 20 gm each) per baiting station as a single feed	Manner of application /use pattern: In and around premises	
4	Bromadiolone 00.25 % CB	Chickpea fields	Rodents	0.005	-	-
5	Bromadiolone 00.005 % RB	Chickpea fields	Rodents	0.005	-	-
6	Zinc Phosphide 80 % Powder	Fields	Rodents	1.5-2.5% active ingredient in bait Mix 10 g of zinc phosphide	Mix 10 g of zinc phosphide with 10g of edible oil and then mix with 380 g of food material. Keep 10 g of poisoned bait at each point.	

vi). Fungicides and Combination Products Approved for Disease Control in Pulses

Sl. No	Name of the fungicide and formulation	Target disease	Dosage /Ha		
			a.i. (gm)	Formulation (gm/ml)	Dilution in water (litre)
1	Carbendazim 50%WP	Powdery mildew	125	250	600
		Powdery mildew	175 gm	350 gm	750
		Powdery mildew	250	500	750
		Leaf spot & Web blight	125-250	250-500	750
		Leaf spot Collar rot, Anthracnose, Powdery mildew	150	300	600
2	Cyflufenamid 5% EW	Powdery mildew	25	500	375-500
3	Lime Sulphur 22% SC	Rust	0.22%	The liquid is used at 1% in conventional sprayers.	-
4	Meptyl Dinocap 35.7% EC	Powdery mildew	108-120	308.6-342.8	500
5	Metiram 70% WG	Cercospora leaf spot	875-1050	1,250-1,500	500
6	Penconazole 10% EC	Powdery mildew	0.005% or 5 gm/100 ltr. water	50 ml/100 ltr. water	500 ltr./ha
7	Streptomycin Sulphate 90% + Tetracycline hydrochloride 10% 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.	-

8	(Streptomycin Sulphate 9% + Tetracycline Hydrochloride 1%) SP	Halo blight	-	Spray Streptocycline 100 to 150 ppm solution thrice at interval of 7 days. For Prevention, apply first spray after 10 days of emergence of leaves.	-
9	Sulphur 40% SC	Powdery mildew	2.25-3.00 kg	5.65-7.50 kg	750-1000
10	Sulphur 52% FS	Powdery mildew	1.04 kg	2.00 ltr.	400
11	Sulphur 80% WP	Powdery mildew	2.5 kg	3.13 kg	750-1000
		Rust	2.5 kg	3.13 kg	750-1000
12	Sulphur 80% WG	Powdery mildew	1.50-2.00 kg	1.875-2.50 Kg	750-1000
13	Sulphur 85% DP	Powdery mildew, Rust	12.75-17 kg	15-20 kg	-
		Powdery mildew	12.75-17 kg	15-20 kg	-
14	Tebuconazole 5.4% w/w FS	Root rot, Wilt	0.24 g/10 kg of seed	4.0 ml/10 kg of seed	-
15	Tebuconazole 25.9% EC	Leaf spot, Anthracnose	187.5	750	500
16	Triadimefon 25% WP	Rust, Powdery mildew	0.025%	0.100%	750
17	Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC	Leaf spot & Powdery mildew	148 g/ha (91 +57)	500 ml/ha or 1ml/lit water	500
18	Azoxystrobin 5.1% w/w +Tebuconazole 9.1% w/w+ Prochloraz 18.2 % w/w EC	Leaf spot & Powdery mildew	70.0 + 125.0 + 250.0	1250	500
19	Captan 70%+ Hexaconazole 5%WP	Powdery mildew, Rust	562.5	750	500

20	Carbendazim 12%+ Mancozeb 63% WP	Rhizoctonia seedling blight, Ascochyta foot rot, Fusarium wilt	2.25	3.0	
21	Carbendazim 25%+ Mancozeb 50% WS	Root rot, Collar rot	7.5+15	30	0.1
		Dry root rot, Collar rot	7.5+15	30	0.1
22	Carboxin 37.5% + Thiram 37.5% WS	Seed rot, Root rot, Stem rot, Fusarium wilt	3 gm/kg seed	4.0 gm/kg seed	10 ml/kg (To make slurry)
23	Metiram 55% + Pyraclostrobin 5% WG	Leaf spot disease	900-1,050	1,500-1,750	500
		Cercospora leaf spot	900-1,050	1,500-1750	500
24	Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w FS	Seed and Seedling rot disease	12.32+12.32- 15.4+15.4	80 – 100	
25	Prochloraz 5.7% + Tebuconazole 1.4% w/w ES	Root rot, Wilt	0.18+ 0.045	3.0 ml/10 kg seed	-
26	Propiconazole 13.9% + Difenconazole 13.9% EC	Powdery Mildew and Leaf Spot	150	500	500
27	Tebuconazole 50% + Trifloxystrobin 25% WG	Powdery mildew	175+87.5	350	500
28	Tebuconazole 15% + Zineb 57% WDG	Wilt, Root rot	2.0	4.0	Sufficient to coat the seeds uniformly

vii). **Herbicides and Combination Products Approved for Weed Control in Pulses**

Sl. No	Name of the herbicide and formulation	Dosage /ha		
		a.i. (gm)	Formulation (gm/ml)	Dilution in water (litre)
FOR PULSES				
1	Clodinafop-propargyl 12.5% EC	125	1,000	500
2	Fenoxaprop-p-ethyl 9.3% w/w EC (9% w/v)	56.25-67.5 g	625-750 ml (15-20 DAS)	375-500

3	Haloxypop R Methyl 10.5% w/w EC	108	1000	500
4	Imazethapyr 10% SL	75 ga.i./ha+ MSO adjuvant @ 2 ml/litre of water	750 MI + MSO adjuvant @ 2 ml/ha of water	375
5	Pendimethalin 30% EC	0.7 – 1.00	2.5 – 3.33	500
6	Propaquizafop 10% EC	75-100 g	750-1,000	500-750
7	Quizalofop-ethyl 5% EC	37.5-50.0	750-1,000	500
8	Fomesafen 17.5% + Clodinafop-propargyl 12.5% w/w ME	175 +125	1,000	500
9	Fomesafen 16.8% w/w + Propaquizafop 5.2% w/w ME	210.0+65.0	1,250	500
10	Imazethapyr 35% + Imazamox 35% WG	70 g a.i./ha + MSO adjuvant @ 2m/l of water	100 g/ha + MSO adjuvant @ 2m/l of water	500
11	Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME	50+75	2,000	500
12	Sodium acifluorfen 16.5% + Clodinafop propargyl 1 8% EC	165+80	1,000	500
FOR NON-CROPPED AREA				
1	Glufosinate ammonium 50 % WG	500	1,000	500
2	Glyphosate 20.2% SL IPA salt	820-1230 kg	4.1-6.15	400-500
3	Glyphosate ammonium salt 20 % SL	4.52-6.79	20-30 ml/lit	300-600
4	Glyphosate 41% SL IPA salt	0.820-1.230	2.0-3.0	500
5	Glyphosate 54% SL (IPA salt)	1800 kg	3.33 ltrs.	400-500
6	Glyphosate Ammonium salt 5% SL	2,000	40 ltrs.	500
7	Glyphosate potassium salt 41.60 % w/w SL (Equivalent to 54% w/v)	2,160-2,430	4,000-4500	500
8	Carfentrazone ethyl 0.43% + Glyphosate 30.82% EW	12.90+92,4.60	3,000	500
9	Diuron 25.6% w/w + Glyphosate 14.4% w/w + Oxyfluorfen 11.5% w/w SC	431.25 + 960+ 540	3,750	500
10	Glufosinate ammonium 14.3 % + Glyphosate (Isopropyl ammonium) 18.04 % SL	400 + 505	2,500	500

11	Oxyfluorfen 2.5% + Isopropyl amine salt of Glyphosate 41% w/w SC	78.125 + 1281.25	3,125	500
12	Paraquat dichloride 7.50% + Glyphosate 30% SC	225+900	3,000	500
13	Pyriithiobac sodium 4.5 w/w % + Glyphosate 60% w/w SG	882-903	1,367-1400	500

viii). Plant Growth Regulators and Combination Product Approved for Use in Pulses

Sl. No.	Name of the PGR and formulation	Time of application/ purpose	Dosage /ha		
			a.i. (ppm/gm/%)	Formulation (gm/ml)	Dilution in water (Litre)
1	Forchlorfenuron 0.12% EC w/w	Single directed spray at the time of 100% flowering	2.5 ppm	1.125 ltr	Spray volume- 450 l/ha. Mix 250 ml of Sitofex in 100 lit water
2	Mepiquat chloride 5% AS	Single spray at flowering stage to control excessive vegetative growth and to increase crop yield.	62.5 g	1.25 ltr	500
3	Pacllobutrazol 40% SC	At flowering initiation stage	30 g	75 ml	500

ix). Bio-Insecticides Approved for Insect Control in Pulses

Sl. No.	Name of the insecticide and formulation	Target Insect Pests	Dosage /Ha		
			a.i. (gm)	Formulation (gm/ml)	Dilution in water (Litre)
1	Azadirachtin 00.03% WSP (300 ppm) neem Oil Based	Pod borer	-	-	-
		Pod fly	-	2,500-5,000	500 1000
2	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> , serotype H-39, 3B, Strain Z-52	Pod borer	0.75	500-750	-
		Pod borer	0.75	500-750	-
3	<i>Bacillus thuringiensis</i> serovar <i>kurstaki</i> (3a, 3b, 3c) 5.0% WP Potency 55,000 SU (<i>Spodoptera</i> unit based) 5x10 ⁷ (spore/mg)	Pod borer	50.00-62.50	1,000-1,250	500-1,000

4	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> 0.5% WP serotype 3a, 3b, 3c, Strain DOR Bt - 1, Potency 16000 IU/mg min.	Pod borers	-	2.0	500
5	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> 2.5% AS (Spicbio-BTK AS)	Pod borers	-	1.0-1.5	500
6	<i>Bacillus thuringiensis</i> var. <i>krustaki</i> , Serotype H-3a, 3b, Strain Z-52. Potency: 50,000 IU/mg min.	Pod borers	-	750	500-750
		Pod borers	-	750	500-750
7	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> 10% WSL (CFU: 2x10 ⁹ /gm min.) Strain - NBAIR-BtG4, Accession no- JN120763, JN120765, Potency- 14,245 IU/ml min.	Pod borers	-	10 liters	200
8	<i>Beauveria bassiana</i> 1.0% WP, Strain No : NBRI – 9947 (1x10 ⁸ CFU/gm Min.)	Pod borers	-	3000	500
9	<i>Beauveria bassiana</i> 1.0% WP (1x10 ⁸ CFU/gm min), Strain No. SVBPU/CSP/Bb-10, Accession No. ITCC-7520	Pod borers	-	3000	500
10	<i>Beauveria bassiana</i> 1.15% WP (1x10 ⁸ /gm min) Accession No – NAIMCC-F-03048	Pod borers	-	2500	500
11	<i>Metarhizium anisopliae</i> 1.15% WP (1x10 ⁸ CFU/gm min) Strain No. AAI, Allahabad, Accession No. NAIMCC-F-03037.	Pod borers	2.5	500	--
12	<i>Nuclear Polyhedrosis Virus</i> of <i>Helicoverpa armigera</i> 2.0% AS, Strain No. GBS/HNPV-01 (1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500	500-750
		Pod borer	-	250-500	500-750
13	<i>Nuclear Polyhedrosis Virus</i> of <i>Helicoverpa armigera</i> 2.0% AS, Strain No. NBRI-8821 (1x10 ⁹ POB/ml Min.)	Pod borer	-	500	500

