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INTEGRATED PEST MANAGEMENT

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ENVIS Newsletter on Environmental Biotechnology is a half-yearly publication publishes articles related to the thematic area of the ENVIS Centre. Popular or easily intelligible expositions of new or recent developments are welcome.

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Figures and typed table should be in separate pages and provided with title and serial numbers. The exact position for the placement of the figures and tables should be marked in the manuscript.

Articles should be sent to

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EDITORIAL

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of observation and common practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment. Pest control materials are selected and applied in a manner that minimizes risks to human health, nontarget organisms, and the environment. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism.

In this newsletter (Vol. no. 26), we have attempted to discuss the **Integrated Pest Management (IPM)** related issues.

(S. C. Santra)

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Integrated Pest Management (IPM)

Agriculture is the primary interface between people and the environment, and therefore, agricultural transformation is essential to meet the global challenges of reducing poverty, food security, and environmental protection. To minimize the over-dependence on pesticides in crop protection, and to avoid harmful effects to the environment in general and hazards to the users of pesticides in particular, the Government of India has adopted Integrated Pest Management (IPM) as a main Government Policy on plant protection since 7th plan period. This program emphasizes surveillance for need-based and timely application of selective pesticides.

Integrated Pest Management (IPM) is a program of prevention, monitoring, and control which offers the opportunity to eliminate or drastically reduce the use of pesticides, and to minimize the toxicity of and exposure to any products which are used. IPM does this by utilizing a variety of methods and techniques, including cultural, biological and structural strategies to control a multitude of pest problems.

- **Integration** is the harmonious use of multiple methods to control single pests or pest complexes.

- **Pest** is any organism that is detrimental to humans and it includes invertebrates (insects, mites, spiders, etc.), vertebrates (ground squirrels, mice, rabbits, birds, etc.), weeds, and pathogens (microorganisms that cause plant diseases (Fig. 1).

- **Management**, which is simply a set of decisions making up a strategy or plan to control a pest based on ecological principles and economic and social considerations.

Fig: 1 Different types of Pest

Pests are the major biotic constraint to achieve self sufficiency in ensuring food security. Losses due to pest vary between 10-30% depending upon the crop, its health and the governing environment. Philosophy of integrated pest management has evolved over time through integrated crop production to integrated farming system targeted at improved crop health. IPM is a multi-tactical maneuver as it often intertwines different tactics in a compatible manner to limit pest population up to desired level and it is also multifaceted as it concerns economy, ecology and safety to environment. Needs of farmers in pest management revolves around pest diagnostics, surveillance, forecasting and dissemination of expert information in short time (Fig. 2)

Fig: 2 Integrated Pest Management

The IPM approach can be applied to both agricultural and non-agricultural sectors, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options, but not limited to, the judicious use of pesticides. In contrast, organic food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

IPM allows the use of pesticides, fertilizers and other materials made from synthetic materials when necessary. Organic programs largely restrict allowable pesticides to those made from natural materials. Pesticides used in organic programs can also have harmful effects on humans, animals and the environment, and must be used carefully and only when needed. IPM strategies can also help organic programs reduce hazards.

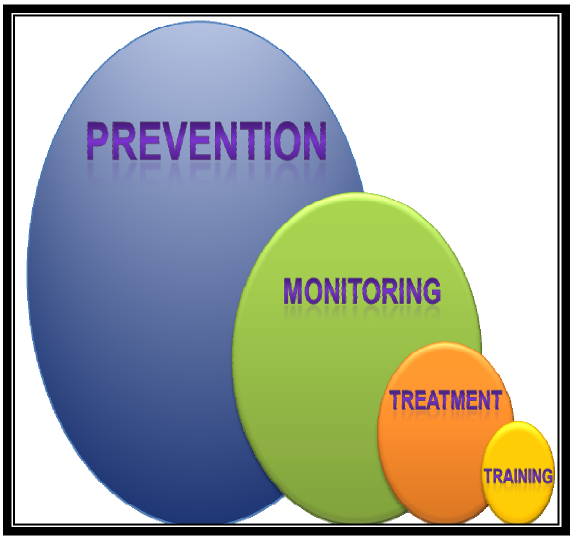

Fig: 3 Integrated Pest Management program

Steps of IPM approach:

IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions, and controls (Fig. 3 & 4)

(1) Action Thresholds: Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed.

(2) Monitoring and Identifying Pests: Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds.

(3) Prevention: As a first line of pest control, IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock.

