Technology Notes

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New frontiers of plant protection research in India

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The source of the insecticidal toxins produced in commercial transgenic plants is the soil bacterium *Bacillus thuringiensis* (Bt). Bt strains show differing specificities of insecticidal activity toward pests, and constitute a large reservoir of genes encoding insecticidal proteins, which are accumulated in the crystalline inclusion bodies produced by the bacterium on sporulation (Cry proteins, Cyt proteins) or expressed during bacterial growth (Vip proteins). Deployment of transgenic crops expressing a single specific Bt toxin can lead to problems in the field, where secondary pest species are not affected, and can cause significant damage to the crop. Introduction of additional Bt cry genes into the crop can afford protection against a wider range of pests. Commercial use of transgenic cotton containing two Bt genes began in 1999, 3 years after the release of the original single Bt variety. Cotton plants expressing both Cry1Ac and Cry2Ab proteins were more toxic to bollworms (*Helicoverpa zea*; target pest) and two species of armyworms (*Spodoptera frugiperda* and *Spodoptera exigua*; secondary pests) than cotton expressing Cry1Ac alone in laboratory trials. Modification of Bt toxins by site-directed mutagenesis to increase toxicity toward target pests has been employed as an alternative to the "domain swap" approach. The key role of domain II in three-domain Cry proteins in mediating interactions with insect receptors has been exploited by mutation of amino acid residues in the loop regions of this domain. Mutation of Cry1Ab increased its toxicity toward larvae of gypsy moth (*Lymantria dispar*) by up to 40-fold. Potential exploitation of lectin genes to confer insect resistance in transgenic plants has targeted hemipteran plant pests, which are not affected by known Bt toxins but have been shown to be susceptible to lectin toxicity.

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Sikkim's Organic Trail

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It has become commonplace to say that agriculture needs to undergo a radical overhaul to become more sustainable as the challenges facing agriculture today are immense. It includes global increase in food prices, food shortages in many countries of the world and challenges of climate change. Climate change, coincident with increasing demand for food, feed, fibre and fuel, has the potential to irreversibly damage the natural resource base on which agriculture depends, with significant consequences for food insecurity.

The business-as-usual scenario of industrial farming, input and energy intensiveness, collateral damage to the environment and marginalization of small-scale farmers is no longer tenable. While past emphasis on production and yields had brought benefits which fructified in the form of Green Revolution but this was at tremendous cost to the environment and social equity. The Green Revolution brought in widespread shifts in the agricultural sector from subsistence and low external input agriculture to mono-cropping with high yielding varieties (HYVs). This agricultural paradigm required the adoption of a 'package' of inputs, including irrigation, chemical pesticides and fertilizers, and hybrid seeds bred for disease resistance and high yield. The rise in use of chemical inputs has also had adverse environmental and health impacts on farmworkers and consumers. A substantial portion of chemical input residues ends up in the environment, causing pollution and biodiversity decline. The extensive use of pesticides has also resulted in pesticide resistance in pests and adverse effects to beneficial natural predators and parasites. Thus, in future planning for agriculture, there is need for such crop production technologies which while feeding the world, are also environmentally, socially and economically sustainable.

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Guest editors of the issue: Dr. Narender K. Bharat, Dr. H.R. Gautam and Dr. Joginder Pal

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expression of the Man-specific snowdrop lectin (GNA) in transgenic rice plants using constitutive or phloem-specific promoters gave plants that were partially resistant to rice brown plant hopper (*Nilaparvata lugens*) and other hemipteran pests. Reductions of up to 50% in survival were observed, with reduced feeding, development, and fertility of survivors.

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Bacterial cholesterol oxidase has an insecticidal activity comparable to Bt toxins, dependent on its enzyme activity, which is thought to promote membrane destabilization. Expression constructs containing part or all of the coding sequence of the protein, or the coding sequence fused to a chloroplast-targeting peptide, resulted in production of active enzyme in transgenic tobacco. Avidin has a strong insecticidal effect on many insects, although susceptibility varies widely between different insect species (apparently based on biotin requirements). Expression of avidin in transgenic maize initially aimed to produce the protein as a high-value product, but maize seed containing more than 0.1% avidin (of total protein) was fully resistant to larvae of three different coleopteran storage pests. Genes encoding two Cyt P450 oxidases and a UDP glycosyltransferase from sorghum (*Sorghum bicolor*) have been transferred to *Arabidopsis*, resulting in the production of the cyanogenic glycoside dhurrin from Tyr. The resulting plants produced hydrogen cyanide on tissue damage and showed enhanced resistance to attack by the flea beetle *Phyllotreta nemorum*, a specialist feeder on crucifers. Other secondary metabolites that have been produced in transgenic plants include the alkaloid caffeine (in tobacco; by the introduction of three genes encoding N-methyl transferases. Engineering volatiles emitted by plants offers possibilities for new methods of crop protection. Volatile composition has been altered in tobacco by RNA interference (RNAi) - mediated suppression of a cytP450 oxidase gene expressed in trichomes, and in Arabidopsis by constitutive overexpression of a plastid dual linalool/nerolidol synthase. The transgenic plants deterred aphid colonization but were not wholly resistant. Volatiles can also be used as attractants for natural enemies of pests; for example, *Arabidopsis* plants transformed with the maize terpene synthase gene TPS10 emitted the sesquiterpene volatiles normally produced in maize and attracted parasitoid wasps that attack maize pests. Volatiles used by insects to communicate with each other can also be exploited; the sesquiterpene (E)-b-farnesene is an alarm pheromone in aphids and attracts aphid predators and parasitoids. When *Arabidopsis* was transformed with an (E)-β-farnesene synthase gene from mint (*Mentha piperita*), the resulting plants showed significant levels of aphid deterrence in choice experiments and were attractive to the aphid parasitoid *Diaeretiella rapae*.