14	<i>Nuclear Polyhedrosis Virus</i> of <i>Helicoverpa armigera</i> 2.0% AS, Strain No. IBH - 17268 (1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500 ml	500-750
		Pod borer	-	250-500 ml	500-750
15	<i>Nuclear Polyhedrosis Virus</i> of <i>Helicoverpa armigera</i> 2.0% AS, Strain No. BIL/HV-9 POB (1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500	500-750
		Pod borer	-	250-500	500-750
16	<i>Nuclear Polyhedrosis Virus</i> of <i>Helicoverpa armigera</i> 2.0% AS, Strain No. IBL - 17268	Pod borer	-	250-500	500-750
		Pod borer	-	500-1000	500-750
17	<i>Nuclear Polyhedrosis Virus</i> of <i>Helicoverpa armigera</i> 0.5% AS, (1x10 ⁹ POB/ml Min.)	Pod borer	-	250	500
18	<i>Nuclear Polyhedrosis Virus</i> of <i>Helicoverpa armigera</i> 2.0% AS, (1x10 ⁹ POBs count / ml min) Biological Insecticide	Pod borer	-	250	600

x). **Bio-Fungicides Approved for Disease Control in Pulses**

Sl. No.	Name of the Bio-fungicides and formulation	Target Insect Pests	Dosage /Ha		
			a.i. (gm)	Formulation (gm/ml)	Dilution in water (Litre)
1	<i>Trichoderma harzianum</i> 1.0% WP (Strain no. h3 Accession no. 5593)	Root rot	-	6 gm/kg of seeds	Seed treatment and soil drenching after 50 days of sowing.
2	<i>Trichoderma viride</i> 1.0% WP	Wilt, Root rot	-	8 g/kg of seed	Seed treatment
			-	5.0 kg/ha	Soil treatment
		Root rot	-	4 g/kg of seed	Seed treatment
3	<i>Trichoderma viride</i> 1.0% WP (TNAU Strain Accession No. ITCC 6914)	Root Rot	-	5 gm/kg seed 2.5 kg/ha	Seed treatment Soil treatment: Mix 2.5 kg of <i>Trichoderma viride</i> 1.0% WP with 62.5 kg FYM and broadcast uniformly over a hectare of land and irrigate the field immediately.

		Root rot	-	4 g/kg seed	Seed treatment
		Root rot	-	4 g/kg seed	Seed treatment
4	<i>Trichoderma viride</i> 1.0% WP (Strain T-14 in house isolate of M/s Indore Biotech Inputs & Research (P) Ltd., Indore)	Wilt	-	5 gm/kg seed	Seed treatment
5	<i>Trichoderma viride</i> 1.0% WP	Seedling wilt, Damping off,	-	9 g/kg seed	Seed treatment
			-	2.5 kg/ha	Root zone application: Mix thoroughly 2.5 kg of the product in 150 kg of compost or farmyard manure and apply this mixture in the field after sowing/ transplanting crops
6	<i>Trichoderma viride</i> 1.0% WP (TNAU Strain Accession No. ITCC 6914)	Root rot	-	4 gm/kg seed	Seed treatment
		Root rot	-	4 gm/kg seed	Seed treatment
7	<i>Trichoderma viride</i> 5.0% Liquid Formulation (Accession no. NAIMCC-F-03034)	Powdery mildew	-	500 liter/ha	Foliar spray

Label Claim of Pesticides in Different Pulse Crops

The label claim of different pesticides (insecticides, fungicides, herbicides, PGRs, bio-insecticides and bio-fungicides in different pulses is given in below tables. Total 46 different pesticides have label claim for use in pigeonpea and chickpea crops. In *Vigna* pulses like blackgram, greengram, cowpea and other minor pulses have label claim for 53 different pesticides for field uses (CIB&RC, 2025 c).

D). Label Claim of Different Pesticides for Uses in Pigeonpea Crop

Sl. No.	Name of the Insecticide and Formulation	Target Insect Pests	Dosage /ha			Waiting Period (days)
			a.i. (gm)	Formulation (gm/ml)	Dilution in water (litre)	
I	INSECTICIDES					
1	Benfuracarb 40% EC	Pod borers	1,000	2,500	500	20
2	Broflanilide 300 g/l SC	Pod borers	12.6-18.6	42-62	500	25
4	Chlorantraniliprole 18.50% SC	Pod borer	30	150	500-750	29
5	Chlorantraniliprole 47.85% w/w SC	Pod borers	30	50	500-750	31
6	Chlorfenapyr 240 g/L SC	Pod borers	192-240	800-1,000	500	41
7	Deltamethrin 02.80% EC	Pod borers and pod fly	12.50	500	500	10
8	Emamectin benzoate 05 % SG	Pod borers	11	220	500-750	14
9	Ethion 50 % EC	Pod borers	500 –750	1000 –1,500	500 – 1,000	21
10	Flubendiamide 20% WG	Pod borers	50	250	500	30
11	Flubendiamide 39.35% w/w SC	Pod borers	48	100	500	10
12	Fluxametamide 10% w/w EC	Pod borers	40	400	500	5
13	Indoxacarb 14.50% SC	Pod borers	50-60	333 - 400	500-1000	15
14	Indoxacarb 15.80% EC	Pod borers, Pod fly	50	333	500-700	12
15	Isocycloseram 9.2% W/W Dc (10% W/V) DC	Pod borers	50-60	500-600	500	58
16	Lambda-cyhalothrin 05% EC	Pod borers, Pod fly	20-25	400-500	400-600	15
17	Lufenuron 05.40% EC	Pod borers, Pod fly	30	600	500-1,000	65

18	Quinalphos 20% AF	Pod borers	500	2500	750-1,000	30
19	Quinalphos 25% EC	Pod borers, Pod fly	350	1400	500 – 1,000	30
20	Quinalphos 01.50% DP	Pod borers	350	23300	-	30
21	Spinetoram 11.70% SC	Pod borers	45-54	375-450	500-1,000	23
22	Spinosad 45% SC	Pod borers	56 – 73	125 – 162	800 – 1,000	47
23	Thiodicarb 75% WP	Pod borers	470 – 750	625 – 1,000	500	30
24	Chlorantraniliprole 09.30% + Lambda - cyhalothrin 04.60% ZC	Pod borers	30	200	500	18
25	Novaluron 05.25% + Emamectin benzoate 0.9% SC	Pod borers	45.94 + 7.87	875	500	25
26	Novaluron 05.25% + Indoxacarb 04.50% SC	Pod borers and Pod fly	43.31 + 37.13- 45.94 + 39.38	825 – 875	500	25
27	Novaluron 9.45% + Lambda-Cyhalothrin 1.9% ZC	Pod borers, Leaf hopper	75+15	750	500	39
II FUNGICIDES						
28	Carboxin 37.5%+ Thiram 37.5% WS	Seed rot, Root rot, Stem rot, <i>fusarium</i> wilt	3 gm/kg seed	4.0 gm/kg seed	10 ml/kg (To make slurry)	Being seed treatment waiting not required
III HERBICIDES						
29	Imazethapyr 10% SL		75 g a.i./ha+ MSO adjuvant @ 2 ml/litre of water	750 ml+MSO adjuvant @ 2 ml/ha of water	375	125
30	Pendimethalin 30% EC		0.7 – 1.00	2.5 – 3.33	500	133
31	Imazethapyr 35% + Imazamox 35% WG		70 g a.i./ha + MSO adjuvant @ 2 ml/l of Water	100 g/ha + MSO adjuvant @ 2 ml/l of water	375-500	125

IV PLANT GROWTH REGULATORS						
32	Forchlorfenuron 0.12% EC w/w	Single directed spray at the time of 100% flowering	2.5 ppm	1.125 ltr	Spray Volume- 450 l/ha. Mix 250 ml of Sitofex in 100 lit water	30
33	Paclobutrazol 40% SC	At flower initiation stage	30 g	75 ml	500	48
V BIO-INSECTICIDES						
34	Azadirachtin 00.03% WSP (300 ppm) Neem oil based	Pod fly	-	2,500-5,000	500-1,000	07
35	<i>Bacillus thuringiensis</i> var. kurstaki, serotype H-39, 3B, Strain Z-52	Pod borers	0.75	500-750	-	-
36	<i>Bacillus thuringiensis</i> <i>serovar kurstaki</i> (3a, 3b, 3c) 5.0% WP Potency 55,000 SU (<i>Spodoptera</i> unit based) 5x10 ⁷ (spore/mg)	Pod borers	50.00- 62.50	1,000-1250	500-1,000	-
37	<i>Bacillus thuringiensis</i> var. kurstaki, Serotype H-3a, 3b, Strain Z-52. Potency: 50000 IU/mg min.	Pod borers	-	750	500-750	-
38	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> 10% WSL (CFU: 2x10 ⁹ /gm min.) Strain - NBAIR-BtG4, Accession no - JN120763, JN120765, Potency - 14245 IU/ml min.	Pod borers	-	10 liters	200	12 hrs

39	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. GBS/HNPV-01 (1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500	500-750	-
40	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. NBRI - 8821 (1x10 ⁹ POB/ml Min.)	Pod borer	-	500	500	-
41	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. IBH - 17268 (1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500 ml	500-750	-
42	<i>Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. BIL/HV -9 POB(1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500	500-750	-
43	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. IBL-17268	Pod borer	-	250-500	500-750	-
VI BIO-FUNGICIDES						
44	<i>Trichoderma viride</i> 1.0% WP	Wilt, Root rot	-	8 g/kg of seed (For seed treatment)		-
			-	5.0 kg/ha (For soil treatment)		-
45	<i>Trichoderma viride</i> 1.0% WP (TNAU Strain Accession No. ITCC 6914)	Root rot	-	4 g/kg seed (For seed treatment)	Seed treatment	-
46	<i>Trichoderma viride</i> 1.0% WP (TNAU Strain Accession No. ITCC 6914)	Root rot	-	4 gm/kg seed (For seed treatment)	Seed treatment	-

II). Label Claim of Different Pesticides for Uses in Chickpea Crop

Sl. No.	Name of the insecticide and formulation	Target Insect Pests	Dosage /ha			Waiting Period (days)
			a.i. (gm)	Formulation (gm/ml)	Dilution in water (litre)	
I	INSECTICIDES					
1	Chlorantraniliprole 18.50% SC	Pod borers	25	125	500	11
2	Chlorantraniliprole 47.85% w/w SC	Pod borers Tobacco caterpillar	25	41.66	500	26
3	Chlorfenapyr 240 g/L SC	Pod borers	192-240	800-1,000	500	49
4	Chlorpyrifos 20% EC	Cut worm	500	2,500	500 – 1,000	
5	Chlorpyrifos 01.50% DP	Pod borers	375	25,000	-	07
6	Emamectin benzoate 05 % SG	Pod borers	11	220	500	14
7	Emamectin benzoate 01.90% EC	Pod borers	7.13	375	500	14
8	Ethion 50% EC	Pod borers	500 –750	1,000–1,500	500 – 1,000	21
9	Flubendiamide 20% WG	Pod borers	50	250	500	15
10	Flubendiamide 39.35% w/w SC	Pod borers & Spodoptera spp.	48	100	500	05
11	Imidacloprid 48% FS	Termite	0.15	0.25	(dosage per 100 kg of seeds)	
12	Indoxacarb 14.50% SC	Pod borers	60-75	400-500	500	19
13	Indoxacarb 15.80% EC	Pod borers	50	333	500	18
14	Lambda-cyhalothrin 05% EC	Pod borers	25	500	300 – 400	06
15	Novaluron 10% EC	Pod borers	75	750	500	07
16	Quinalphos 25% EC	Pod borers	250	1,000	500-1,000	-
17	Quinalphos 01.50% DP	Pod borers	350	23300	At pod formation	