(4) Control: Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective, less risky pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding.

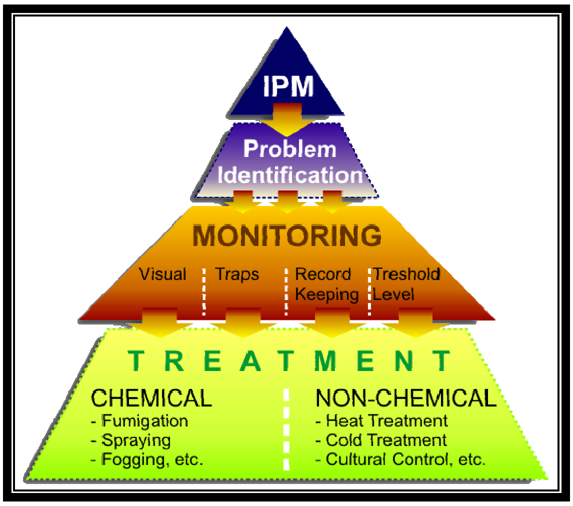

Fig: 4 Steps of IPM

Management of IPM

IPM involves a combination of various measures to ensure effective pest management without disturbing the ecosystem, reducing environmental pollution and eliminate direct and indirect health hazards to human beings.

1. Observation methods

(a) Identification:

Identification of pests and beneficial insects is of prime importance before any pest control operation is executed. Proper education at farmers level is very essential so that farmers can identify beneficial insects/pests and take proper and appropriate measures in time to check pest menace.

(b) Surveillance and forecasting :

Periodical studies have to be made in climate changes, rainfall, temperature etc. which can be congenial for a pest or a disease of the agroclimatic zone. Scientific surveillance and forecasting will enable extension workers to pass on proper recommendations to farmers for timely and appropriate crop protection measures.

(c) Diagnostics:

Many a time, symptoms manifested on crops due to insect attack are not properly diagnosed. This might probably result in improper use of plant protection measures not only include pest but also its intensity, stage etc. to enable planning all possible preventive and curative operations.

(d) Scouting:

Each and every farmer should scout for pests and beneficial insects in his individual holding. Periodical visits during cropping season and detailed observation will enable him to plan for strategic measures in pest/disease control.

(e) Economic threshold levels :

Economic threshold level (ETL) can be defined as "the population density of pest which will cause sufficient loss to justify cost of control". ETL for all major pests should be standardised and this scientific information should be disseminated among farmers.

(f) Pheromones:

Pheromones play an important role in IPM. Pheromones to attract adults of some major pests like fruit borers (Heliothis) are available. Erecting pheromone traps in fields helps in pest monitoring. It can also be used for "attract and destroy" method of pest control where in adult males collected in these traps are destroyed which indirectly helps in reducing mating, egg laying and pest multiplication on crop (Fig. 5).

Fig:5 Pheromone Traps Effective Tools for Monitoring Insect Pests

2. Preventive methods

(a) Cultural Operations:

- ✓ Whenever possible, buy pest resistant varieties of plants. Traditional plant breeding methods have greatly increased the number of plants available resistant to diseases and even some insects.
- ✓ Select only plants well adapted to the particular site where they will be planted.
- ✓ When possible irrigate vegetable and flower plantings at ground level with a hand held watering device or using a slow trickle from the nozzle or specially designed trickle type of soaker hose.
- ✓ Thoroughly inspect plants on a regular basis; especially check the undersides of leaves.
- ✓ Finally, use organic mulches around your plants to help conserve soil moisture, moderate soil temperatures and provide weed control.

(b) Crop rotation :

Monocropping provides a continuous and suitable micro environment, and host plant availability for some insects which thrive, multiply and destroy the crop. Growing non preferred crops alternatively in each agrosystem will not only break the chain of host pest relationship but also reduce pest pressure on both crops. Crop rotation with shallow and deep rooted crops regulates uptake of nutrients from different layers of soil. It also checks effectively soil borne pests. Suitable crop rotation can be developed for individual agroclimatic zones.

(c) Intercropping / Trap Crops :

Intercropping of two or more crops has been followed by our farmers from a very long time. Many intercropping systems have been evolved over years which has become an important arm of pest management. Certain intercropping like peanut / coriander, maize / soyabean etc. are helpful in enhancing activity of beneficial predators like lady bird beetles, spiders etc. and reducing weed population.