Disrupting gene function by the use of RNAi is a well-established technique in insect genetics based on delivery by injection into insect cells or tissues. The observation that RNAi could also be effective in reducing gene expression, measured by mRNA level, when fed to insects has led to development of transgenic plants producing double stranded RNAs (ds RNAs) exhibiting partial resistance to insect pests. Transgenic maize producing ds RNA directed against V-type ATPase of corn rootworm showed suppression of mRNA in the insect and reduction in feeding damage compared to controls. Similarly, transgenic tobacco and *Arabidopsis* plant material expressing ds RNA directed against a detoxification enzyme (Cyt P450 gene CYP6AE14) for gossypol in cotton bollworm caused the insect to become more sensitive to gossypol in the diet.

Nanotechnological applications in plant disease management still infancy. However, there have been some examples where nanotechnology have been used for nanosized silica silver, (Si Ag) particles which were successfully used for contorllling fungal pathogens *viz. Pythium ultimum*, *Magnaporthe griseaus*, *Botrytis cinerea*, *Colletotrichum gleosporioides* , *Rhizoctonia solani* and also bacterial pathogens such as *Xanthomonas campestris*. Iron nano particles coated with carbon have been used for treating specific plant parts (local applications). A product of nanotechnology "Nano- Gro" has been launched as plant growth regulator and immunity enhncer. Another product "Nano-5" is available in the market as natural mucilage organic solutions for controlling several plant pathogens and pests.

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Sustainable agricultural approaches can be in many forms, such as agro-ecology, organic agriculture, ecological agriculture, biological agriculture, etc. There are tremendous efforts in our country by Central and various State Governments to promote sustainable forms of agriculture. Today, Sikkim is a model State and the initiatives of the Government of Sikkim in supporting sustainable management practices to

deliver long-term benefits to the communities are comprehensive with results on the fields.

Organic agriculture was considered to be an important option for the small and marginal farmers of the State. Organic farming is not new to Sikkim. Farmers have been practicing organic agriculture for several decades, wherein different farming practices were largely in harmony with nature and the use of synthetic agro-chemicals was negligible. The farmers used animal compost and crop residue recycling as the principal soil fertility management strategies. To this end the farms in Sikkim could be defined as organic by default.

The policy initiatives of Government of Sikkim gave paramount importance to the Sikkim's position as a repository of biodiversity (Sikkim is located in one of the 'biodiversity hotspots' of the world). Further, with increasing severity of climate change, it was felt that there is a need to increase food production in a sustainable way so as halt the degradation of ecosystems, ecosystem functions and the loss of natural resources and biodiversity.

At a time when the desire for a sustainable agriculture was gaining universality, yet agreement on how to progress towards it remaining elusive, a decision was taken by the Government of Sikkim in the year 2003 through a resolution in the State Legislative Assembly to create farming methods and models that enhance sustainability and also mitigate climate change. ***This was the first policy initiative towards developing an organic farming state and with this;*** Sikkim became the first State in the country to enact such a far sighted and visionary policy for adoption of organic farming concepts.

Several notable initiatives were taken between the period 2003 and 2010 such as framing of action plan, discouraging use of chemical fertilizers, providing manure production infrastructure such as rural compost, vermi compost, establishment of bio fertilizer production unit, soil testing facilities, organic seed production units etc. As a part of capacity building of farmers, numerous trainings have been imparted to farmers about organic farming and its advantages. Pilot projects on organic certification were carried out between the period 2006 and 2008 and an area of 8,157 ha was certified.

The organic movement in the State was given a formal approach with the launch of the Sikkim Organic Mission on 15th August, 2010 with the following objectives:

- To promote Sikkim as an Organic State.
- To brand organic product of the state as "Sikkim Organic"
- To outline measures to discourage use of chemical fertilizers and pesticides in Sikkim and gradually substitute plant nutrients by organic manures and fertilizers as well as manage control of diseases and insect pests by biological control measures.
- To develop the basic infrastructure and statutory development, pre-requisite to initiation of actual organic farming in Sikkim.
- To create or develop market linkage for organic produce along with the evolvement of suitable strategies.
- To formulate a policy of organic farming in Sikkim.