18	Spinetoram 11.70% SC	Pod borers	45-54	375-450	500-1,000	20
19	Chlorantraniliprole 5.2% + Novaluron 8.5% SC	Pod borers	20.8 + 34	400	500	7
20	Methoxyfenozide 20% + Chlorpyrifos 25% SE	Pod borers	100+500	2000	500	15
21	Novaluron 05.25% + Emamectin Benzoate 0.9% SC	Pod borers	45.94 + 7.88	875	500	11
22	Novaluron 05.25% + Indoxacarb 04.50% SC	Pod borers	43.31 + 37.13-45.94 + 39.38	825 – 875	500	09
II FUNGICIDES						
23	Tebuconazole 5.4% w/w FS	Root rot, Wilt	0.24 g/10 kg of seed	4.0 ml/10 kg of seed	-	Seed dresser
24	Carbendazim 25% + Mancozeb 50% WS	Dry Root rot, Collar rot	7.5+15	30	0.1	-
25	Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w FS	Seed and Seedling rot disease	12.32+12.32-15.4+15.4	80 – 100		
26	Prochloraz 5.7% + Tebuconazole 1.4% w/w ES	Root rot Wilt	0.18+ 0.045	3.0 ml/10 kg seeds	-	Seed dresser
27	Tebuconazole 15% + Zineb 57% WDG	Wilt Root rot	2.0	4.0	Sufficient to coat the seeds uniformly	Seed dresser
III PLANT GROWTH REGULATORS						
28	Mepiquat chloride 5% AS	Single spray at flowering stage to control excessive vegetative growth and to increase crop yield in chickpea	62.5 g	1.25 ltr	500	56

IV BIOINSECTICIDES						
29	Azadirachtin 00.03% WSP (300 PPM) <i>Neem</i> Oil Based	Pod borers	-	-	-	07
30	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> , serotype H-39, 3B, Strain Z-52	Pod borers	0.75	500-750	-	-
31	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> 0.5% WP serotype 3a, 3b, 3c, Strain DOR Bt-1, Potency 16,000 IU/mg min.	Pod borers	-	2.0	500	-
32	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> 2.5% AS (Spicbio-BTK AS)	Pod borers	-	1.0-1.5	500	-
33	<i>Bacillus thuringiensis</i> var. <i>krustaki</i> , Serotype H-3a, 3b, Strain Z -52. Potency: 50000 IU/mg min.	Pod borers	-	750	500-750	-
34	<i>Beauveria bassiana</i> 1.0% WP, Strain No: NBRI – 9947 (1x10 ⁸ CFU/gm Min.)	Pod borers	-	3,000	500	-
35	<i>Beauveria bassiana</i> 1.0% WP (1x10 ⁸ CFU/gm min), Strain No. SVBPU/CSP/Bb - 10, Accession No. ITCC-7520	Pod borers	-	3,000	500	-
36	<i>Beauveria bassiana</i> 1.15% WP (1x10 ⁸ /gm min) Accession No – NAIMCC-F-03048	Pod borers	-	2500	500	-
37	<i>Metarhizium anisopliae</i> 1.15% WP (1x10 ⁸ CFU/gm min) Strain No. AAI, Allahabad, Accession No. NAIMCC-F-03037.	Pod borers	2.5	500	--	-

38	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. GBS/HNPV-01 (1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500	500-750	-
39	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. IBH -17268 (1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500 ml	500-750	-
40	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. BIL/HV -9 POB(1x10 ⁹ POB/ml Min.)	Pod borer	-	250-500	500-750	-
41	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, Strain No. IBL-17268	Pod borer	-	500-1,000	500-750	-
42	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 0.5% AS, (1x10 ⁹ POB/ml Min.)	Pod borer	-	250	500	-
43	<i>Nuclear Polyhedrosis Virus of Helicoverpa armigera</i> 2.0% AS, (1x10 ⁹ POBs count / ml min) Biological Insecticide	Pod borer	-	250	600	-
V	BIO-FUNGICIDES					
44	<i>Trichoderma harzianum</i> 1.0% WP (Strain no. h3 Accession no. 5593)	Root rot	-	6 gm/kg of seeds	Seed treatment and soil drenching after 50 days of sowing.	-
45	<i>Trichoderma viride</i> 1.0% WP (Strain T-14 in house isolate of M/s Indore Biotech Inputs & Research (P) Ltd., Indore)	Wilt	-	5 gm/kg seed	Seed treatment	-

46	<i>Trichoderma viride</i> 1.0% WP	Seedling wilt, Damping off,	-	9 g/kg seed	Seed treatment	-
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III. Label Claim of Different Pesticides for Uses in Vigna Pulses (Greengram, Blackgram, Cowpea) and Other Minor Pulses

Sl. No.	Name of the insecticide and formulation	Crop	Target Insect Pests	Dosage /ha			Waiting Period (days)
				a.i. (gm)	Formulation (gm/ml)	Dilution in water (Litre)	
I INSECTICIDES							
1	Carbofuran 03% CG	French Bean	White grub	750	23,300	-	-
		French Bean	Grey & Stem weevil	1000	33,300	-	-
		Pea	Shoot fly & Aphid	1000	33,300	-	-
2	Chlorantraniliprole 18.50% SC	Blackgram	Pod borers	20	100	500	20
		Greengram	Pod borers	25	125	400-600	14
3	Chlorantraniliprole 47.85% w/w SC	Greengram	Pod borers Tobacco caterpillar semilooper	25	41.67	400-600	26
4	Chlorpyrifos 20% EC	Beans	Pod borers, Black bug	600	3,000	500 –1,000	-
5	Flubendiamide 20% WG	Blackgram	Pod borers, <i>Spodoptera litura</i>	60	300	500	23
6	Flubendiamide 39.35% w/w SC	Blackgram	Pod borers	48	100	500	11
7	Imidacloprid 48% FS	Green Pea	Aphids, Jassids	0.12- 0.18	0.2-0.3	Dosage per 100 kg of seeds	
		Blackgram	Aphids, Jassids, Whitefly	0.42	0.7		
8	Lufenuron 05.40% EC	Blackgram	Pod borers	30	600	500	10

9	Quinalphos 25 % EC	Black gram	Bihar hairy caterpillar	375	1,500	500 – 1,000	-
		French bean	Stem fly	250	1,000	500 – 1,000	-
	Quinalphos 01.50% DP	French bean	Stem fly	30	20,000	-	-
11	Thiodicarb 75% WP	Blackgram	Pod borers	468 – 562	625 – 750	375 – 500	17
12	Chlorantraniliprole 09.30% + Lambda-cyhalothrin 04.60% ZC	Blackgram	Pod borers & <i>Spodoptera litura</i>	28	200	500	24
13	Emamectin benzoate 3% + Thiamethoxam 12% WG	Green gram	Pod borers & Leaf hopper	6 + 24	200	500	15
14	Novaluron 05.25% + Indoxacarb 04.50% SC	Blackgram	Pod borers & <i>Spodoptera litura</i>	43.31 + 37.13-45.94 + 39.38	825 – 875	500	14
15	Pyriproxyfen 10% + Bifenthrin 10% w/w EC	Greengram	Whitefly	100+100	1000	500	25
II FUNGICIDES							
16	Carbendazim 50%WP	Peas	Powdery mildew	125	250	600	-
		Cluster beans	Powdery mildew	175gm	350gm	750	-
		Greengram	Powdery mildew	250	500	750	-
			Leaf spot & Web blight	125-250	250-500	750	-
		Cowpea	Leaf spot, Collar rot Anthracnose Powdery mildew	150	300	600	-
17	Cyflufenamid 5% EW	Black gram	Powdery mildew	25	500	375-500	24

18	Lime sulphur 22% SC	Bean	Rust	0.22%	The liquid is used at 1% in conventional sprayer.	-	2% pre & 1% post blossom
19	Meptyl dinocap 35.7% EC	Pea	Powdery mildew	108-120	308.6-342.8	500	7
20	Metiram 70%WG	Blackgram	Cercospora leaf spot	875-1050	1,250-1,500	500	34
21	Penconazole 10% EC	Blackgram Greengram	Powdery mildew	0.005% or 5gm/100 ltr. water	50 ml/100 ltr. water	500	30
22	Streptomycin sulphate 90% + Tetracycline Hydrochloride 10% SP	Beans	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.	-	-
23	Streptomycin sulphate 9% + Tetracycline hydrochloride 1%) SP	Beans	Halo blight	-	Spray Streptocycline 100 to 150 ppm solution thrice at interval of 7 days. For prevention apply first spray after 10 days of emergence of leaves.	-	-
24	Sulphur 40% SC	Peas	Powdery mildew	2,250-3,000	5,650-7,500	750-1,000	-

25	Sulphur 52% FS	Pea	Powdery mildew	1,040	2.00 ltr.	400	
26	Sulphur 80% WP	Cowpea, Greengram, Blackgram	Powdery mildew	2,500	3,130	750-1,000	
		Pea	Rust	2,500	3,130	750-1,000	
27	Sulphur 80% WG	Cowpea, Guar, Greenpea	Powdery mildew	1,500-2,000	1,875-2,500	750-1,000	-
28	Sulphur 85 % DP	Cowpea, Greengram, Blackgram	Powdery mildew, Rust	1,275-1,700	15000-20,000	-	-
		Greenpea	Powdery mildew	1,275-1,700	15000-20,000	-	-
29	Tebuconazole 25.9% EC	Blackgram	Leaf spot, Anthracnose	187.5	750	500	17
30	Triadimefon 25% WP	Pea	Rust, Powdery mildew	0.025%	0.100%	750	25
31	Azoxystrobin 18.2 % + Difenoconazole 11.4%w/w SC	Blackgram	Leaf spot & Powdery mildew	148 g/ha (91 +57)	500 ml/ha or 1ml/lit water	500	23
32	Azoxystrobin 5.1%w/w +Tebuconazole 9.1% w/w+ Prochloraz 18.2 % w/w EC	Blackgram	Leaf Spot & Powdery Mildew	70.0 + 125.0 + 250.0	1,250	500	35
33	Captan 70%+ Hexaconazole 5%WP	Blackgram	Powdery mildew, Rust	562.5	750	500	20
34	Carbendazim 12%+ Mancozeb 63% WP	Greenpea	<i>Rhizoctonia</i> seedling blight, <i>Ascochyta</i> , root rot, Fusarium wilt	2.25	3.0	-	Seed treatment
35	Carbendazim 25%+ Mancozeb 50% WS	Black gram	Root rot, Collar rot	7.5+15	30	0.1	-
		Bengal gram	Dry Root rot, Collar rot	7.5+15	30	0.1	-

36	Metiram 55% + Pyraclostrobin 5% WG	Blackgram	Leaf spot disease	900-1,050	1,500-1,750	500	32
		Greengram	Cercospora leaf spot	900-1,050	1,500-1,750	500	18
37	Propiconazole 13.9% + Difenoconazole 13.9% EC	Blackgram	Powdery mildew and Leaf Spot	150	500	500	28
38	Tebuconazole 50% + Trifloxystrobin 25% WG	Greenpea	Powdery mildew	175+87.5	350	500	10
III	HERBICIDE						
39	Clodinafop-propargyl 12.5% EC	Greengram	-	125	1,000	500	75
40	Fenoxaprop-p-ethyl 9.3% w/w EC (9% w/v)	Blackgram	-	56.25-67.5g	625-750 ml (15-20 DAS)	375-500	43
41	Haloxypol R Methyl 10.5% w/w EC	Blackgram	-	108	1,000	500	60
42	Imazethapyr 10% SL	Blackgram	-	75 ga., i./ha + MSO adjuvant @ 2 ml/litre of water	750 MI + MSO adjuvant @ 2ml/ha of water	375	56
		Greengram	-	75 g a.i./ha+ MSO adjuvant @ 2 ml/litre of water	750 ml+MSO adjuvant @ 2ml/ha of water	375	46
43	Propaquizafop 10% EC	Blackgram	-	75-100 g	750-1,000	500-750	21
44	Quizalofop-ethyl 5% EC	Blackgram	-	37.5-50.0	750-1,000	500	52

