BIO-PESTICIDES : THE REAL NEED FOR ECO-FRIENDLY PEST MANAGEMENT

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Agriculture is the mainstay of livelihood and continues to be the backbone of Indian economy. It is the single largest sector which provides direct or indirect livelihood to more than 70 per cent of India's population. Besides, it contributes to 1/5th of the total gross domestic product (GDP), employment to 69 per cent of total workforce, 10 per cent of the total export earnings and raw material to a large number of Industries.

Insect pests and diseases continue to be one of the major constraints for optimum crop productivity. More than 30 per cent of the crops are lost after being affected by insects and diseases. Farmers consider pesticides as first line of weapon for control of insect and diseases which affect the crops. However, indiscriminate use of these toxic chemicals has led to serious health hazards for the human beings, as well as to the livestock, aquatic animals, plants and environment. Also this has led to development of resistance, resurgence and secondary pest outbreak of insect pests and the most important is residues of pesticides in food stuffs leading to severe health issues. It is noteworthy that the food production in the country has not increased as desired in the last two decades, even though the use of pesticides has increased by 20 per cent per annum. According to reports, Indian food products have 25 per cent more pesticide residues over tolerance level as compared to 2.5 percent globally, resulting in rejection of agricultural exports to the tune of Rs 4 to 5 thousand crore annually.

Bio- pesticides are the products derived from biological sources rightly termed as "Crop Health Products" and are emerging as new crop protection strategy. Three broad groups of biological origin are included under bio-pesticides viz. Bio-chemical pesticides (e.g. Plant products like neem, begunia etc. and pheromones), bio-control agents (predators, parasites etc and microbials e.g. bacteria, fungi, viruses etc.), and genetically modified plants created by incorporation of gene. These bio-pesticides when used as a component of IPM for management of pests in all crops or used singly in organic farming for management of pests in medicinalcrops, spices and some export oriented crops are cheaper than chemical pesticides by 40-50per cent.

Plant bio Pesticides

Plant products take pivotal position as bio-pesticides because these are bio-degradable, ecologically safe and have significant toxicity on target species. Plants (either their extracts of parts or oils or oilcake etc.) which are used as bio-pesticides are neem, mahaneem, Karanja, Begunia, Mahua, custard apple, tulsi, chrysanthemum, ryania, sabadila, Thuja tobacco piper, onion, garlic, zinger, turmeric eucalyptus, palmarosa, lemongrass, clove, ginger, garlic, citronella, castor etc. These plants contain alkaloids, limonoids (terpinoids) and isoflavonoids which act as pesticides. Alkaloids such of nicotine from tobacco, rotenone from Derris, pyrethrins and cinerins (pyrethroids) from chrysanthemum and limonoids / terpenoids (azadirachtin) from neem make them good plant by pesticides. Bio-chemical pesticides are natural occurring substances such as insect sex pheromones that interfere with mating as well as various scented plant extracts that attract insect pests to traps. Phenomones can manage insect pest by mass trapping, monitoring mating disruption and auto confusion techniques.

Use of Natural Enemies

Use of natural enemies e.g. parasitoids, predators and pathogens for management of pests is other wise known as biological control. It also refers to the various activities of man which enhances the efficiency of the natural enemies already present in the eco-system. The various techniques of bio-control are conservation, augmentation and importation. Conservation refers to actions to preserve and increase the natural enemies by environmental manipulation like avoiding cultural practices and use of selective insecticides which are harmful to NES, use of appropriate practices which favours the survival and multiplication of natural enemies, providing of alternate hosts, refusia, food like pollen and nectar for adult stages of NES, increased environmental opportunities by increasing bio-diversity etc. Importation / Introduction refers to importing foreign natural enemies to combat the introduced pests. In India 79 species of natural enemies were imported out of which 53 were successfully multiplied and 21 have established in the field.

Augmentation refers to the activities designed to increase the natural enemy population either by propagation and release or by environmental manipulation. It is of two types viz. inoculative release where control is expected from the progeny and subsequent generations and not from release itself and innundative release which involve mass culture and release of natural enemies to suppress pests that have only one or a few generation per year. Natural enemies may be parasitoid which is usually smaller in size, live and complete one stage of life in or on the prey, derive nutrition and kill the prey in the process. Parasitoids may be egg, larval and pupal depending on the stage on which they attack. Trichogramma is the excellent egg parasite which has been successfully employed to manage lepidopterous insects in rice, sugarcane, cotton, pulses vegetables like okra, brinjal, tomato etc. and bracon and goniozus has successfully managed coconut black headed caterpillar predator which is usually larger and stronger than prey and they catch and kill a large number of prey.