The Sikkim Organic Mission has been an article of faith for all. Every Department had played its role to make the Organic initiative a success. To mention a few, the Human Resource Development Department introduced a chapter on Organic Farming in the course curriculum of class V. The Urban Development Department in order to avoid sale of chemical inputs for agriculture, amended the norms for issue of Trade Licence by replacing the term "Chemical Inputs" with "inputs of organic origin". The Forest Department has banned the burning of organic plant materials. The Police Department kept a vigil at the entry points to prevent entry of prohibited inputs.

The Department of Agriculture enacted a legislation, "The Sikkim Agricultural, Horticultural input and Livestock Feed Regulatory Act, 2014" in order to regulate the import, sale, distribution and use of inorganic agricultural environmental inputs and livestock feed to make the State of Sikkim an Organic Farming State. This is the first such Legislation in the country. Organic Regulatory Inspectors have been appointed to prevent, detect and investigate offences related to the Act. The Departments of Agriculture and Horticulture, in collaboration with ICAR Research Complex Sikkim Centre, Gangtok, brought out a publication titled. "Handbook of Organic Crops Production in Sikkim" a first of its kind in the country. The handbook provides a complete package of practice on organic farming methods for more than 30 crops. The Government has also established the Sikkim State Organic Certification Agency (SSOCA) in the year 2015, another notable achievement.

Sikkim, by the end of 2015, was able to convert 76,169.6 ha of its cultivated area into organically certified cultivation in compliance with NPOP. To mark this special occasion, the Sikkim Organic

Festival-2016 was organized in January, 2016. The event was graced by Hon'ble Prime Minister on India, Shri. Narendra Modi who declared that Sikkim had become the first completely organic farming State in the country. Being the second smallest state in the country after Goa, Sikkim took a giant, bold leap towards becoming the first fully organic farming State.

The Government of Sikkim has given the highest priority to the agriculture sector. After becoming the fully certified organic farming State, the focus has now shifted to creating value chain to link growers with consumers and to support the development of entire value chain starting from inputs, seeds, certification to creation of facilities for collection, aggregation processing, marketing and brand building initiative. Our farmers need support - support for entitlement to scientific knowledge; for equitable access to resources and financial services; for investment in processing and marketing infrastructure. This all has been done in a participatory mode. What is required is a grand alliance of people's organizations, private enterprises, governments and other organizations. The concern is not just to produce and distribute more food, but to do this in a sustainable manner and to guarantee the access of present and future generations to a wholesome and nutritious diet.

Need for Smart Plant Protection Techniques for Revolution in Agriculture

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Innovations and new technologies in agriculture have always paid dividends. India ushered in 'Green Revolution' in the second half of the 20th century with the introduction of high yielding varieties of wheat and rice in irrigated conditions with application of chemical fertilizers and pesticides. The gains of the 'Green Revolution' continued for 3 to 4 decades and then there was a continuous decrease in the incremental increase of the food grains productivity accompanied with problems of soil degradation, pesticide residues in the food articles and environmental degradation. Now, we need to go for a 'technology revolution' to accelerate the growth in the agriculture sector. Smart agriculture has the potential to double the food production in 40 years with lesser impact on climate change. Decision-making in agriculture is increasingly becoming digitalized through the use of robotics, sensors or drones. Emerging digital technologies like global networks, increasing computing power, geo-information systems, sensitive optical sensor systems, and robotic and actuator technologies are going to withdraw the famers to the control rooms and machines to the fields. Smart agriculture involves the incorporation of information and communication technologies into machinery, equipment, and sensors for use in agricultural production systems. New technologies such as the internet of things and cloud computing are expected to advance this development, introducing more robots and artificial intelligence into farming.

As diseases and pests results in 25-35 per cent losses in the harvest, plant protection also needs new, innovative and smart techniques to address forthcoming challenges that require more precision. Disease diagnostics is an important task in the right prescription for the management and here technology can play an important role. Remote sensors can detect plant disease occurrence directly in the field in real time and before visible symptoms tems are present, as light reflectance of a healthy leaf will differ from that of a stressed leaf. This enables farmers to use timely, targeted crop protection strategies. Thermography and chlorophyll fluorescence sensors measure changes in leaf surface temperature and in chlorophyll activity, respectively. These sensors are powerful for picking up early stress responses, but they lack the ability to distinguish between different pathogens. Technological advances in machine vision, global positioning systems (GPS), laser technologies, actuators, and mechatronics (embedded computers, micro-sensors, electrical motors, etc.) will immensely increase our capabilities in right diagnosis of the diseases and site-specific application of pesticides. Hyperspectral sensors and imaging techniques have shown an enormous potential to provide new insights into plant-pathogen interactions and for the detection of plant diseases. Different optical sensors, such as **red,**