45	Fomesafen 17.5% + Clodinafop- propargyl 12.5% w/w ME	Greengram	-	175 +125	1,000	500	83
46	Fomesafen 16.8% w/w + Propaquizafop 5.2% w/w ME	Blackgram	-	210.0+65.0	1,250	500	51
		Greengram	-	210.0+65.0	1,250	500	46
47	Imazethapyr 35% + Imazamox 35% WG	Cluster bean		70 g a.i./ha + MSO adjuvant @ 2ml/l of water	100 g/ha + MSO adjuvant @ 2 ml/l of water	500	64
48	Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME	Blackgram		50+75	2,000	500	56
		Clusterbean		50+75	2,000	500	69
49	Sodium Acifluorfen 16.5% + Clodinafop Propargyl 8% EC	Blackgram		165+80	1,000	500	54
		Greengram		165+80	1,000	500	54
IV BIO-FUNGICIDES							
50	<i>Trichoderma viride</i> 1.0% WP	Cowpea, Greengram, Blackgram	Root rot	-	4 g/kg of seed	Seed treatment	Nil
51	<i>Trichoderma viride</i> 1.0% WP (TNAU Strain Accession No. ITCC 6914)	Cowpea	Root Rot	-	5 gm/kg seed	Seed treatment	Nil
					2.5 kg/ha	Soil Treatment: Mix 2.5 kg of <i>Trichoderma viride</i> 1.0% WP with 62.5 kg FYM and broadcast uniformly over a	Nil

						hectare of land and irrigate the field immediately	
		Urdbean	Root rot	-	4 g/kg seed	Seed treatment	Nil
				-	2.5 kg/ha	Root zone application: Mix thoroughly 2.5 kg of the product in 150 kg of compost or farmyard manure and apply this mixture in the field after sowing/transplanting crops	-
52	<i>Trichoderma viride</i> 1.0% WP (TNAU Strain Accession No. ITCC 6914)	Blackgram	Root rot	-	4 gm/kg seed	Seed treatment	-
53	<i>Trichoderma viride</i> 5.0% Liquid formulation (Accession no. NAIMCC-F-03034)	Pea	Powdery mildew	-	500 liter/ha	Foliar spray	-

Standards for Pest Management in Organic Pulse Production

I. National Standards for Pest Management During Organic Pulse Production

General Principles

Organic farming systems should be carried out in a way which ensures that losses from pests, diseases and weeds are minimized. Emphasis is placed on the use of a balanced fertilizing 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 seed bed 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 for insect pest, disease and weed management

- Insect pest, disease and weed management should rely primarily on Good Agricultural Practices such as balanced soil fertility management, use of crops and varieties resistant to pests and adapted to local situations, diversity management, effective crop rotations, multi-cropping/ intercropping, green manures, manipulation of planting and sowing time and habitat manipulation through diversified plots, hedge rows, insectary plants, trap crops *etc.*
- Pest problems may also be controlled through physical, mechanical and biological approaches such as:
 - Removal of infested plants/ parts,
 - Collection and destruction of egg masses
 - Use of light traps, yellow and blue sticky traps, pheromone traps
 - Mechanical such as tilling, scrapping, hoeing
 - Biological control like release of pest predators, parasites, pathogens, installation of bird perches.
- In cases where cultural and preventive approaches are not sufficient and there is imminent threat to the crop then plant protection products derived from plant or animal origin and prepared by using physical, mechanical or biological methods can be used. Products approved for use in organic farming by certification bodies accredited under National Programme for Organic Production (NPOP) can also be used.
- Natural mined products and biological products such as microbial biopesticides can be used
- On-farm produced plant extracts, oils or fermented products can be used provided no synthetic ingredients is used in such preparations.

- Weed management can be done through mulching with biodegradable material, mowing, livestock grazing, hand or mechanical weeding, flame, heat or electrical means or by using plastic or other synthetic mulches, provided that such mulches are removed from the field after harvest.
- 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.
- Branded products must always be evaluated.
- 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.
- The use of synthetic growth regulators and synthetic dyes are prohibited.
- The use of genetically engineered organisms or products are prohibited.
- Accredited certification programmes shall ensure that measures are in place to prevent transmission of pests, parasites and infectious agents.

II. National Standards for Pest Management During Food Storage, Processing and Handling

General Principles

Pests should be avoided by Good Manufacturing Practices. This includes general cleanliness and hygiene. Treatments with pest regulating agents must, thus, be regarded as the last resort.

Recommendations

- Recommended treatments are physical barriers, sound, ultra-sound, light, and UV-light, traps (incl. 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 shall 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
 - Other substances used in traps
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 allowed for use in organic agriculture for the control of pests and diseases in plant production. Many of these products are restricted for use in organic production. 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 programme/agency.

Table. List of substances permitted for plant pest and disease control in organic farming

Sl. No.	Name of Substance	Description, compositional requirements and conditions for use
I.	Plant and Animal	
1	<i>Azadirachta indica</i> (neem preparations, neem oil)	Need to be recognized by certification body or authority.
2	Preparation of rotenone from <i>Derris elliptica</i> , <i>Lonchocarpus</i> , <i>Thephrosia spp.</i>	Need to be recognized by certification body or authority.
3	Gelatine	-
4	Propolis	Need to be recognized by certification body or authority.
5	Plant based extracts (e.g. neem, garlic, pongamia, etc.)	Need to be recognized by certification body or authority.
6	Preparation on basis of pyrethrins extracted from <i>Chrysanthemum cinerariaefolium</i> , containing possibly a synergist <i>pyrethrum cinerifolium</i>	Need to be recognized by certification body or authority.
7	Preparation from <i>Quassia amara</i>	Need to be recognized by certification body or authority.
8	Release of parasite predators of insect pests	-
9	Preparation from <i>Ryania speciosa</i>	Need to be recognized by certification body or authority.
10	Tobacco tea (except pure nicotine)	Need to be recognized by certification body or authority.
11	Lecithin	Need to be recognized by certification body or authority.
12	Casein	-
13	Sea weeds, sea weed meal, sea weed extracts, sea salt and salty water	Not chemically treated.
14	Extract from mushroom (Shiitake fungus)	-
15	Extract from <i>Chlorella</i>	-
16	Fermented product from <i>Aspergillus</i>	-

17	Natural acids (vinegar)	Need to be recognized by certification body or authority.
18	Plant and animal oils	-
II. Minerals		
1	Chloride of lime/soda	Need to be recognized by certification body or authority.
2	Clay (<i>e.g.</i> bentonite, perlite, vermiculite, zeolite)	-
3	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	Need to be recognized by certification body or authority.
4	Copper salts	Need to be recognized by certification body or authority.
5	Mineral powders (stone meal, silicates)	-
6	Diatomaceous earth	Need to be recognized by certification body or authority.
7	Light mineral oils	-
8	Potassium permanganate	Need to be recognized by certification body or authority.
9	Lime sulphur (calcium polysulphide)	-
10	Silicates, clay (Bentonite)	-
11	Sodium bicarbonate	-
12	Sulphur (as a fungicide, acaricide, repellent)	Need to be recognized by certification body or authority.
13	Paraffin oil	Need to be recognized by certification body or authority.
14	Sodium silicate	-
III. Microorganisms used for biological pest controls		
1	Viral preparations (<i>e.g.</i> , Granulosis viruses, Nuclear polyhedrosis, viruses <i>etc.</i>)	Need to be recognized by certification body or authority.
2	Fungal preparations (<i>e.g.</i> , <i>Trichoderma</i> species <i>etc.</i>)	Need to be recognized by certification body or authority.
3	Bacterial preparations (<i>e.g.</i> , <i>Bacillus</i> species <i>etc.</i>)	Need to be recognized by certification body or authority.

4	Parasites, predators and sterilized insects	Need to be recognized by certification body or authority.
IV. Others		
1	Carbon dioxide and nitrogen gas	Need to be recognized by certification body or authority.
2	Potassium soap (soft soap)	-
3	Ethyl alcohol	Need to be recognized by certification body or authority.
4	Homeopathic and Ayurvedic preparations	-
5	Herbal and biodynamic preparations	-
6	Sterilized insect males	Need to be recognized by certification body or authority.
V. Traps		
1	Pheromone preparations	-
2	Preparations on the basis of metaldehyde containing a repellent to higher animal species and as far as applied in traps.	Need to be recognized by certification body or authority.
3	Mulches, nets	-

Source: APEDA (NPOP) 2005; NCOF, 2022.

Maximum Residue Limits (MRL) for Pesticides Used in Pulses

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. Pesticide residues can be a major concern in pulses and *dals* for domestic consumption and their export. There is possibility of higher level of residues of herbicides, fungicides and insecticide in pulses, which may adversely affect the health of consumers. In India, the Ministry of Health and Family Welfare regulates MRLs of pesticides and agrochemicals in food products through the Prevention of Food Adulteration Act (PFA), 1955 as amended. However, with the implementation of Food Safety and Standards Act (FSSA), 2006, the PFA rules are being phased 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 and 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 items / commodities. In the absence of an established MRL, the Ministry of Health authorities generally refer to FAO/WHO's Codex Alimentarius Commissions (CAC) MRLs, as long as the pesticide in question has not been banned. The Codex MRL serve as the reference standards in international trade, but many countries use their own set of MRLs for imported and domestic food products. The European Union (EU) MRLs are generally lower than US 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 of registered insecticides and fungicides as per CIB & RC for different pulses are given in the below Table.

Table: MRLs for different pesticides used in pulses

Name of the Pesticide	Pulse Crop	MRL Values (mg/kg)
Benfuracarb	Pigeonpea	0.05
Captan	Blackgram	0.01
Chlorantranilprole	Chickpea	0.03
	Blackgram	0.03
	Pigeonpea	0.03
Copper sulphate	Pea	0.01
Deltamethrin	Pigeonpea	0.01
Ethion	Chickpea	0.01
	Pigeonpea	0.01
Fenoxaprop-p-ethyl	Blackgram	0.01
Flubendiamide	Chickpea	1.0
	Pigeonpea	1.0
	Blackgram	1.0
Hexaconazole	Blackgram	0.01
Indoxacarb	Pigeonpea	0.1
	Chickpea	0.2
Lambda Cyhalothrin	Pigeonpea	0.05
	Chickpea	0.05

Lufenuron	Blackgram	0.02
	Pigeonpea	0.01
Linuron	Peas	0.05
Methomyl	Pigeonpea seeds	0.05
Methyl parathion	Blackgram	0.01
Metiram	Blackgram	0.05
	Greengram	0.05
Novaluron	Chickpea	0.01
Penconazole	Blackgram seeds	0.02
Pendimethalin	Pigeonpea	0.05
Phorate	Greengram	0.01
Propaquizafop	Blackgram	0.01
Pyraclostrobin	Blackgram	0.02
	Greengram	0.02
Quinalphos	Chickpea	0.05
	Pigeonpea	0.01
Quizalop-ethly	Blackgram	0.01
Spinosad	Pigeonpea	0.01
Tebucanazole	Blackgram	0.01
Thiodicarb	Pigeonpea	0.05
	Blackgram	0.03
Thiophanate methyl	Pigeonpea	0.03
Triadimefon	Pea	0.1
Glyphosate	Beans (Dry)	2.0
	Lentil (Dry)	5.0
	Peas (Dry)	5.0

Source: FSSAI, 2019

Selection of Pesticides for Safety of Honey Bees and Pollinators

The pollination requirements of most of the pulse crops are unknown, whether they are self-fertile or self-sterile. Pollination by *Apis* and non *Apis* pollinator has been reported to enhance the yields of pulse crops and benefit both qualitatively and quantitatively. Pollinators help in increase in seed set of self-pollinated pulse crops but more importantly enhance cross-pollination. Pollinating insect activities are beneficial in increasing the number of pod set, the number of seeds per pod, or both (Abrol *et al.* 2024).