(d) Resistant varieties

- ✓ Selection of high yeilding varieties for different crops
- ✓ Selection of comparatively pest resistant/tolerant varieties (Fig. 6)
- ✓ Use of genetically modified seeds e.g. B.t. cotton
- ✓ Release of sterile males of insects in sufficient number in field to compete with fertile males.

Fig: 6 Genetic engineering can be used to develop pest and disease resistant crop strains

(e) Water management:

Irrigation water is becoming a scarce resource due to erratic climate conditions. Even underground water table is gradually going down. All crops require certain optimum moisture levels to give higher yields and less pest attack.

3. Intervention methods

(a) Mechanical Control:

a. Removal and destruction of egg masses, larvae, pupae and adults of insect pests and diseased parts of plants wherever possible.

b. Use of light traps and destruction of trapped insects.

c. Use of rope for dislodging leaf feeding larvae e.g. caseworm and leaf folders.

d. Installation of bird scarer in the field where required

e. Installation of bird perchers in the field for allowing birds to sit and feed on insects and their immature stages viz., eggs, larvae and pupae.

f. Use of pheromones for mating disruption and kill zone creation.

g. Use of pheromone traps for monitoring and suppression of pest population and trapping.

h. Use of pheromen traps fr mass traping.

(b) Biological control:

Biological control of insect pests and diseases through biological means is most important component of IPM. In broader sense, biocontrol is use of living organisms to control unwanted living organisms pests (Fig. 7).

Parasitoids: These are the organisms which lay eggs in or on the bodies of their hosts and complete their life cycles on host bodies as a result of which hosts die. Example are different species of Trichogramma, Apanteles, Bracon, Chelonus, Brachemeria, Pseudogonotopus etc.

Predators: These are free living organisms which prey upon other organisms for their food. Examples are different species of spiders, dragon flies, damsel flies, lady bird beetles, Chrysopa species, birds etc.

Pathogens: These are micro-organisims which infest and cause diseases in their hosts as a result of which hosts are killed. Major groups of pathogens are fungi, viruses and bacteria.

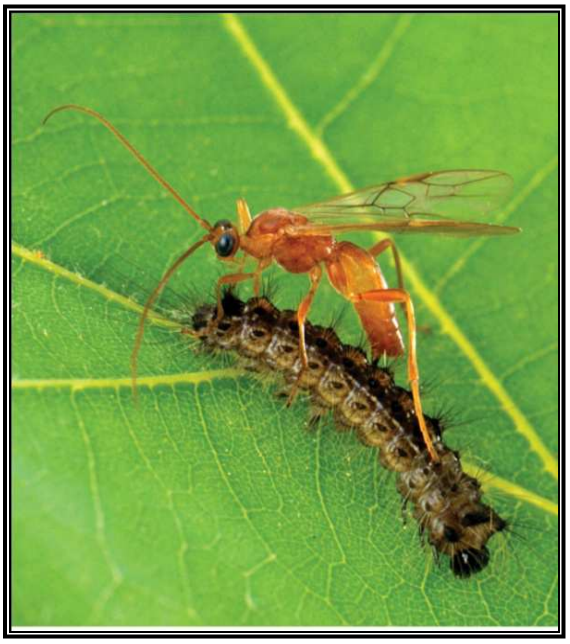

Fig: 7 Wasp parasitizing a gypsy moth caterpillar

(c) Chemical control:

Use of chemical pesticides is the last resort when all other methods fail to keep the pest population below economic loss.

- Pheromones and other attractants to lure and/or confuse the pest
- Juvenile hormones that arrest pest development
- Repellents
- Allelopathins
- Sterilants or contraceptives to reduce breeding of future generations
- Contact, stomach, and other poisons
- Fumigants
- Combinations of the above (e.g. baits with attractant and stomach poison)
- Other chemicals with judicious use.

The Future of IPM

The following key issues considering for the future of IPM.

1. Gene technology constraints.

Future crops may be modified for increased compatibility with IPM systems. Key unresolved issues include the extent to which genetically engineered crops will be used in production systems, the rate at which they will be adopted, their compatibility with IPM systems.

2. Genetic diversity and pest adaptability.

The ecological elasticity of many animal and crop pests allows them to adapt to almost limitless habitats. Genetic diversity within most crop pests often limits the utility of plant varieties developed with resistance to one or more pests.

3. Ecologically based IPM.

Interest is growing in shifting the focus of IPM from pesticide management to a biointensive systems approach based on biological knowledge of pests and their interactions with crops

4. Evolving pool of trainers and speed of technology transfer.

IPM include in School college level curriculum, vocational training, training to farmers and distance education programs may help to expand the IPM programme in future.