The Government has decided to pump in fifty thousand crore rupees in 'Pradhaan Mantri Krishi Sinchaai Yojna'. We have to launch a movement in our agricultural sector with the mantra of "Save Water, Save Energy, and Save Fertilizers". Hence, "Per drop more crop" is our watchword; each drop of water can contribute towards producing more crop and hence successful farming. "Neem-Coating" is an idea propounded by scientists, and in our country, urea worth millions and billions of rupees is allocated in the names of farmers, but 15, 20 or 25 per cent of this urea is diverted to the chemical factories as raw material. Allocated in the names of farmers, this urea is pilfered through the middlemen. This pilferage of urea cannot be stopped unless we go for cent per cent "Neem-Coating" of urea. Therefore, irrespective of the burden caused to the exchequer, we have accomplished the task of doing hundred per cent "Neem-Coating" of urea. As a result of this, now urea cannot be used for any purpose other than farming. Now, no chemical factory can indulge in any kind of pilferage of urea. The farmers will have as much urea as they need. Since the urea is "Neem Coated", even if they use 10 per cent less of urea, their land will be benefitted with the nutritional value it requires.

The important predators like chrysoperla, cryptolaenus, coccinella, cheilomenes, chilocorus, corulus are amenable to laboratory rearing and effectively manage sucking insect pests like aphid, whitefly mealybugs, thrips, scales, psyllids, plant hoppers, eggs, and young larvae of Lepidoptera of cotton, pulses, oilseeds, vegetables, subabul, citrus and mango etc. Telenomus, Tetrastichus, Apanteles, Gonatocerus, Anagrus Cotesia, Stenobracon, Compoletis, Epipyrops and Brachyumeria are important natural parasites and spiders, preying mantids, dragon / damselfly, tiger beetle, pentatomid bugs, water striders, syrphids, mirid bugs and rove beetles are important natural predators which needs to be conserved.

Bacteria, virus, fungi, protozoa, ricketsia and nematodes are the principal groups of insect pathogens and are effective microbial bio-pesticides and can be used in pest management. These pathogens must possess a suitable strain, virulent toxins and persistence (long shelf life)' to be a successful microbial bio-pesticide. Among a wide group of entomogenous bacteria, the crystalliferous spore forming, rod shaped, gram positive bacteria *Bacillus thuringiensis* (Bt) proved as potential bio-pesticide which has gained popularity worldwide. The most prominent Bt product is BTK and is sold under trade names viz. Dipel, thuricide biobit, delfin, bactospein, Halt, fighter, bactrin, bioasp and used at 1kg/ ha against different lepidopterous insects. Entomopathogemic viruses can be grouped into two categories viz. Inclusion / occluded viruses (IV) producing inclusion bodies of crystalline protein and non-inclusion viruses (NIV). Based on the shape of inclusion bodies, occluded viruses can be divided into polyhedral viruses e.g. nuclear poly hydrosis virus (NPV), cytoplasmic polyhydrosis virus (CPV) and granulosis virus (GV). All these can be used in pest management and among these NPV has shown the greatest potentical because they are more virulent.

Viruses are host specific, no adverse effect on environment, higher acceptability, yields and quality improvement. At 250-500 LE/ ha, HaNPV (heliocel, helicide, biorocil-H and bio-virus-H) and Sl-NPV (Spodocide, litucide, biorocil-s and bio-virus-s) can respectively manage pod borer (Helicoverpa) attacking pulses, sunflower, Okra, tomato, maize etc and tobacco caterpillar (spodoptera) attacking oil seeds, pulses and many vegetables, Entomogenous fungi of genera Beauveria, Metarhizium, verticillium Hirsutella, Aschersonia, Lecanicillium, Entomopthora have been used for insect pest management. Amongst these Beauveria are highly effective on lepidopterans, white flies, hoppers coffepodborer, aphids, white grubs, red spider mites etc. verticillium is most efficacious on aphids, jassids and whiteflies and entomopthora on white flies and metarhizium on white grubs and locusts. Eentomphillic nematodes like Hexamermis, mermis, steinernema, tylenchids and Rhabitids are useful in insect management. Some of the successful examples are agamermis against yellow stemborer, Hexamermis against BPH, Sugarcane topshoot / early shoot borer and tobacco caterpillar (spodoptera) and steinernema carpocapsee against yellow stemborer and Earcutting caterpillar in rice. Ricketssiella are pathogenic to coleoptera, Diptera, Lepidoptera, Orthoptera etc. of which *R. meldothae* cause Lorsch disease in white grub, *Nosema locustae, Varirimorpha necatrix* used against grasshoppers and caterpillars respectively. The recently discovered cephalogregarine, Gregarina sp attack nyumphs and adults of 15 species of grasshoppers. Sporozoa and cnidospora are the protozoans which multiply inter/ intracellularly in the host and kill them. Till date protozoans, rickett sials and nematodes have not been exploited properly for management of insect pests.