green, and blue wave bands, three-dimensional (3D) imaging, chlorophyll fluorescence imaging, thermography, and multispectral and **hyperspectral imaging**, have been investigated for the detection of plant diseases. A method based on visible spectrum image processing was able to detect symptoms of citrus greening diseases caused by *Candidatus liberibacter* on leaves with high detection accuracy. Citrus canker caused by *Xanthomonas axonopodis* caused foliar symptoms that were analyzed to evaluate the efficacy of image analysis and the image analysis was more accurate than visual observations. Artificial Intelligence (AI) technology helps in detecting disease in plants, pests and poor nutrition of farms. AI can identify a disease with 98 per cent accuracy. Machine Learning (ML) is another potential area to bring efficiency and precision in the area of plant protection. The main application areas of ML in plant–pathogen interactions have thus far been the prediction of gene regulatory networks, genomic selection for disease resistance and prediction of pathogen effector proteins. ML can also combine diverse technologies such as hyperspectral imaging with genomic selection. ML has also been applied to predict bacterial and fungal effectors, which typically lack informative sequence homologies or motifs. ML can also combine diverse technologies such as hyperspectral imaging with genomic selection. ML has also been applied to predict bacterial and fungal effectors, which typically lack informative sequence homologies or motifs.A Berlin-based agricultural tech startup developed a multi-lingual plant disease and pest diagnostic app, which uses various images of the plant to detect diseases. Plantix uses Machine Learning techniques in its software algorithm that can detect soil defects, and plant diseases in agriculture based on soil patterns. Farmers can see the information through their smartphone camera along with techniques and solutions to fix the problem. In this way, the application uses AI and ML to solve plant diseases. Over seven million farmers have downloaded this app and it has helped identify over 385 crop diseases among field crops, fruits, and vegetables. Google is working to train AI to recognize 5,000 species of plants and animals, which would improve drone ability to detect pest disease and crop damage. AI sensors can also detect and target weeds and then decide which herbicide to apply within the region. Many technological companies have developed robots, which use computer vision and artificial intelligence to monitor and precisely spray on weeds. These robots are able to eliminate 80 per cent of the volume of the chemicals normally sprayed on the crops and bring down the expenditure of herbicide by 90 per cent. Such robots like the spraying and weeding robots recently acquired by John Deere can reduce agrochemical use by an incredible 90 per cent. Companies like Blue River Technology are using automation and robotics to discover efficient ways in order to protect crops from weeds. The company has developed See & Spray robot which leverages computer vision to monitor and spray weed on cotton plants precisely. Spraying with precision can be helpful in preventing herbicide resistance. Another company DroneFly estimates that drones can spray fertilizer 40 to 60 times faster than doing so by hand. In China, drones are being used to spray pesticides in cotton fields. These can spray over 1,544 square miles at one go.

Tartan Sense from Bangalore designs robots for small farms, applying computer vision and robotics to build precision sprayers. These robots are able to detect weeds or diseased plants, and to spray them precisely. Tartan Sense's first product, Brij Bot, has been a weed spraying robot for smallholder cotton farmers, whose task is to reduce weeding costs by up to 70 per cent. CropIn is a Bangalore-based start-up that offers SaaS tools for farm management, business intelligence, CRM system solutions to forecast and improve sales. It utilizes technologies based on Big Data, AI algorithms, geotagging or satellite monitoring. These services also allow farmers to analyse and interpret data coming from their farms and obtain information on crop health in real time. The World Bank chose CropIn to be a technology partner for an Indian government and World Bank public-private partnership project, which is intended to introduce technological changes into agricultural practices in Madhya Pradesh and Bihar, as well as to help farmers cope with the climate change and subsequent unpredictable weather conditions.

Computer vision technology, data from IoT sensors on the ground and from drones flying above the cultivated land can be merged to achieve more optimal solutions. High-resolution drone cameras are capable of collecting precision field images which can be passed into a neural network system to detect areas with weed, disease or identify stress levels in plants at their different growth stages. Algorithms are already capable of detecting 26 diseases in 14 crop species with 99% accuracy. If the plants are classified as infected, drones can also deliver remedies. Other models that predict pest attacks with AI and machine learning algorithms facilitate their forecasting based on weather conditions and plant life cycle.

Novel sensors deployed on robots can reduce pesticide use by both detecting pests and diseases and precisely targeting the application of insecticides and fungicides. Robots and drone mounted sprayers would be able to target pesticides to the plants that need them, in contrast to current practices, which waste 95% to 99% of pesticides and herbicides because they are blanketed across entire fields. Most of this is wasted, but it promotes resistance among pests and weeds, rendering the harsh chemicals ineffective and encouraging farmers to use more. Some pesticides used in this way are also harmful to pollinators, such as bees, and their blanket use has been banned. Further, curricula of future academics in agriculture as a whole and also in plant pathology need to be an amalgam of biology and engineering and experts with training in both biology and computer science will be central for ML-driven progress in the field.