5. Assessments of IPM.

Surveys suggest that the greatest shortcoming in most current IPM programs is the limited use of a systems approach. The ongoing national and international debates on the future of genetically modified organisms will affect policies related to production, marketing, and use of these new products.

6. Government policy and regulations.

Implementation of IPM for urban pests likely will be the policy for most public properties at the federal, state, and local levels.

7. Systems approaches.

A major goal for maximizing the benefits of IPM and related cropping systems is to increase understanding of the interactions of microflora/fauna in natural and agricultural ecosystems. Effective collaborative research and extension programs as well as coordination with funding and support agencies are necessary.

Naturally based pesticides

Some natural and organic products that can be used for insect and disease control in necessary.

- **Bacillus thuringiensis (BT):** Bacteria for controlling caterpillars of butterflies and moths.
- **Copper based materials**: Some fungicide and insecticide activity.
- **Diatomaceous earth:** Treatment primarily for garden slugs.
- **Horticultural oils:** Fungicide and insecticide activity.
- **Insecticidal soaps**: Mostly insecticide activity.
- **Liquid formulations of lime-sulfur:** Fungicide and insecticide activity.
- **Neem products (Azadirachtin):** Fungicide and insecticide activity.
- **Pyrethrum (Pyrethrin):** Insecticide.
- **Sulfur:** Fungicide and insecticide activity.

Table 1. Commercial bio-pesticides for the control of plant pathogens
Bactericides

Microorganisms	Trade Name	Pathogens/ Diseases
Bacteriophages of *Xanthomonas sp.* and *Pseudomonas syringae* pv. Tomato	Agriphage™	Bacterial spot in pepper & tomatoes & bacterial speck in tomatoes
Pseudomonas syringae strain ESC 10	Bio-Save® 10LP3	Ice inducing bacteria & biological decay
Pantoea agglomerans strain E325	Bloom time, Biological™ 3	Fire blight (*Erwinia amylovora*)

Benefits of IPM

To Agricultural Producers:

- ✓ Reduction in producer's economic risk by the promotion of low-cost and carefully targeted pest management practices.
- ✓ Proactive avoidance of future pest management crisis; through research directed at potential short-, medium-, and long-term challenges.
- ✓ Reduction of health risk to agricultural workers by fostering best management practice adoption.

To the Environment:

- ✓ Reduction of environmental risk associated with pest management by encouraging the adoption of more ecologically benign control tactics.
- ✓ Protection of at-risk ecosystems and nontarget species through reduced impact of pest management activities.
- ✓ Promotion of sustainable biobased pest management alternatives.

To Pest Management Professionals & Organizations:

- ✓ Augmentation of private research development efforts to develop lower-risk pest control tactics and expand the use of existing low-risk tactics to specialty markets.
- ✓ Promotion of innovative practices that improve pest management effectiveness, which can increase customer satisfaction and reduce the risk of customer complaints.
- ✓ Creation of a demand for new, innovative, and marketable products and services.

To the General Public:

- ✓ Reduction of risk to the public by promoting responsible pest management in public spaces including schools, recreational facilities, and playgrounds.
- ✓ Promotion of lower-risk residential and community pest control through educational programs tailored to homeowners.
- ✓ Assurance of safe, reliable, low-cost pest control through improved pest management

Disadvantages of an IPM programme

An IPM program requires a higher degree of management

Making the decision not to use pesticides on a routine or regular basis. This planning includes attention to field histories to anticipate what the pest problems might be, selecting crop varieties which are resistant or tolerant to pest damage.

IPM can be more labor intensive

Consistent, timely and accurate field scouting takes time. However, it is this information that is necessary and is the corner stone of IPM programs.

Success can be weather dependant

Weather can complicate IPM planning. An extended wet period may reduce (or eliminate) the effectiveness of row cultivation. Therefore, good IPM planners will have a alternate plan for when these problems arise

Current news/ research

Entomopathogenic Viruses and Bacteria for Insect-Pest Control

Pest problems are an inevitable part of modern day agriculture. They occur because agro-ecosystems have created less stable natural ecosystems which otherwise govern ecological forces that regulate potential pest species in natural ecosystems. Raising crops in a monoculture thus provides a food resource cycle that allows pest populations to achieve far higher densities than they would in natural environments. A certain cultivation practice can also make the physico-chemical environment more favourable for pest activity, for example, through irrigation or the warm conditions found in glasshouses. New cultivars or new crops introduced into a certain area or country may provide food resources for potential pests. Also, the use of broad spectrum insecticides can destroy natural predators that help keep pests under control. In these scenarios, new pest problems arise or existing pests become more serious and cause significant damage to crops, biodiversity and landscape valued at billions of dollars per annum. New strains of plant insect-pests may arise to overcome varietal resistance in crops (Fig.8).
Source:http://www.sciencedirect.com/