Pesticides are one of the main agents of poisoning honeybees and other pollinators in the agricultural ecosystem. Honeybees are very much susceptible to many groups of pesticide. 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 honeybees and other pollinators. In recent years, many insecticides have been screened for their efficiency to target pests and their toxicity to honeybees and pollinators.

The hazards or causes of bee poisoning are:

- Pesticide application during the blooming period of crop.
- When the pesticide is applied directly on to bees foraging on the crop.
- When bees fly to the treated plants and collect contaminated nectar and/or pollen.
- Bee feeding on contaminated food and water sources.
- Contamination of flowering cover crops when orchards are sprayed.
- Pollen collecting bees collect pesticide dust and/or contaminated pollen and return these to the hive.
- Drift of toxic chemicals from the point of application on to flower, pollen and nectar or across apiaries.
- Insecticidal dusts adhere to foraging bees and ultimately become packed with the pollen onto the hind legs. *e.g.* Carbaryl is especially dangerous because they may be stored with pollen and kill newly emerged workers the following season.
- Use of broad-spectrum insecticides (chlorinated hydrocarbons, synthetic pyrethroids).
- 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 of different groups of pesticides in bees. The general and most common symptoms of bee poisoning are as follows:

- 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 lack of 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 becomes distended and regurgitation of honey 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	Level of poisoning
100	Normal death rate
200-400	Low
500-1000	Medium
More than 1,000	High

Effects of bee poisoning

Three types of harmful effects evident in agriculture are

1. Reduction in the yield of crops
2. Loss in production of honey
3. 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 toxicity to bees. This can help in choosing and selection of appropriate pesticides, particularly when alternate choices for a pest control are not available. There are three main categories of pesticides, which are as follows:

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.

Commonly Used Highly Toxic Insecticides

Carbaryl	Imidacloprid
Carbofuran	Monocrotophos
Carbophenothion	Oxydemeton-methyl
Chlorpyrifos	Parathion
Clothianidin	Permethrin
Cypermethrin	Phorate
Deltamethrin	Phosphamidon
Dichlorvos (DDVP)	Quinalphos
Dicrotophos	Thiometon
Dimethoate	Thiamethoxam
Fenvalerate	Abamectin
Acephate	Alpha-cypermethrin
Dinotefuran	Emamectin benzoate
Fipronil	Indoxacarb
Malathion	Lambda-cyhalothrin
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 within 3 hours of spray. Bees should not be exposed to these insecticides.

i. Moderately Toxic Insecticides

Acetamiprid	Heptachlor
DDT	Lindane
Diazinon	Malathion
Dieldrin	Metasystox
Endrin	Methyl demeton
Ethyl parathion	Methyl parathion
Fenitrothion	Mevinphos
Fenthion	Monocrotophos
Formothion	Trichlorphon
HCH	Thiacloprid
Azadirachtin	<i>Beauvaria bassiana</i>
Bifenazate	Chlorfenapyr
Thiodicarb	Diatomaceous earth
Fluvalinate	Horticultural oil
ii. Moderately Toxic Fungicides	
Bavistin	Difolatan
Carbendazim	Foltaf
Mancozeb	Ediphenphos
Copper hydroxide	

Category III: Relatively non-toxic pesticides

Pesticides under this category are the least toxic to bees and can be applied at any time with reasonable safety to honeybees. Their toxicity is usually low with direct application.

i. Relatively Non-Toxic Insecticides	
<i>Bacillus thuringiensis</i>	Methoxychlor
Chlorobenzilate	Morestan
Dicofol	Nicotine
Dimite	Nuclear polyhedrosis virus
Endosulfan	Phosalone
Ethion	Pyrethrum
Menazon	Sabadilla
<i>B.t. tenebrionis</i>	Chlorantraniliprole
Flonicamid	Fenbutatin-oxide
Diflubenzuron	Amitraz
Etoxazole	Fenproximate
Flubendiamide	Nosema locusate fungus
Lime sulfur	Propargite
Metaldehyde bait	Pyriproxyfen
Methoxyfenozide	
ii. Relatively Non-Toxic Fungicides	
Anilazine	Dinocap
Benomyl	Dodine
Bordeaux mixture	Folcid
Catafol	Thiram
Captan	Ziram
Cuprous oxide	Polyram
Azoxystrobin	Trifloxystrobin
Benomyl	Mancozeb
Sulphur	Ziram
iii. Relatively Non-Toxic Herbicides, Defoliants and Desiccants	
Amitrole	Diuron
Ammate	Methazole
Atrazine	Nitrofen
Bromocil	Oil sprays
Cynazine	Ammonium sulphate
Acetochlor	2,4-D
Alachlor	Glyphosate
Paraquat	

Source: Abrol, 1997. www.uaex.uada.edu

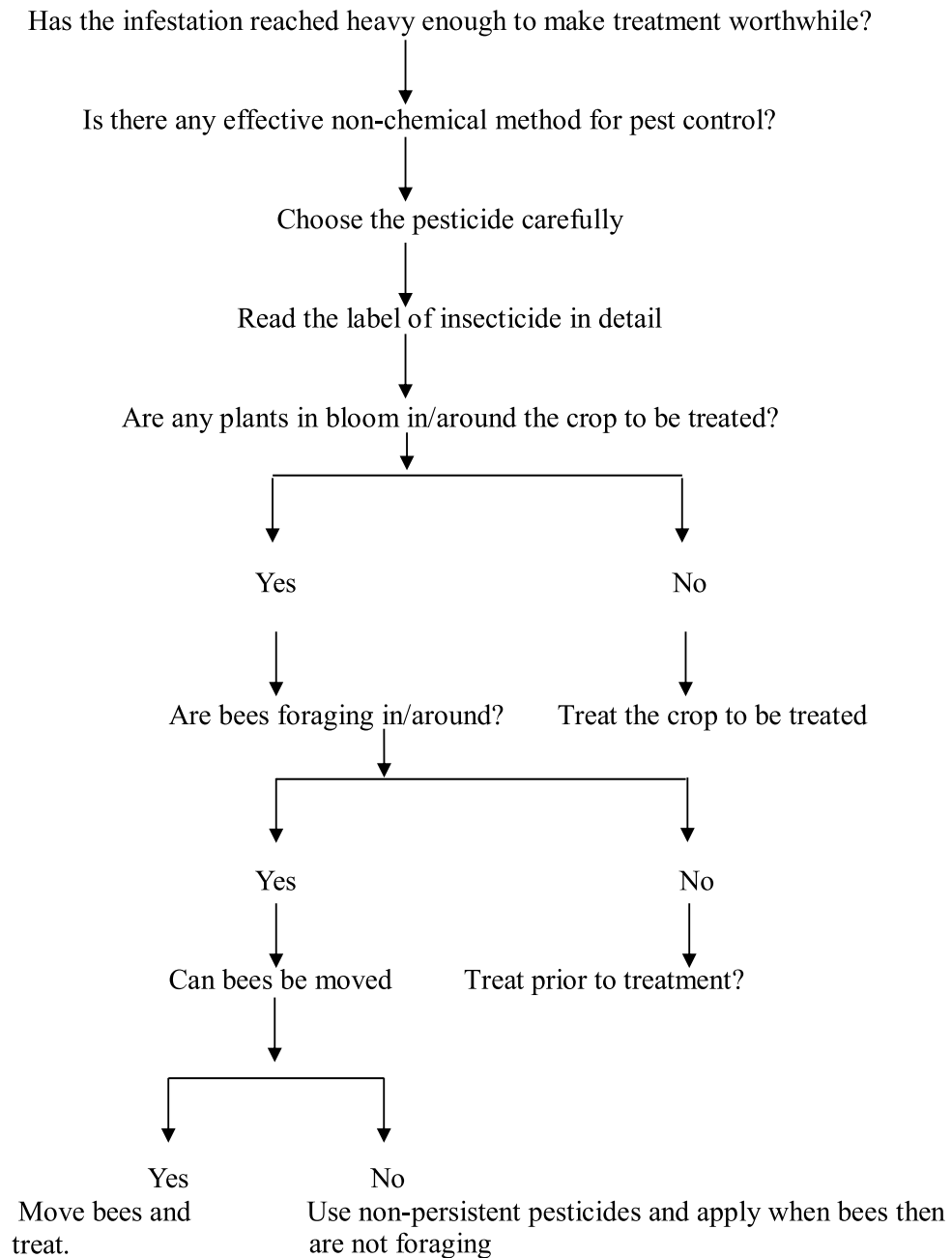
How to reduce bee poisoning

Bee poisoning by pesticides can be reduced to maximum extent and bees and bee colonies can be protected by following certain precautions and pesticide management practices. These practices should be kept in mind and has to be adopted by the beekeepers, farmers and pesticide applicators in order to minimize the bee poisoning by pesticides. Some of the measures to be practiced are given below:

- Non-toxic and safest insecticides to the bees should be applied only when crop is heavily infested and treatment is worthwhile or their use is justified. Ex: Phosalone are insecticides non-toxic/less toxic to bees and possible bioagents and botanicals like *Bt* products, NPVs, *neem* etc. should be used.
- Avoid the application of a pesticide to a crop in bloom and do not spray on cover crops or inter crops in bloom even if main crop is not in bloom.
- Insecticides having selective action and selective formulation (causing low toxicity to the bees) should be used.
- Pesticides Formulation – always choose and use safest formulation of the pesticides that will kill the pest and safe to bees. In general
 - Granular formulations are the safest to the bees. So also seed treatments.
 - Dusts are more hazardous than liquid formulations for spray of the same insecticides.
 - Emulsifiable Concentrates (EC) are less hazardous and the safest for bees than water-soluble or wettable formulations since the former has shorter residual toxicity than the latter.
 - Do not use broad-spectrum pesticides and instead pesticides with shorter residual effects are used.
 - ULV formulations are more hazardous than other liquid formulations.
- When using pesticides hazardous to bees, the beekeepers should be notified so that they may provide protection to their colonies.
- Time of application and location of colonies are important considerations:
 - a) Never apply pesticides while the crop is in bloom or while interplants, weeds or adjacent crops are in bloom
 - b) Never apply insecticides when bees are flying. Evening or late evening applications depending upon bee activity on the crop are relatively safe. For example by overnight, toxicity of parathion reduced by 50%. Small reduction in dosage brings down bid reduction in the kill of the bees.
 - c) Nights when dews occur toxicity may last longer.
 - d) Pyrethroids generally degrade faster than other groups of insecticides.
- Pesticidal dusts and small granules should not be left open or thrown carelessly anywhere because bees are likely to collect such dust during acute dearth periods.
- Before applying pesticides, the hives may be moved to another place temporarily or they may be confined for a short period. While confining;
 - a) Provide sufficient space in hives.
 - b) Provide proper ventilation.
 - c) Shade is provided to the hive.
 - d) Colonies may be covered with wet absorbent material, which helps to reduce the hive temperature.
 - e) Minimize the period of confinement. The bees must be confined in the hive as long as the pesticide near the hive retains unacceptable toxicity.

- Treatments during hot weather when bees are clustering on the outside of the hive may cause severe losses.
- Treating large areas and repeating applications may cause greater damage and bee losses.
- Insecticides should not be applied when unusually low temperatures are expected afterwards, because residues would remain toxic to bees for a much longer time.
- Primary emphasis should be on the use of Integrated Pest Management (IPM) programmes, which mainly relies on biological/cultural methods and which tend to minimize the use of chemicals, should be advocated.
- Care should be taken when discarding the pesticides.
- The combs with contaminated pollen are removed.
- Unite weak colonies and provide artificial feeding.
- Beekeeper should be intimated with the spray schedule so that it may be shifted or closed as the need be.
- In intensely bee keeping areas, there should be proper and close communication between beekeeper, grower, and extension worker to save the bees from pesticides.