Volo Drone launched by autonomous drone-based transportation startup Volocopter in partnership with the agricultural and industrial heavy equipment company- John Deere to dispense pesticides, liquid fertilizer etc.

ICT based Pest Surveillance and Advisory System: A path breaking initiative

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Pest surveillance or monitoring is the cornerstone of the philosophy of integrated pest management (IPM) as compared to calendar-based treatments. IPM stresses monitoring of pest and determines when the action is necessary to be taken. The basic purpose of surveillance is to determine whether pests are present in the field at a level to initiate pest management interventions. Through regular and systematic pest surveillance, epidemic situations can be avoided by detecting damage before endemic establishment of a pest in any area. New technologies have made significant impact in the field of pest management but not much of Information and Communication Technology (ICT) is being implemented by the agencies. Use of ICT for pest surveillance and pest management advisory services constitutes e-pest surveillance and advisory system that is basically an internet-based system of capturing pest information from fields and producing – instant and customized pest reports to the plant protection experts to advise the state agriculture agencies who further advise concerned farmers and the same information is available for agricultural policy planners.

ICT based pest surveillance

The goal of using ICT for pest surveillance is to capture the pest information from farmer's field, transferring it to a centralized database, compilation, reporting and dissemination of data to different stakeholders using internet. In fact, pest surveillance provides field-specific information on pest incidence and crop injury leading to appropriate selection and application of pest management procedures by pest management professionals. Fields are scouted to determine what pest management practices need to apply and when? Thus, the success of the recommended pest management procedures depends on the accurate and timely completion of all the pest surveillance activities. So, the use of information and communication technologies facilitates in reporting pest situations of different locations at a click of mouse and plays an important role in pest management decision making. Therefore, ICAR-National Research Centre for Integrated Pest Management (NCIPM), New Delhi took initiative to develop an ICT based surveillance system for Soybean and Cotton in year 2009 in collaboration with State Department of Agriculture, Pune, Maharashtra and its success has been demonstrated. The system has been continuing till date in the state. More crops including horticultural crops have been included into the system. The system has also been replicated in other crops and states across the country.

Preparations for pest surveillance

An elaborate preparation is necessary for successful pest surveillance and thus it improves the efficiency of the activity. Preparation includes pest scouts training, field selection, sampling plan and material required such as data books, set of guidelines, electronic devices, software etc. Before starting scouting, a well thought sampling plan should be prepared which includes crop distribution in the area, field selection, field size, route through the field, selection of spots in the field and finally the number of plants to be surveyed from different spots. The sample

plan is the procedure to draw a sample to estimate the population of different pests or the crop damage. A pest scout should also have access to published information and portable handouts on guidelines for crop pest surveillance. Completely randomized plan is best for pest surveillance so that each spot in a field has equal chance of scouting. The scouts should be educated about the identification of pests and their sampling plan and its execution. A well thought time schedule is must for taking pest observations considering pest biology and crop growth. One has to carefully plan surveillance frequency since the success of any programme heavily depends upon it. Information such as crop variety, agronomic practices, pesticide applied etc. is also to be recorded. Better preparation helps to anticipate and measure the economic significance of pest problems and comprise the baseline information of future planning.

Development of ICT based pest surveillance and advisory system

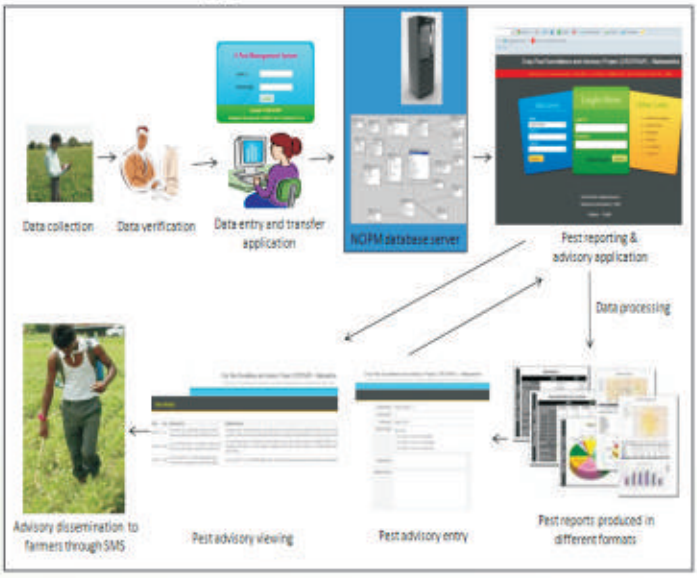
Keeping in view the size of data and internet connectivity in remote areas, three tier architecture based system was designed consisting three major functional components viz. database; offline data entry & transfer application; online pest reporting & advisory application. Following is the Information flow chart of the system:

Data collection Offline data entry Data verification, compilation and transfer into database online pest reporting & advisory issuance Pest advisory dissemination

The interconnection and arrangement of these modules is shown in the picture below.