Genetically modified plants have created by incorporating Bt gene into the cells of cotton, Brinjal, rice, tobacco, tomato etc to manage bollworm complex, fruit and shoot borer, yellow stemborer, tobacco caterpillar and fruit borer respectively. Now GM plants of Bt cotton are successfully cultivated by managing bollworm complex in cotton in India and GM plants of other crops have been successfully cultivated in USA and European countries by controlling the lopidopterous insects of the crops.

Novel insecticides of Biological origin:

The novel insecticides of bio-logical origin derived from micro-organism like *spinosyns, saccharopolyspora spinosa,* a soil bacterium actionomycetes; Avervmectins, *streptomyces avermectalis;* Milbemycins *streptomyces hygroscopicus,* a soil based actinomycetes; Diabroactins, *Bacillus subtillis* and *B. Cereus* from

soil bacterium and cartap hydrochloride from *Lumbriconereis hateropoda* a sea annelid which can be used as bio-pesticides.

Bio-pesticides scenario in India :

In India, of all the available pesticides in the market, bio-pesticides contribute only 0.2per cent in 2000, 2.5per cent in 2005 which increased upto 5per cent in 2013. Many bio-pesticides like neem oil, neem kernel extracts, trichogramma cards, Bt, NPV, Metarhizium, Beauveria (to manage insect pests) and trichoderma, pseudomonas (for management of diseases) are now commercially available in the Indian market. Among all these Bt stands first followed by neem in terms of consumption. Now in India, more than 100 companies are involved in manufacture / formulation of bio-pesticides and biocontrol agents and some are being imported. We have succeeded in managing insects like gram pod borer, *Helicoverpa armigera*, Diamond back moth, sugar cane borers, cotton bollwers, mangohoppers, whitefly sugarcan pyrilla and diseases like rots and wilts by the use of biopesticides. Trichogramma, Bracon, chelonus and chrysopa have successfully managed bollwarms and sucking insect pests in cotton.

Sugarcane borers have been successfully managed in the status of Tamilnadu, Karnataka, Odisha, Rajstan, U.P., Bihar and Haryana by use of Trichogramma. Pyrilla in sugar cane have also been successfully managed in the above states by the introduction of *Epiricamia melanoleuca*. Lantana weed has been successfully managed by the bug *Telonomia scrupulosa*. Last decade has witnessed a tremendous break through on standardization for production technique of Trichogramma, Bt, NPV, Beauveria, Metarhizum, pseudomonas, Gliocladium, trichoderma to use them in many insect pests and diseases. Now many research Institutes, state Agril universities, Krishi Vigyan Kendras, private organizations are involved in research related to various aspects of bio-pesticides development, usage, quality control but they have not reached in the door step of farmers because of lack of promotional strategies, lack of access, lack of awareness and most important is lack of willingness on the part of extension workers. There is also Constraints like, Improper and inappropriate quality of bio-pesticides and their delivery system, lack of technical know how and trained personal for production and use, lack of multidiseiplinary approach and improper toxicology and regulatory matters, Enterprises for bio-pesticides are small and medium and reduction in International and national research support system.