Quick Guide to Minimize Killing of Bees Due to Pesticides



(Source: Adey et al., 1986)

Methods for Pesticide Doses Calculations for Field Applications

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:

I. 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 spray fluid required (ml or g)

Example 1. How much spray fluid of 0.2% concentration can be prepared from 150 g of Mancozeb 75 WP?

$$C_1 = 75\%$$

$$C_2 = 0.2\%$$

$$V_1 = 150 \text{ g}$$

$$V_2 = ?$$

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

$$= (75 \times 150) / 0.2$$

$$= 56,250 \text{ ml}$$

$$= 56.25 \text{ liters}$$

Example 2. Calculate the amount of Copper oxychloride 50 WP required to prepare 20 liters of 0.25% spray solution

$$C_1 = 50\%$$

$$C_2 = 0.25\%$$

$$V_2 = 20 \text{ liters} = 20,000 \text{ ml}$$

$$V_1 = ?$$

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

$$= (0.25 \times 20000) / 50$$

$$= 100 \text{ g}$$

Example 3. How much quantity of Imidacloprid 17.8 SL is needed to prepare 0.005% spray solution for 500 L/ha over 1/50 hectare?

$$C_1 = 17.8\%$$

$$C_2 = 0.005\%$$

$$\text{Rate} = 500 \text{ L/ha}$$

For 1/50 hectare:

$$V_2 = 500 \times 1/50 = 10 \text{ liters} = 10,000 \text{ ml}$$

$$V_1 = ?$$

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

$$= (0.005 \times 10000) / 17.8$$

$$= 2.81 \text{ ml (approx)}$$

Example 4. Chlorpyrifos 20 EC of 250 ml is added to 100 liters of water. Determine spray concentration

$$C_1 = 20\%$$

$$V_1 = 250 \text{ ml}$$

$$V_2 = 100 \text{ liters} = 1,00,000 \text{ ml}$$

$$C_2 = ?$$

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

$$= (20 \times 250) / 1,00,000$$

$$= 0.05\%$$

II. For Granules and Dust Formulations

$$C_1 V_1 = 100 RA$$

$$C_1 = \text{Concentration of formulation available (\%)}$$

$$V_1 = \text{Amount of formulation required (g or kg)}$$

$$R = \text{Recommended rate of pesticide application [g or kg ingredient (a.i.)/ha]}$$

$$A = \text{Area to be treated (ha)}$$

Example 1. Calculate the amount of 3% Phorate granules required @ 1.2 kg a.i./ha for an area of 2 ha.

$$C_1 = 3\%$$

$$V_1 = ?$$

$$R = 1.2 \text{ kg a.i./ha}$$

$$A = 2 \text{ ha}$$

$$C_1 V_1 = 100 RA$$

$$V_1 = (100 \times R \times A) / C_1$$

$$= (100 \times 1.2 \times 2) / 3$$

$$= 240 / 3$$

$$= 80 \text{ kg}$$

Example 2. How much 1.5% Chlorantraniliprole granules are needed to treat 1500 m² at 0.5 kg a.i./ha?

$$C_1 = 1.5\%$$

$$V_1 = ?$$

$$R = 0.5 \text{ kg a.i./ha}$$

$$A = 1,500 \text{ m}^2 = 0.15 \text{ ha}$$

$$V_1 = (100 \times R \times A) / C_1$$

$$\begin{aligned}
 &= (100 \times 0.5 \times 0.15) / 1.5 \\
 &= 7.5 / 1.5 \\
 &= 5 \text{ kg}
 \end{aligned}$$

Example 3. Determine the amount of 2% Quinalphos dust formulation needed @ 3 kg a.i./ha for 0.4 ha

$$C_1 = 2\%$$

$$V_1 = ?$$

$$R = 3 \text{ kg a.i./ha}$$

$$A = 0.4 \text{ ha}$$

$$V_1 = (100 \times R \times A) / C_1$$

$$= (100 \times 3 \times 0.4) / 2$$

$$= 120 / 2$$

$$= 60 \text{ kg}$$

III. Calculation of Formulated Product Requirement

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

$$\text{Commercial product (g/ha)} = \frac{\text{Dose in g.a.i./ha} \times 100}{\% \text{ a.i. in the Kg/L formulation}}$$

Examples:

1. Solid Formulations like WP, Dust – To calculate quantity of Mancozeb 75 WP required to cover 1 hectare of land @ 600 g active ingredient per hectare;

$$= \frac{600 \text{ g.a. /ha} \times 100}{75 \% \text{ a.i. in 1 kg}}$$

$$= 800 \text{ g/ha}$$

2. Liquid Formulations like EC, SC, SL – To calculate quantity of Cypermethrin 25 EC required to cover 1 hectare of land @ 12.5 g active ingredient per hectare;

$$= \frac{12.5 \text{ g.a.i./ ha}}{25 \% \text{ a.i. in 1 kg}} \times 100$$

$$= 50 \text{ ml/ha}$$

3. Granule Formulation – To calculate quantity of Cartap Hydrochloride 4G required to cover 1 hectare of land @ 500 g active ingredient per hectare;

$$= \frac{500 \text{ g.a.i.}}{4 \% \text{ a.i. in 1 kg}} \times 100$$

$$= 12,500 \text{ g (12.5 kg)/ha}$$

Note- Since 1 ha is approx 2.5 acres, to calculate quantity required for 1 acre area, divided the quantity required per hectare by 2.5

Safe Use of Pesticides in Pulse Crops and Guidelines for Handling Pesticide Poisoning

Basic Principles Before Use or Application of Any Agrochemicals

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

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 or 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 parts.
- 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

Guidelines For Handling Pesticides Poisoning

Skin Contamination

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

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.

Inhaled Poisons (dusts, vapours, 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.

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.

How to Induce Vomiting

- Do not waste a lot of time 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.

Table. Symptoms of pesticide poisoning and antidotes for plant protection chemicals

SL No	Chemical group /Class	Examples	Symptoms	Treatment/ Antidote
1.	Organochlorine	Aldrin, Dieldrin, 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 (Adrenalin) Do not give stimulants. Give calcium gluconate (10% in 10 ml. Ampules) intravenously every four hours. Consult Doctor immediately.
2.	Organophosphorus	Fenthion, Quinolophos, Chlorpyrifos, 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 assisted pulmonary ventilation, if respiration is 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 hours. Relieves nicotinic as well as muscarinic effect. Consult Doctor immediately.

3.	Carbamate	Carbofuran, Carbaryl, Methomyl, <i>etc.</i>	Fever, Vomiting, Headache, Giddiness, Gripping in muscles, Stomach pain, Excessive sweating	<p>Remove the contaminated and dirty clothes. Wash the body and clothes. Ensure clear airway.</p> <p>Intubate the patient & aspirate the secretion.</p> <p>Administer oxygen by mechanically assisted pulmonary ventilation, if respiration is depressed.</p> <p>Improve tissue oxygenation before atropine.</p> <p>In case the patient is unconscious, then administer Atropine injection.</p> <p>Use glycopyrolate as alternative to atropine.</p> <p>Avoid theophyllin and aminophyllin or barbiturates.</p> <p>2-PAM and other oximes are harmful and in fact contra indicated for routine usage.</p> <p>Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.</p> <p>Consult Doctor immediately.</p>
4.	Pyrethrins or Synthetic Pyrethroids	Cypermethrin, Alpha-Cypermethrin, Fenvalerate	Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin, allergic manifestations <i>etc.</i> Parasthesia, sometimes bronchospasm. In severe cases, convulsion can occur, and anxiety	<p>No specific antidote. Induce vomiting. Treatment is essentially symptomatic. If swallowed, then give active Charcol dissolved in water.</p> <p>Vit E oil preparation in parasthesia.</p> <p>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.</p> <p>Consult Doctor immediately.</p>

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 is extremely irritating to skin and eyes. Inhalation of spray mist 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	No specific antidote. Perform gastric lavage. Give Fuller's Earth (an adsorbent) 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 activated charcoal 50 to 100 g dissolved in 200 ml of water. Take patient to Doctor immediately.

				epistaxis, as a result of local irritation. Giddiness, headache, fever, diarrhoea and myalgia. Proteinuria, haematuria, pyrexia, azotemia followed by oliguria/anuria	If Fuller's earth is not available, give Bentonite 1 litre of 7.5% suspension or activated charcoal 50 to 100 g dissolved in 200 ml of water. Take patient to Doctor immediately.
9.	Copper Compounds	Copper Oxochloride, 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.
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, 0.3 gm t.i.d. 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.

Source: TNAU Crop Protection, Pesticides, Antidotes

General Guidelines for Insecticide Resistance Management

Insecticide resistance is a widespread phenomenon where an insect population develop the ability to survive/avoid the lethal concentrations of insecticides and biopesticides that would kill the majority of individuals in a normal population of the same species. Resistance frequently leads to the increased use, overuse, and even misuse of pesticides, which poses a risk to the environment and phytosanitation.

There are two types of resistance, simple resistance where resistance is limited to only one insecticide and not to the related ones and cross resistance where an insect resistant to one insecticide is also resistant to the related ones. It is widely accepted that the development of insecticide resistance by insects is due to the selection of variants in the population carrying pre adaptive genes for resistance. The rate at which resistance develops in a population depends on:

1. the frequency of resistant genes present, in the population;
2. the nature of these genes (either single or multiple, dominant or recessive);
3. the intensity of selection pressure, that is, the magnitude of the population exposed to the chemical and the proportion killed; and
4. the rate at which the species breeds (number of generations per year).

Resistance is the single most important phenomenon that threatens sustainable pest management in pulse crops. It is therefore important to detect resistance when it is at initial levels and monitor its increase and geographical spread so that appropriate measures can be initiated to curtail its increase. Insecticide resistance mechanism in insects is usually a complex phenomenon with more than one mechanism operating simultaneously within the same insect strain. Many factors are involved in insect resistance to insecticides. The most important of these are as follows:

1. Increased detoxication of the insecticide (physiological or biochemical factor).
2. Reduced penetration of the chemical (morphological factor),
3. Altered site of action (insensitivity of target site).
4. Altered behavioural patterns

The main aim of Insecticide Resistance Management (IRM) is to a) avoid development of resistance and maintain the level of susceptibility in the pest populations, b) slowing the rate of resistance development and c) once resistance has already developed to try to bring down resistance to manageable levels and to maintain it at this level. IRM should be integral part of IPM strategy. The general guidelines of insecticide resistance management (IRM) can be adopted or followed to prevent development of insecticide resistance by any insect pests in pulses.

Recommended IRM Principles by Insecticide Resistance Action Committee (IRAC)

- Consult a local plant protection advisor or extension services in the area for up-to-date recommendations and advice on IPM and IRM programmes.
- Consider options for minimizing insecticide use by selecting early maturing or pest-tolerant varieties of crop plants.
- Include effective cultural and biological control practices that work in harmony with effective IRM programmes. Adopt all non-chemical techniques known to control or suppress pest populations, including

biological sprays such as *Bt*'s, resistant varieties, within-field refugia (untreated areas) and crop rotation.