Fig: 8 Bt is used for the control of caterpillar pests

The Bioherbicide Approach to Weed Control Using Plant Pathogens

Weeds cause severe economic impacts in agriculture and threaten our global food supply. These risks are primarily mitigated with herbicide applications. Unfortunately, improper herbicide use causes harm to the environment and people. Consumers no longer tolerate these risks and are urging governments to adopt new reduced-risk herbicide strategies. Bioherbicides are weed-control products derived from living organisms to suppress weed populations and comprise part of this reduced-risk strategy. Benefits of bioherbicides include short-lived environmental fate, multiple modes of action reducing the risk of herbicide resistance, and low toxicity. This chapter explains the process of discovering and developing naturally occurring microorganisms for commercialization as bioherbicides and outlines the current status of bioherbicides registered worldwide. As experience in developing bioherbicides grows, more products emerge in the marketplace, facilitating their adoption and fuelling cyclical development, thus creating a pathway for bioherbicides to become mainstream products in the future.

Biotechnological Approaches for Insect Pest Management

Biotechnology provides ample opportunities for effective and targeted insect-pest control through critical analysis and engineering of biological processes. The success of these approaches has utilized various tools and techniques of genetic engineering, molecular biology and plant biotechnology. In addition to Bt-toxin genes, which have been widely accepted in insect pest control, a range of alternative genes have also become available for exploitation as biological weapons against other insect-pest species. Most of these genes find utility through transgenic plants, but others find application in improving the performance of different biocontrol agents including microbial species and natural enemies. In this respect, metabolomics, providing molecular dissection of metabolic pathways for identifying vital genes, also offers a means for specific dis-functioning of these genes to cause mortality in individual insect species.

Plant growth promotion and reduction in disease incidence by *Trichoderma spp*

The promising isolates of *Trichoderma spp*. were characterized for biopriming, plant growth promoting characteristics, reduction of disease incidence and corresponding yield increase in cabbage, cauliflower, mustard and field pea. The seeds of cabbage, cauliflower, mustard and field pea were bioprimed with freshly prepared biocontrol (*Trichoderma)* in the form of slurry @ 5-10 g/kg seed. Another important method of delivery of *Trichoderma* is soil application/soil treatment (Fig. 9).

(Source: http://www.ncipm.org.in/)

Fig: 9 Trichoderma fungus

Institutes involved on the R & D of Integrated pest Management

1. National Centre for Integrated Pest Management, New Delhi (http://www.ncipm.org.in)
2. National Centre for Agricultural Economics and Policy Research, New Delhi
3. Central Integrated Pest Management Centre, Gangtok (http://cipmcsikkim.nic.in)
4. National Institute of Plant Health Management (NIPHM), Andhra Pradesh
5. Indian Pest Control Association (IPCA), Kirti Nagar, New Delhi
6. Institute of Pesticide Formulation Technology (IPFT), Gurgaon
7. CSIR-Indian Institute of Chemical Technology, Hyderabad
8. Central Intigrated Pest Management Centre, Srinagar (Jammu & Kashmir)

Invited Aticles

RED SPIDER MITE: A MAJOR TEA PEST AND FUNGAL BIOCONTROL

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Pesticides used in tea cultivation increase the risk of pesticide residue in made tea. In view of the increasing awareness of health and contamination of made tea, a search for better alternative is being felt globally to reduce dependence on chemical pesticides. The concept of plant protection in tea has recently been changing to the adoption of an integrated approach, which includes biocontrol measures also. In biological control system a natural biotic force helps to regulate populations of insects. Conservation of native entomopathogen, augmentation manipulation and if possible, introduction of exotic biotic agents help the tea crop to reduce the pesticidal load. Considering the need for an alternative eco-friendly approach to control the red spider mite of tea, it was felt to be worthwhile to screen the indigenous entomopathogenic fungal pathogens of certain parts of Assam. The potentiality of biocontrol agents against red spider mite has not been fully explored till date.