Different software components of ICT based pest surveillance system were developed to acquire pest data from fields and to analyze the data for reporting of pest status in turn for issuing advisory for pest management using internet.

The system was developed in ASP.net environment using C# & Java languages, Google@ API, SQL Server 2000 and XML technologies. The development of the system was very systematic and accomplished in different phases, having elaborate discussions with all the stakeholders and insertion of their valuable suggestion.



Impact of ICT based pest surveillance and advisory system– a glimpse

Constant and timely watch over pest scenario of the crop with the help of ICT based pest surveillance system aided in identifying the pest hot spots across the state. Staff of state agriculture department was geared up to manage epidemic situations through awareness creation and supply of critical pest management inputs. The pest affected areas across the crops under pest surveillance viz., soybean, cotton, rice, tur and gram get implemented with scientifically based pest management practices over wider area which in turn aids in increased productivity of the crops per se in the region.

While the technological inputs relating to crop production inclusive of crop protection are yield enhancing, the ICT tools aid in rapid dissemination of information related them facilitating their adoption at the growers' level. Successful execution of ICT based pest surveillance and advisory system in Maharashtra has demonstrated area wide implementation of plant protection in the context of Integrated Pest Management (IPM). It has integrated not only the pest management options in respect of the target crops for an effective and efficient plant protection over space and time but also brought personnel of research, extension and farmer communities under the same umbrella where the information flow is across all directions in a quicker pace.

Role of Entomopathogenic Fungi in Insect-pest Management

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Due to various environmental impacts of chemical pesticides, current emphasis is on the development of safe and sustainable pest management strategies. In this context, biological control involving microbials becomes an important component of integrated pest management. Among microbials, entomopathogenic fungi are the most important and commonly exploited due to their easy delivery, availability of a large number of pathogenic strains, broad host range and ability to penetrate insect cuticle. Furthermore, they have the ability to colonize the rhizosphere and may act as saprotrophs for their survival in the absence of suitable host.

Mode of infection:

The first step in the infection process is the attachment of the infective units (conidia, spore, zoospore) to the insect cuticle. The infective unit germinates and penetrates the cuticle by enzymatic action and the physical pressure by the germ tube or infection peg from appresoria. After reaching the haemocoel, the fungus quickly multiplies through budding to produce yeast phase hyphal bodies to fill the haemocoel cavity. At this stage the death of the host insect occurs and the fungus starts to multiply and grow through mycelial phase. Fungal mycelium then invades almost all the host organs and penetrates through the cuticle to the exterior of the insect and the cadaver is covered with a mat of mycelium. This stage is shortly followed by the production of infective units which are ready for further dissemination to spread the disease to other susceptible hosts.

Important species:

Species	Host insect
Beauveria bassiana	Many insects in the orders Coleoptera, Hemiptera, Diptera and Hymenoptera.
Beauveria brongniartii	White grubs.
Metarhizium anisopliae	Coleopterans and Orthopterans especially root grubs, locusts and grasshoppers
Lecanicellium lecanii	Sucking pests like aphids, whiteflies, thrips and scales
Metarhizium (= *Nomuraea*) *rileyi*	Lepidopterans especially Noctuids like *Spodoptera litura* and *Helicoverpa armigera*
Isaria (= *Paecilomyces*) *fumosorosea*	Sucking pests like whiteflies, scales and aphids.
Hirsutella thompsonii	Phytophagous mites

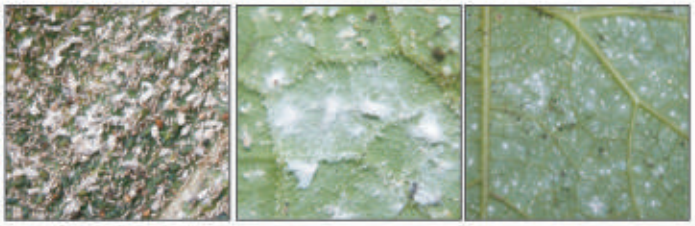
Advantages:

1. Being specific they are safe to the non-target organisms like predators, parasitoids, pollinators, etc.
2. They are safe to the environment with no ill effects on the human health.
3. They have multiple modes of insect killing, hence no problems of resistance by insects.
4. They have genes for secretion of insect toxins, hence can be improved by biotechnological research.
5. They can be used endophytically to activate or improve the plant immune system against the target pest.
6. They have the ability to persist in the environment to ensure long term suppression of the pests.

Disadvantages:

1. They are slow in action and require specific environmental conditions for pathogenesis.
2. They have narrow host range, therefore, different bioagents are required to control different pests.
3. They have short shelf life and need to be used within few months for better results.
4. Different strains vary in virulence, hence identification of a correct strain is crucial. Generally local strains are more effective than the exotic ones.