- Where possible select insecticides and other pest management tools that preserve beneficial insects.
- Use products at their full, recommended doses. Reduced (sub-lethal) doses quickly select populations with average levels of tolerance, while doses that are too high may impose excessive selection pressures.
- Appropriate, well-maintained equipment should be used to apply insecticides. Recommended water volumes, spray pressures and optimal temperatures should be used to obtain optimal coverage.
- Where larval stages are being controlled, target younger larval instars where possible because these are usually much more susceptible and therefore much more effectively controlled by insecticides than older stages.
- Use appropriate local economic thresholds levels (ETL) and recommended spray intervals.
- Follow label recommendations or local expert advice for use of alternations or sequences of different classes of insecticide with differing modes of action as part of an IRM strategy.
- Where there are multiple applications per year or growing season, alternate products of different mode of action (MoA) classes should be used.
- In the event of a control failure, do not reapply the same insecticide but change the class of insecticides to one having a different MoA and to which there is no [locally] known cross-resistance.
- Mixtures may offer a short-term solution to resistance problems, but it is essential to ensure that each component of a mixture belongs to a different insecticide MoA class, and that each component is used at its full rate.
- Consideration should be given to monitoring for the incidence of resistance in the most commercially important situations and gauge levels of control obtained.
- Withholding use of a insecticide to which resistance has developed until susceptibility returns may be a valid tactic if sufficient alternative chemical classes remain to provide effective control.

Source: IRAC, 2025

Pesticides Registered, Banned, Withdrawn and Restricted for Use in Agriculture in India

In India, all the pesticides to be used for agricultural purposes for protecting the crops and general public for house-hold use from the ravages of pests, humans from diseases and nuisance caused by public health pests have to be registered under Insecticides Act, 1968 by Central Insecticides Board and Registration Committee. Till date, 359 pesticides have been registered for uses in agricultural and household purposes (CIB&RC,2025a). This includes 106 insecticides, 10 miticides, 3 nematocides, 12 rodenticides & fumigants, 94 fungicides, 103 herbicides, 14 plant growth regulators and 17 biopesticides. Apart from this more than 350 combi-products or pesticide mixtures of insecticides, fungicides, herbicides, PGRs and insecticides + fungicides have been registered by CIBRC for uses in agriculture. The list of registered pesticides, banned for manufacture, import, export, use, withdrawn, refused registration and restricted for use in agriculture is given in below tables (CIB&RC, 2025b) :

A). List of Pesticides Registered for Use in India (As on 31.03.2025)

Sl. No.	Name of Pesticides	Sl. No.	Name of Pesticides
I	INSECTICIDES	23	Chromafenozide
1	Abamectin	24	Clothianidin
2	Acephate	25	Cyantraniliprole
3	Acetamiprid	26	Cyclaniliprole
4	Afidopyropen	27	Cyfluthrin
5	Allethrin	28	Cypermethri
6	Alphacypermethrin	29	Cyphenothrin
7	Bendiocarb	30	Deltamethrin (Decamethrin)
8	Benfuracarb	31	Diafenthiuron
9	Benzpyrimoxan	32	Dichloro Diphenyl Trichloroethane (DDT)
10	Beta Cyfluthrin	33	Diflubenzuron
11	Bifenazate	34	Dimethoate
12	Bifenthrin	35	Dimpropridaz
13	Broflanilide	36	Dinotefuron
14	Buprofezin	37	D-trans Allethrin
15	Carbofuran	38	Emamectin Benzoate
16	Carbosulfan	39	Ethion
17	Cartap Hydrochloride	40	Ethiprole
18	Chlorantraniliprole	41	Ethofenprox (Etofenprox)
19	Chlorfenopyr	42	Fenitrothion
20	Chlorfluazuron	43	Fenobucarb (BPMC)
21	Chlorpyriphos	44	Fenpropathrin
22	Chlorpyriphos Methyl	45	Fenvalerate

Sl. No.	Name of Pesticides	Sl. No.	Name of Pesticides
46	Fipronil	84	Pyridalyl
47	Flometoquin	85	Pyrifluquinazon
48	Flonicamid	86	Pyriproxyfen
49	Flubendiamide	87	Quinalphos
50	Flufenoxuron	88	Renofluthrin
51	Flupyradifurone	89	S-bioallethrin
52	Flupyrimin	90	Spinetoram
53	Fluvalinat	91	Spinosad
54	Fluoxametamide	92	Spiromesife
55	Gossyplure	93	Spiropidion
56	Imidacloprid	94	Spirotetramat
57	Imiprothrin	95	Sulfoxaflor
58	Indoxacarb	96	Tebufenozide
59	Isocycloseram	97	Teflubenzuron
60	Lambdacyhalothrin	98	Temephos
61	Lufenuron	99	Tetraniliprole
62	Malathion	100	Thiacloprid
63	Metaflumizon	101	Thiocyclam Hydrogen oxalate
64	Metaldehyde	102	Thiodicarb
65	Methoxyfenozide	103	Thiomethoxam
66	Metofluthrin	104	Tolfenpyrad
67	Milbemectin	105	Transfluthrin
68	Monocrotophos	106	Triflumezopyrim
69	Nitenpyram	II	MITICIDES
70	Novaluron	1	Acequinocyl
71	Oxydemeton-Methyl	2	Acynonapyr
72	Permethrin	3	Cyenopyrafen
73	Phenthoate	4	Cyflumetofen
74	Phosalone	5	Etoazole
75	Phosmet	6	Fenazaquin
76	Prallethrin	7	Fenpyroximate
77	Primiphos-methyl	8	Hexythiazox
78	Profenophos	9	Propergite
79	Propamocarb hydrochloride	10	Tebufenpyrad
80	Propetamphos	III	NEMATICIDES
81	Propoxur	1	Cyclobutrifluram
82	Pymetrozin	2	Fluazaindolizine
83	Pyridaben	3	Fluensulfone

Sl. No.	Name of Pesticides	Sl. No.	Name of Pesticides
IV	RODENTICIDE AND FUMIGANTS	23	Cyproconazole
1	Aluminum Phosphide	24	Cyzofamide
2	Barium Carbonate	25	Difenoconazole
3	Brodifacoum	26	Dimethomorph
4	Bromadiolone	27	Dithianon
5	Coumachlor	28	Dodine
6	Coumatetralyl	29	Edifenphos
7	Dichloropropene and Dichloropropane mixture (DD mixture)	30	Epoxyconazole
8	Ethylene Dichloride and Carbon Tetrachloride mixture	31	Famoxadone
9	Flocoumafen	32	Fenamidone
10	Magnesium Phosphide Plates	33	Fenoxanil
11	Methyl Bromide	34	Fludioxonil
12	Zinc Phosphide	35	Flufenazine
V	FUNGICIDES	36	Fluopicolide
1	Ametoctradin	37	Fluopyram
2	Amisulbrom	38	Flusilazole
3	Aureofungin	39	Flutriafol
4	Azoxystrobin	40	Fluxapyroxad
5	Benalaxyl	41	Fluoxapiprolin
6	Benalaxyl M	42	Fosetyl-Al
7	Bitertanol	43	Hexaconazole
8	Boscalid	44	Ipflufenquin
9	Buprimate	45	Iprobenfos (Kitazin)
10	Captan	46	Iprodione
11	Carbendazim	47	Iprovalicarb
12	Carboxin	48	Isoprothiolane
13	Carpropamid	49	Isopyrazam
14	Chlorothalonil	50	Kasugamycin
15	Copper Hydroxide	51	Kresoxim Methyl
16	Copper Oxychloride	52	Lime Sulphur
17	Copper Sulphate	53	Mancozeb
18	Copper Sulphate Pentahydrate	54	Mandipropamid
19	Cuprous Oxide	55	Mefentrifluaconazole
20	Cyazofamid	56	Meptyldinocap
21	Cyflufenamide	57	Metalaxyl
22	Cymoxanil	58	Metalaxyl-M
		59	Metiram
		60	Metrafenone

Sl. No.	Name of Pesticides	Sl. No.	Name of Pesticides
61	Myclobutanil	5	Ametryn
62	Oxathiapipron	6	Anilophos
63	Oxycarboxin	7	Atrazine
64	Penconazole	8	Azimsulfuron
65	Pencycuron	9	Beflubutamid
66	Penflufen	10	Bensulfuron Methyl
67	Picoxystrobin	11	Bentazone
68	Picabutraxox	12	Bispyribac Sodium
69	Polyoxin D Zinc salt	13	Bixlozone
70	Prochloraz	14	Butachlor
71	Propiconazole	15	Carfentrazone Ethyl
72	Pydiflumetofen	16	Chlorimuron ethyl
73	Pyraclostrobin	17	Chlormequat Chloride (CCC)
74	Sedaxane	18	Chlorpropham
75	Streptomycin	19	Cinmethylin
76	Sulphur	20	Clethodim
77	Tebuconazole	21	Clodinafop-propargyl
78	Tetraconazole	22	Clomazone
79	Tetracycline	23	Cyhalofop-butyl
80	Thifluzamide	24	Dazomet
81	Thiophanate-Methyl	25	Dicamba
82	Thiram	26	Diclofop-Methyl
83	Triadimefon	27	Diclosulam
84	Tribasic Copper Sulfate	28	Diffufenican
85	Tricyclazole	29	Dimethenamid-P
86	Trifloxystrobin	30	Diuron
87	Triflumizole ⁸⁸ Triticonazole	31	Ethalfuralin
89	Oxathiapiprolin	32	Ethoxysulfuron
90	Validamycin	33	Fenoxaprop-p-ethyl
91	Valifenalate	34	Florasulam
92	Zineb	35	Florpyrauxifen-benzyl
93	Ziram	36	Fluazifop-p-butyl
94	Zoxamide	37	Flucetosulfuron
VI	HERBICIDES	38	Fluchloralin
1	2,4-D Amine salt	39	Flufenacet
2	2,4-D- Ethyl Ester	40	Flumioxazin
3	2,4-D Sodium Salt	41	Flurochloridone
4	Aclonifen	42	Fluroxypyr meptyl

Sl. No.	Name of Pesticides	Sl. No.	Name of Pesticides
43	Fluthiacet methyl	81	Propineb
44	Fomesafen	82	Pyraflufen ethyl
45	Glufosinate Ammonium	83	Pyrazosulfuron ethyl
46	Glyphosate (IPA Salt)	84	Pyribenzoxim
47	Glyphosate Ammonium Salt	85	Pyriofenone
48	Glyphosate Potassium salt	86	Pyriftalid
49	Halauxifen-methyl	87	Pyrithiobac sodium
50	Haloxyfop-R-methyl	88	Pyroxasulfon
51	Halosulfuron methyl	89	Quinclorac
52	Hexazinone	90	Quizalofop ethyl
53	Imazamox	91	Quizalofop-P-tefuryl
54	Imazethapyr	92	Saflufenacil
55	Imazosulfuron	93	Sodium acifluorfen
56	Indaziflam	94	Sulfentrazone
57	Iodosulfuron methyl sodium	95	Sulfosulfuron
58	Ipfencarbazone	96	Tembotrione
59	Isoproturon	97	Thiobencarb (Benthiocarb)
60	MCPA, Amine salt	98	Topramezone
61	Mesosulfuron Methyl	99	Triafamone
62	Mesotrione	100	Triallate
63	Metamifop	101	Triasulfuron
64	Metamitron	102	Trifloxysulfuron Sodium
65	Methabenzthiazuron	103	Trifluralin
66	Methyl Chlorophenoxy Acetic Acid (MCPA)	VII	PLANT GROWTH REGULATORS
67	Metolachlor	1	1-Methyl Cyclopropene
68	Metribuzin	2	6-Benzyladenine
69	Metsulfuron Methyl	3	Alphanaphthyl Acetic Acid
70	Orthosulfamuron	4	Cyclanilide
71	Oxadiargyl	5	Ethephon
72	Oxadiazon	6	Forchlorfenuron
73	Oxyfluorfen	7	Gibberellic Acid
74	Paraquat dichloride	8	Hydrogen Cyanamide
75	Pendimethalin	9	Mepiquat Chloride
76	Penoxsulam	10	Nitrobenzene
77	Pinoxaden	11	Paclobutrazol
78	Pretilachlor	12	Prohexadione Calcium
79	Propanil	13	Sodium paranitrophenolate
80	Propaquizafop	14	Triacantanol