This mite (*Oligonychus coffeae*) is one of the most serious pests of tea in Northeast India. The laboratory studies on evaluation of different TV clones for mite resistance were carried out in the Department of Biotechnology and Zoology of University of Gauhati, Assam, during 2003-2006. Based on leaf consumption, fecundity, percent of leaf area damaged and hatching of eggs in different clones, it was found that TV 1 was the most preferred while TV6 is the least preferred clone.

TV1 is the most susceptible clone which showed typical symptom earlier in comparison to other and TV6 was the least preferred clone. The fecundity on different clones was also found to be varied significantly; the highest eggs being recorded on TV1 and the lowest on TV6.The fecundity in other clones varied. The percentage of egg hatching was found to be maximum on TV1 and the minimum on TV6. Assam hybrids generally being more vigorous are normally less attacked by mites in comparison to china hybrids. Leaves having depression on the surface, in curved margins or deflected tips are suitable for mite build up as well as egg deposition. The red spider mites in all stages of their development are found almost anytime throughout the year. The duration of the life cycle (i.e. from egg to adult) is shorter in summer months, in May and July, while it is longer in the cold weather in laboratory condition. In the field condition the duration of egg to adult shows the similar result.

Duration of larval stages of *O. coffeae* was recorded to be lowest in the month of June and during the month of November it was recorded to be highest . Total duration of larvae and nymphal stages were also found to be lowest in the month of June while highest duration recorded in month of February. From the study, it was revealed that amongst the factors which influence the incidence of red spider mite and intensity of its attack, weather conditions play an important role. Incubation period was also found to be highest in the month of February-March and it was followed by month of April. In the month of May-June it was recorded to be the lowest days. As the sex ratio of male and female red spider mites was observed it was found that the females constitute the great majority in the field since the adult males have a much shorter life. It was found that female lived longer and longevity ranged from 23 to 31 days while male was found short lived and longevity ranged from 10 to 17 days.

The red spider mite is found to be active and breeds on tea plants throughout the year. Their population rises as the temperature increases and by studying the three consecutive years it was found that their number was maximum from the month of May onwards and decreases from July. During the cold weather their number decreases and found to be minimum in the month of December. Moreover, the population of red spider mite was also affected by the presence of some predatory mites. *Amblyseius sp, Prenematus sp.* are some of the predatory mites. Their population was found to be highest during the month of October to December and consecutively at that period the red spider mite population decreases.

Several entomopathogenic fungi have been isolated and identified which are found to be potential for the control of red spider mite. Extensive survey work may be undertaken to collect and identify more and more pathogens. Studies may also be conducted to evaluate the role of these organisms in natural control and determine if they can be developed as microbial control agents. Potentiality of these strains depends subsequently on their compatibility with numerous factors in the field environment. From the present study it was found that with the increased spore concentrations the mortality per cent also increased. Efficacy of 10^8 spores/ml was comparable with that of 10^7 spores/ml. However, in almost all treatments the spore load (10^8) shows better response, so the spore load of 10^8 is preferable. Among the native strains studied *Penicillium purpurogenum* was found to be most potent in view of the mortality test.

Hundred per cent mortality of red spider mite (all stages) was recorded with the treatment of *Penicillium purpurogenum* at the spore load ranging 10^7 to 10^8 spores/ml after 24 hours of treatment. It was followed by *Metarhizium anisopliae, Beauveria bassiana, Verticillium lecanii, Trichoderma harzanum and Paecilomyces lilacinus.* Therefore, *Penicillium purpurogenum* and *Metarhizium anisopliae* offer great potential for its development into fungal insecticide for the management of the tea pest red spider mite, *O . coffeae(* Fig. 8)

Fig: 8 Tea plant with mite (*Oligonychus coffeae*)

The radial growth and sporulation of *Penicillium purpurogenum* was maximal in special peptone media. In *Beauveria bassiana* it was found to be highest in Special Peptone media ,in *Verticillum lecanii* in Rose Bengal media , in *Trichoderma harzanum* highest in Rose Bengal media and for *Metarhizium anisopliae* radial growth was recorded to be highest in Special Peptone medium , while in case of *Paecilomyces lilacinus* it was found maximal in PDA media.

It was established that in field condition also, the effectiveness of the entomopathogenic fungi against red spider mite pests depends on various factors like the correct fungal species with the susceptible insect life stage, the appropriate humidity and temperature. It also reveals that durations followed by treatment also have influence on the reduction of mite population.