Apple root borer and white grubs infected with *Metarhizium anisopliae*



Maize aphid and greenhouse whitefly infected with *Lecanicillium lecanii*

Spodoptera litura* infected with *Metarhizium rileyi

Spodoptera litura* infected with *Beauveria bassiana

Prediction Models for Managing Foliar Diseases of Apple

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Over the growing season, apple orchards are under constant threat from a large number of insects, fungal, bacterial and viral pathogens. Early pest and disease detection are critical for appropriate and timely deployment of disease and pest management programme. The primary purpose of predictive models for diseases is to help growers in timing fungicide application. Use of disease-forecasting models together with other farming management practices can lead to significant savings. For this, various workers around the globe have worked out various prediction models and management programmes based on a number of years field observations on incidence, severity, time of infection and taking into account current and forecasted weather data. Accurate prediction of potential for infection and inoculum availability is critical to preventing infections during the primary period for foliar diseases of apple such as apple scab (*Venturia inaequalis*), which overwinters in infected apple leaves on orchard floor. For its management, models that estimate development and release of the primary inoculum (Gadoury & MacHardy 1982), and its subsequent infection of the host have been created and deployed (Holb, 2006; Mills, 1944). Heat units, referred to as degree-days (DD) is another model (Allen, 1976; Baskerville & Emin, 1969) as the base temperature used for *V. inaequalis* ascospore development is 0°C (32°F). Below this temperature, little or no biological activity occurs (James & Sutton, 1982a; MacHardy & Gadoury, 1985). Gadoury and MacHardy (1982) developed a temperature-driven model (New Hampshire model) which tracks ascospore maturation from the time the first mature spores are available to the point at which they have all matured and been ejected. Mills (1944) stated that at given inoculum in the orchard, hours of wetting and concurrent average temperatures are used to calculate whether or not there would be an infection event and its severity. When leaves are wet, infection at warmer temperatures requires less time than at colder temperatures. RIMpro (Relative Infection Measurement Program) suggested by Trapman and Polfliet (1997) predicts maturation process of overwintering scab lesions as basis of its forecast. Some computer-based early warning systems such as WELTE, METOS, HP-100, ADEM have been designed to determine infection periods for apple scab. For more complex decision support-system for managing scab, RIMpro (RIMpro B.V., Zoelmond, Netherlands) have been developed by Marc Trapman at Hudson Valley Research Laboratory with assistance from many European scientists. In addition to providing information on apple scab, also contains software modules that provides management information for apple powdery mildew and Marssonina leaf blotch also. This programme can be accessed via computer or smart phone. To assist growers to adopt an improved strategy for managing apple powdery mildew, a mathematical model was developed recently at Horticulture Research International at East Malling to simulate the dynamics of secondary mildew. The model (Podem, Podosphaera East Malling) was written in Turbo Pascal, rewritten recently in Delphi, and implemented on an IBM-compatible PC. An empirical model for forecasting incidence of alternaria leaf spot in apple has been given by Kim et al. (1987) to predict initial disease occurrence and subsequent progress of disease and the model was constructed on the basis of modified degree day temperature and frequency of rainfall. Cumulative degree portion that is over 10°C in the daily average temperature was used as a parameter to determine the relationship between temperature and initial disease occurrence. MBCAST model developed by Kim et al. (2019) is a recent predictive model for Marssonina leaf blotch on apple and consists of two sub models, ASM (Airborne Spore Model) and IRM (Infection Rate Model), to estimate airborne spore catches and daily infection rate respectively, of Marssonina leaf blotch on apple. It was developed on the basis of field observations on airborne spore catches, weather conditions and disease incidence.

Next Generation Sequencing- Expanding Omics in Plant Virology

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Next-generation sequencing (NGS) refers to the deep, high-throughput, in-parallel DNA sequencing technologies developed a few decades after the Sanger DNA sequencing method first emerged in 1977 and then dominated for three decades. The NGS technologies are different from the Sanger method in that they provide massively parallel analysis, extremely high-throughput from multiple samples at much reduced cost.NGS technologies using DNA, RNA, or methylation sequencing have an

enormous impact on advanced molecular plant pathology particularly plant virology. NGS is the choice for large-scale genomic and transcriptomic sequencing because of the high-throughput production and outputs of sequencing data and the lower cost compared to the traditional Sanger first-generation sequencing method. The vast amounts of data generated by NGS have broadened our understanding of structural and functional genomics of plant viruses providing new insight into the diversity of plant viruses. NGS today is more than ever about how different plant viruses use genetic information and molecular biology to survive and reproduce with and without mutations andcause diseases in plantsunder changing environments.