Sl. No.	Name of Pesticides	Sl. No.	Name of Pesticides
VIII BIOPESTICIDES		10	<i>Nuclear polyhydrosis virus of Helicoverpaarmigera</i>
1	<i>Ampelomyces quisqualis</i>	11	<i>Nuclear polyhydrosis virus of Spodoptera litura</i>
2	Azadirachtin (Neem Products)	12	<i>Pseudomonas fluorescens</i>
3	<i>Bacillus subtilis</i>	13	Pyrethrin (pyrethrum)
4	<i>Bacillus thuringiensis var. galleriae</i>	14	<i>Trichoderma harzianum</i>
5	<i>Bacillus sphaericus</i>	15	<i>Trichoderma viride</i>
6	<i>Bacillus thuringiensis var. israelensis</i>	16	<i>Verticillium lecanii</i>
7	<i>Bacillus thuringiensis var. kurstaki</i>	17	<i>Verticillium chlamyosporium</i>
8	<i>Beauveria bassiana</i>		
9	<i>Metarhizium anisopliae</i>		

B). Pesticides Banned for Manufacture, Import and Use in India

Sl. No.	Name of Pesticide	Group
1.	Alachlor	Herbicides
2.	Aldicarb	Insecticides
3.	Aldrin	Insecticides
4.	Benzene Hexachloride	Insecticides
5.	Benomyl	Fungicide
6.	Calcium Cyanide	Insecticides
7.	Carbaryl	Insecticides
8.	Chlorbenzilate	Insecticides
9.	Chlordane	Insecticides
10.	Chlorofenvinphos	Insecticides
11.	Copper Acetoarsenite	Fungicide
12.	Diazinon	Insecticides
13.	Dibromochloropropane	Insecticides
14.	Dichlorovos	Insecticides
15.	Dicofol	Insecticides
16.	Dieldrin	Insecticides
17.	Dinocap	Insecticides
18.	Endosulfron	Insecticides
19.	Endrin	Insecticides
20.	Ethyl Mercury Chloride	Insecticides
21.	Ethyl Parathion	Insecticides
22.	Ethylene Dibromide	Insecticides
23.	Fenarimol	Fungicide

24.	Fenthion	Insecticides
25.	Heptachlor	Insecticides
26.	Lindane	Insecticides
27.	Linuron	Fungicide
28.	Maleic Hydrazide	Herbicides
29.	Menazon	Insecticides
30.	Methomyl	Insecticides
31.	Methoxy Ethyl Mercury Chloride	Fungicide
32.	Methyl Parathion	Insecticides
33.	Metoxuron	Herbicides
34.	Nitrofen	Herbicides
35.	Paraquat Dimethyl Sulphate	Herbicides
36.	Pentachloro Nitrobenzene	Fungicide
37.	Pentachlorophenol	Herbicides
38.	Phenyl Mercury Acetate	Herbicides
39.	Phorate	Insecticides
40.	Phosphamidon	Insecticides
41.	Sodium Cyanide	Insecticides
42.	Sodium Methane Arsonate	Herbicides
43.	Tetradifon	Acaricide
44.	Thiometon	Insecticides
45.	Toxaphene	Insecticides
46.	Triazophos	Insecticides
47.	Tridemorph	Fungicide
48.	Trichloroaceticacid	Herbicides
49.	Trichlorfon	Insecticides

C). Pesticide Formulations Banned for Use but Continued to Manufacture for Export

Sl. No.	Name of Pesticide	Group
1.	Captafol 80% Powder	Fungicide
2.	Dichlorvos	Insecticides
3.	Nicotin Sulfate	Insecticides
4.	Phorate	Insecticides
5.	Triazophos	Insecticides

D). Pesticides Withdrawn for Use in India

Sl. No.	Name of Pesticide	Group
1.	Dalapon	Herbicides
2.	Ferbam	Fungicide
3.	Formothion	Insecticides

Sl. No.	Name of Pesticide	Group
4.	Nickel Chloride	Fungicide
5.	Paradichlorobenzene	Insecticides
6.	Simazine	Herbicides
7.	Sirmate	Herbicides
8.	Warfarin	Rodenticide

E). Pesticides Refused Registration in India

Sl. No.	Name of Pesticide	Group
1.	2,4,5-T	Herbicides
2.	Ammonium Sulphamate	Herbicides
3.	Azinphos Ethyl	Insecticides
4.	Azinphos Methyl	Insecticides
5.	Binapacryl	Insecticides
6.	Calcium Arsenate	Insecticides
7.	Carbophenothion	Insecticides
8.	Chinomethionate (Morestan)	Fungicide
9.	Dicrotophos	Insecticides
10.	EPN	Nematode
11.	Fentin Acetate	Fungicide
12.	Fentin Hydroxide	Fungicide
13.	Lead Arsenate	Insecticides
14.	Leptophos (Phosvel)	Insecticides
15.	Mephosfolan	Insecticides
16.	Mevinphos (Phosdrin)	Insecticides
17.	Thiodemeton/Disulfoton	Insecticides
18.	Vamidothion	Insecticides

F). Pesticides Restricted for Use in India

Sl. No.	Name of Pesticides	Details of Restrictions	Group
1.	Aluminium Phosphide	The pest control operations with Aluminium Phosphide may be undertaken only by Govt. /Govt. undertakings / Govt. Organizations / pest control operators under the strict supervision of Govt. Experts or experts whose expertise is approved by the Plant Protection Advisor to Govt. of India except Aluminium Phosphide 15% 12 g tablet and Aluminum Phosphide 6% tablet. [RC decision circular F No. 14-11(2)-CIR-II (Vol. II) dated 21-09-1984 and G.S.R. 371(E) dated 20 th May 1999]. Decision of 282 nd RC held on 02 -11-2007 and Decision of 326 th RC held on 15 -02-2012. The production, marketing and use of Aluminium Phosphide tube packs with a capacity of 10 and 20	Insecticide

		tablets of 3 g each of Aluminium Phosphide are banned completely. (S.O.677 (E) dated 17th July, 2001)	
2.	Carbofuran	All other formulations of carbofuran except carbofuran three per cent Encapsulated granule (CG) along with the crop labels may be stopped from use (S.O.4294 (E) dated 3 rd October, 2023)	Insecticide
3.	Captafol	The use of captafol as foliar spray is banned. Captafol shall be used only as seed dresser. (S.O.569 (E) dated 25 th 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 17 th July, 2001)	Fungicide
4.	Cypermethrin	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 1407 - 2009 and LPA-429/2009 dated 08-09-2009]	Insecticide
5.	Chlorpyrifos	Chlorpyrifos is banned for use in Ber, Citrus and Tobacco. (S.O. 4294(E) dated 3 rd October, 2023)	Insecticide
6.	Dimethoate	Dimethoate is banned for use in fruits and vegetables that are consumed as raw food items. (S.O.4294 (E) dated 3 rd October, 2023)	Insecticide
7.	Dazomet	The use of Dazomet is not permitted on Tea. (S.O.3006 (E) dated 31st Dec, 2008)	Herbicide
8.	Dicohloro Diphenyl Trichloroethane (DDT)	The use of DDT for the domestic Public Health Programme is restricted up to 10,000 Metric Tonnes per annum, except in case of any major outbreak of epidemic. M/s Hindustan Insecticides Ltd., the sole manufacturer of DDT in the country may manufacture DDT for export to other countries for use in vector control for public health purpose. The export of DDT to parties and state non-parties shall be strictly in accordance with the paragraph 2(b) article 3 of the Stockholm Convention on Persistent Organic Pollutants (POPs). (S.O.295 (E) dated 8 th 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 26 th May, 1989)	Insecticide
9.	Fenitrothion	The use of Fenitrothion is banned in Agriculture except for locust control in scheduled desert area and public health. (S.O.706 (E) dated 03 rd May, 2007)	Insecticide

10.	Malathion	Malathion is banned for use on Sorghum, Pea, Soybean, Castor, Sunflower, Bhindi, Brinjal, Cauliflower, Radish, Turnip, Tomato, Apple, Mango and Grape. (S.O.4294 (E) dated 3 rd October, 2023)	Insecticide
11.	Mancozeb	Mancozeb is banned for use on Guava, Jowar and Tapioca. (S.O. 4294(E) dated 3 rd October, 2023)	Fungicide
12.	Methyl Bromide	Methyl Bromide may be used only by Govt. /Govt. undertakings/Govt. Organizations / Pest control operators under the strict supervision of Govt. Experts or Experts whose expertise is approved by the Plant Protection Advisor. [G.S.R.371 (E) dated 20th May, 1999 and earlier RC decision]	Insecticide
13.	Monocrotophos	Monocrotophos is banned for use on vegetables. (S.O.1482 (E) dated 10th Oct, 2005) 1). The use of Monocrotophos 36% SL formulation is to be discontinued and no new certificate of registration for its manufacture shall be issued after publication of S.O. 4294(E) dated 3 rd October, 2023. 2) With an objective of providing alternatives of this formulation so that the farmers do not suffer losses due to non-availability of effective control against certain insect pests in specific crops, the label claims for other formulations of Monocrotophos may be extended in one - year period from the date of publication of S.O. 4294(E) dated 3 rd October, 2023. 3) After this period, all the certificates of registration of Monocrotophos 36% SL will stand cancelled. Sale, distribution or use of Monocrotophos 36% SL shall be allowed only for clearance of existing stock till its expiry period. (S.O. 4294(E) dated 3 rd October, 2023)	Insecticide
14.	Oxyfluorfen	Oxyfluorfen is banned for use on Potato and Groundnut. (S.O. 4294(E) dated 3 rd October, 2023)	Herbicide
15.	Quinalphos	Quinalphos is banned for use on Jute, Cardamom and Sorghum. (S.O. 4294(E) dated 3 rd October, 2023)	Insecticide
16.	Trifluralin	The registration, import, manufacture, formulation, transport, sell and its all uses except use in wheat shall be prohibited and completely banned from 8 th August, 2018. A cautionary statement has to be incorporated in the label and leaflet that it is toxic to aquatic organism, hence should not be used near water bodies, aquaculture or pisciculture area. (S.O3951 (E) dated 8 th August, 2018)	Herbicide

Abbreviations

a.i.	: Active ingredient
AChE	: Acetylcholinesterase
AF	: Aqueous flowable
APEDA	: Agricultural and Processed Food Products Export Development Authority
AS	: Aqueous Solution or Aqueous Suspension
ATP	: Adenosine triphosphate
BB	: Block Bait
CAC	: Codex Alimentarius Commission
CB	: Bait Concentrate
CFU	: Colony Forming Units
CG	: Encapsulated Granule
CIB & RC	: Central Insecticide Board and Registration Committee
CS	: Capsule Suspension
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
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 Regulator
IPM	:	Integrated Pest Management
IRAC	:	Insecticide Resistance Action Committee
IRM	:	Insecticide Resistance Management
Kg	:	Kilogram
l	:	Litre
ME	:	Micro Emulsion
ml	:	Milliliter
MoA	:	Mode of Action
MRL	:	Maximum Residue Limit
nAChR	:	Nicotinic acetylcholine receptor
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
POB	:	Polyhedral Occlusion Body
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
WDG	:	Water Dispersible Granules
WG	:	Water Dispersible Granules
WHO	:	World Health Organization
WP	:	Wettable Powder
WS	:	Water Dispersible Powder for Slurry Treatment
ZC	:	Mixed formulation of Capsule Suspension and Suspension Concentrate



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