BACTERIAL ANTAGONISTS OF PLANT PATHOGENS

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ABSTRACT

Protection of plants from the pathogens using antagonistic organisms is an alternative and eco-friendly approach for sustainable agricultural system. Antagonistic bacteria suppress growth of pathogens by antibiosis, competition, parasitism and the induction of systemic resistance of the plants. Soil microbial diversity should be explored for antagonistic bacteria since they are well adapted to the soil environment from which they are isolated. A siderophore-producing *Bacillus* sp. (B3) isolated from Kalyani University premises showed antifungal activity against five pathogens *viz., Alternaria solani. Curvularia lunata, Fusarium* sp.*, Helminthosporium oryzae,* and *Rhizoctonia solani.*

Keywords: Antagonism, Bacillus, Biocontrol, Fungal pathogens

Introduction

Plant-pathogens are a large and diverse group of organisms which create a great economic loss associated with yield reductions in agriculture and natural plant communities. Hence protection of plants from the pathogens is the primary objective of many research programmes. Albeit the farmers prefer to use pesticides due to their rapid action and easy accessibility, residual effect of the chemicals may cause environmental hazards. Moreover, their indiscriminate use may emerge drug resistant pathogens. Control of plant pathogens using antagonistic organisms is an alternative and eco-friendly approach for sustainable agricultural system.

Mechanisms of antagonism

Bacterial antagonism, responsible for biological control, may operate by antibiosis, competition or parasitism (Chet et al., 1990; Handelsman & Stabb, 1996). Antibiotic producing organisms commonly found in rhizoshere inhibit growth of deleterious microorganisms. *Pseudomonas fluorescens* strain Pf-5 was reported to produce pyoluteorin, pyrrolnitrin, 2,4-diacetylphloro- glucinol**,** HCN and was considered to be a good biocontrol PGPR. *P. fluorescens* strain 2-79 produced the antibiotic phenazine-l-carboxylate, which was active against *Gaeumannomyces graminis var. tritici* causal agent of 'Take-all' disease of wheat and other fungal root pathogens. *Rhizoctonia solani* was suppressed in soil by applying purified geldanomycin, an antibiotics produced by *Streptomyces hygroscopicus* var. *geldonus. Bacillus cereus* strain UW85 suppressed diseases caused by the oomycetes and produced two antibiotics, zwittermicin A and kanosamine. Competition between the biocontrol bacteria and the pathogen can result in displacement of the pathogen. Microorganisms compete with each other for food and essential elements in the soil and around the rhizosphere. Competition for iron is associated with production of siderophore which is a low molecular weight, high affinity Fe^{3+} chelator that transports iron into cells of microorganisms. Antagonistic organisms produce siderophore(s) to sequester necessary iron and deprive pathogenic fungi of the element since the fungal siderophores have lower affinity for iron. Fluorescent pseudomonads which produce siderophores such as, pyochelin, pyoverdin, pseudobactin and *Bacillus subtilis* which produces siderophore, bacillibactin are considered to be good biocontrol agents. Various bacteria and fungi have been shown to produce hydrolytic enzymes that cause lysis of other microorganisms. Chitinase producing *Serratia marcescens* has been used to control *Sclerotium rolfsii* (Ordentlich et al., 1988). Hyphal lysis induced by *Bacillus* sp. in soil, was involved in the biological control of *G.*

graminis. As well, pretreatment of seeds and roots with antagonistic bacteria can induce the plant host defense reactions against fungal pathogens (Graham et al., 1977). The degradation of pathogenicity factors of the pathogen by the antagonistic organisms has also been reported as protective mechanism (Haas & Defago, 2005).

Characteristics of efficient antagonists

To be considered as an effective antagonistic strain, bacteria must be rhizospherically competent, able to survive onto seed and multiply in the spermosphere even in the presence of seed exudates, to attach to the root surface and to colonize the developing root system. Unfortunately, the relationship between antagonistic bacteria and plants can be unstable. Although promising results might be obtained *in vitro*, they are not necessarily reproducible under field conditions. The variability with the performance of antagonistic bacteria may be attributable to various environmental factors that can determine antagonistic bacteria growth and as a result, affect their ability to exert a beneficial effect on the plant. Therefore, soil microbial diversity should be explored for antagonistic bacteria which are assumed to be well adapted to the soil environment from which they are isolated. Jin et al. (2011) studied the genetic diversity of antagonistic bacteria from the tobacco rhizosphere and identified representing over 33 species from 17 different genera. They for the first time reported that *Delftia tsuruhatensis*, *Stenotrophomonas maltophilia*, *Advenella incenata*, *Bacillus altitudinis*, *Kocuria palustris*, *Bacillus licheniformis*, *Agrobacterium tumefaciens* and *Myroides odoratimimus* displayed antagonistic activity towards *Phytophthora nicotianae*.