Steps for development and use of bio-pesticides:

- An organization or body need to be established at national level for research and development of bio-pesticides.
- Bio-control agents repository established at project directorate of Bio-logical control (ICAR) Bangalore and all the co-ordinated research projects on bio-control functioning at SAU and research Institutes need to be further strengthened.
- Plant based products / pesticides, bio-control agents, including microbial agents and pheromones should be included in the package of practices, IPM programmes of SAUS, ICAR research Institutes, state Department of Agriculture / Horticulture with a view to reduce / avoid the use of harmful chemical pesticides and promotion of bio-pesticides.
- Registration of bio-pesticides need to be done for commercial sale and supply of quality bio-pesticide to farmers.
- Need based packaging and labeling strategies need to be developed for promotion of bio-pesticides.
- Govt. should provide subsidies / exemptions or reduction of sales tax for survival and establishment of bio-pesticide industry.
- Govt. regulatory procedure should be smoothened further to bring in new bio-pesticides quickly for use by the famers.
- Research need to be initiated and intensified for achieving in vitro production of microbes and laboratory hosts on synthetic diets.
- Formulation of bio-pesticides need to be done properly and effective delivery systems should be created for early availability of bio-pesticides at the door step of farmers.
- Loaning policy should be liberal for un-employed agriculture gradates with reduced rate of interest as this would help and encourage self-employment.
- Bio-pesticides viz. bio-agents (parasitoids, predators, pathogens), plant based products and pesticides (neem etc.), bio-based seed treating

agents viz. trichoderma and pheromone traps and other bio-based minkits should be supplied to farmers in national demonstration programmes under RKVY, NFSM, ISOPOM, NHM etc instead of chemical pesticides for effective management of insects and diseases etc.

- Tax policies should be liberal for youth and tax concession should also be offered to encourage entrepreneurs.
- The rules for registration of bio-pesticides should be simple and less rigid than those of chemical pesticides. Registration of a microbial pesticides requires toxicological tests for oral, dermal, eye and other health hazards using test animals in USA. If these tests show no adverse effects and the bio-control agent is not a plant pathogen it should be registered and sold. This procedure should be followed in India which will help the bio-pesticide industry and the farming community.

Establishment of better linkage between research and industry as farmer research linkages have already become strong.

Implementation of Insecticides Act, 1968:

Government of India has already included as many as 45 bio- pesticides in the schedule to the insecticides Act, 1968 and 18 bio-pesticides have already been registered by the registration committee constituted u/s 5 of the Insecticides Act 1968 for use in the country. How ever all the producers of Bio-pesticides, irrespective of private or Government organization are required to have registration of their products under the provisions of the insecticide Act 1968. The details regarding procedure for registration are available on the website www.cibrc.nic.in. But unfortunately it has been brought to the notice of the Govt. of India that many state Agriculture Universities, Krishi Vigyan Kendra, non-Govt. and other private organization are producing bio-pesticides without obtaining registration from the registration committee constituted u/s 5 of the Insecticides Act 1968 and manufacturing licenses from the licensing authority of the concerned state which is against the law and the insecticides Act. Hence to produce and provide quality bio-pesticides (as per the policy of Govt. of India) to the farmers, research organization, institution of State Govt., all the organizations irrespective of Private and Govt. engaged in production of bio-pesticides should take necessary and pertinent steps for registration of bio-pesticides as per the insecticides Act 1968.

Future thrust and needs:

- Suitable species / strains of bio-pesticides should be indentified for use in different crops and agro-eco system.
- Research on the bio-ecology of pests and their natural enemies including pathogens should be intensified and strengthened.
- Conservation methods of natural enemies should be standardized properly.
- Genetic variability of natural enemies viz. predator, parasites and microbial pathogens need to be identified.
- Net work of bio-pesticide industries should be established and strengthened for proper availability of microbial preparations and bio-agents viz. predators / parasites.
- Proper arrangements should be done for international exchange of beneficial organisms.

Due to growing concern for the consequences of chemical pesticides, bio-pesticides has a tremendous scope in environment friendly pest management in spite of some disadvantages. It is now deemed necessary to impart special emphasis at Institutional level on development of bio-control agents. (Parasites, predatons, microbials), plant based pesticides, pheromones, suitable genetically modified plants and their use at farmers door step. Rich diversity of micro-flora for standardization and use of plant products and microfauna for bio-control agents (parasites, predators, microbials like bacteria, virus and fungi) in the Indian subcontinent provides excellent opportunities for development and use of bio-pesticides for eco-friendly biointensive based pest-management for sustainable and organic crop production. Concerted and need based efforts for appropriate understanding of bio-control agents, plant based products, pheromones, need based genetically modified plants and their effective utilization in eco-friendly pest management will definitely help ecological equilibrium in natural protection of flora and fauna of nature and provide "Food for all" and "Health for all".

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