The bacilli are particularly more suitable for practical use because they produce stable endospores, which can survive the heat and desiccation conditions that may be faced by biocontrol agents. In my preliminary study, three *Bacillus* spp. were isolated from the soil sample collected at Kalyani University premises and were tested for their antimicrobial property against six fungal pathogens via dual culture technique. The antagonism effect was determined by observing the zone of inhibition and percentage of inhibition (I) was measured using the formula: $I = (R - r)/R \times 100$; where r = radius of the fungal colony opposite the bacterial colony in treated plate and R = maximum radius of the fungal colony in control plate. One of the isolate (B3) showed promising results (Table 2). Maximum antagonism was observed against *Alternaria solani* (I= 75) and minimum against *Fusarium* sp. (I= 33). Siderophore production of the isolate B3 was determined by observing orange halo around the colony on CAS-agar medium and quantitative estimation of siderophore production was carried out using CAS assay with desferal as standard. *Bacillus* B3 produced substantial amount of siderophore (90 nmole/ml) in potato dextrose broth. Thus the isolate has potential biocontrol activity; its plant inoculation study would be carried out for its further application (Fig. 9).

Fig: 9 . Inhibition of growth of *Phytophthora nicotianae* by antagonistic bacteria (Jin et al., 2011)

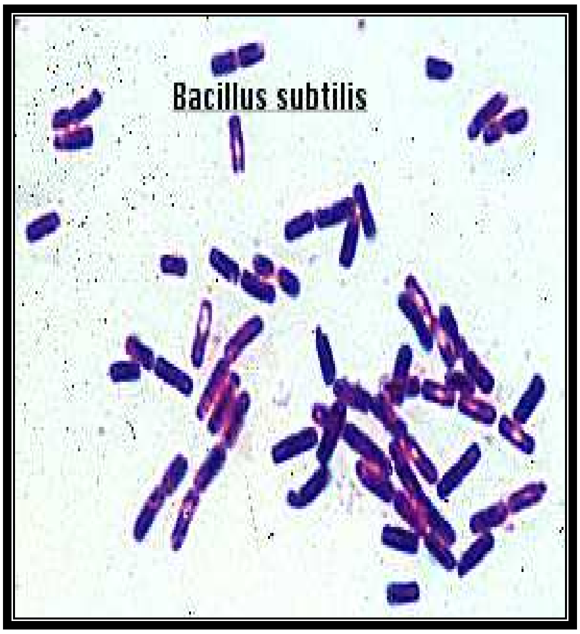

Fig: 10 *Bacillus subtillis*

Table 2. Antagonism of *Bacillus* B3 against plant pathogens

Fungal pathogens	Radius of fungal colony (mm)		% of inhibition [I = (R – r)/R X 100]
	Control plate (R)	Treated plate	
Alternaria solani	40	10	75
Curvularia lunata	30	15	50
Helminthosporium oryzae	35	15	57
Fusarium sp.	30	20	33
Rhizoctonia solani	40	25	37.5

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References

- Chet I., Ordentlich A., Shapira R., Oppenheim A., 1990, Mechanisms of biocontrol of soil-borne plant pathogens by Rhizobacteria, Plant and Soil, 129: 85-92.
- Graham T.L., Sequeira L., Huang T.R., 1977, Bacterial lipopolysaccharides as inducers of disease resistance in tobacco, Applied and Environmental Microbiology 34: 424–432.
- Haas D., Defago G., 2005, Biological control of soil-borne pathogens by fluorescent pseudomonads, Nature Reviews Microbiology, 3: 307-319.
- Handelsman J., Stabb E.V., 1996, Biocontrol of soilborne plant pathogens, The Plant Cell, 8: 1855-1869.
- Jin F., Ding Y., Ding W., Reddy M.S., Fernando W.G.D., Du B., 2011, genetic diversity and phylogeny of antagonistic bacteria against *Phytophthora nicotianae* isolated from tobacco rhizosphere, International Journal of Molecular Sciences, 12: 3055-3071
- Ordentlich A., Elad Y., Chet I., 1988, The role of chitinase of *Serratia marcescens* in biocontrol of *Sclerotium rolfsii*, Phytopathology 78: 84-88.

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