Next-generation sequencing has significantly increased the number of novel plant viruses discovered and characterized both in host plants and in insect vectors. More than 100 novel DNA and RNA plant viruses from different genera and families have been reported in the recent years. Only two novel viroids, however, were discovered: persimmon viroid 2 and grapevine latent viroid. This trend has been observed in crop plants but also, to a very large extent, in wild plant species through the use of NGS in metagenomic approaches. Likewise, the sequences of many novel virus and viroid strains have been reported. In addition to discovering novel viruses, the complete nucleotide sequences of many known viruses were determined by NGS for complete virus characterization and/or virus identification in known and new hosts or for other reasons. For example, NGS has shown that the artichoke latent virus (ArLV) is a member of the genus *Macluravirus*, family *Potyviridae*, and that ranunculus latent virus should be considered as a strain of ArLV but not a distinct species; potato virus Y and potato virus S have been identified in Maori potato (*Solanum tuberosum*) and turnip mosaic virus in rengarenga (*Arthropodium cirratum*) which is a new host. NGS analyses do not generally provide the final word on a new virus or viroid. The genome sequence generally has to be finalized using PCR-based approaches and Sanger sequencing and, as a general rule, the existence of the new virus or viroid should always be sought using an alternative technique. In addition, NGS librarypreparation methods with minimal bias should be used in order to obtain accurate and easy to interpret data. Another area where NGS has proven very valuable is in the detection of isolates, strains, or variants of known viruses that escape existing detection procedures and, particularly, PCR assays. The data obtained may afford a better knowledge of the polyvalence or specificity of existing assays and, if needed, facilitate the design of new detection primers of broader specificity for improving the classical detection assays. For example, the NGS discovery of a non-detectable isolate of plum bark necrotic and stem pitting associated virus led to develop a new PCR assay of broader specificity..

NGS has provided a very powerful alternative for detection and identification of plant viruses and viroids without *a priori* knowledge of pathogen sequence as required for PCR-based detection and identification methods. For this reason, NGS has become a universal approach for accurate detection and identification of many novel and known plant viruses. Viroids are also accurately and easily detected and identified by NGS. Thus, NGS has the potential to be used as a primary diagnostic tool for plant viruses and viroids as the cost of sequencing platforms has become more competitive and affordable. Currently, the cost of NGS-based diagnostics is still high as compared to that of a PCR or serological assay, so that the technique is limited to situations where exhaustiveness is critical, such as quarantine or when trying to identify a causal agent, or to situations involving high value added samples, such as nuclear stock mother plants used for production of certified planting materials. It should be stressed that nucleic acids purifications and sequencing bank preparation protocols may have to be optimized and fine-tuned to particular plant species that may contain inhibitory substances that may otherwise interfere with the sensitivity of the detection procedure.

White Thread Blight on Pome Fruit Plants in Himachal Pradesh

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White thread blight disease (WTBD) is an emerging foliar disease on apple in Himachal Pradesh. The disease was observed in apple orchards of Lug Valley in Kullu district of Himachal Pradesh with 2-3 per cent disease incidence. Poor maintenance significantly increased the levels of disease occurrence and severity. Older apple trees also appeared more susceptible than younger ones. The disease caused by *Ceratobasidium stevensii* is worldwide in distribution and it has been reported on several important plant species including 18 fruit trees.

Usually, thread blight symptoms are noticeable on the interior or shaded portions of the tree in early summer or during rainy season. **The typical symptoms of this disease include** wilting and browning of leaves.The white thread blight disease derives its name from white mycelial strands (threads) of the fungal pathogen that grow underneath apple branches, petioles and leaves causing leaf blight. Blighted leaves show distinct brown to dark-brown decay followed by defoliation. Dead leaves with mycelia are major source of inoculum.The disease spreads by wind, rain, insects and human activities.

Thread blight, once established in an orchard, is difficult to control with fungicides. Applying preventive fungicide sprays on trees prior to infection may help protect the orchard from this disease. Certain cultural practicessuch as avoiding hollow areas and other poorly ventilated and shaded areas when selecting an orchard site can also prevent the disease. Pruning to promote better penetration of sunlight and air is also an important management strategy.Prune out blighted twigs and branches when disease pressure is low.

Management of Important Forest Nursery Diseases

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Nursery is pre requisite for producing quality seedlings in lesser input and nursery management is a potential tool to execute the activity as successful means The availability of quality seedlings at lower cost offers ample scope for large scale planting. Putting efforts on quality seedling production offers scope for sustainable agriculture. India has only 23.81% forest cover (Annual Report, CAZRI), which is far below the recommended 33% of our National Forest Policy, 1988.Forests provide multipurpose benefits such as timber, fodder, fuel and minor forest produces. They also help in conserving soil and water, offering food and shelter for wild life, adding to the aesthetic value and recreational needs of man. Diseases and insect pests constitute major biological determinants of forest productivity, particularly in nurseries and plantations. They cause heavy damage to seedlings and hence reduce both quantity and quality of planting stock. Large-scale mortality in the nursery due to disease problems could seriously affect the plantation programme by reducing the stock of seedlings. In plantations, they cause major problems resulting in the reduction of biomass production or loss of valuable germplasm collections. Further, the infected seedlings are weakened and unable to withstand the adverse field/plantation conditions. Thus, the economic loss resulting from nursery diseases are considerable. Therefore, raising disease free, healthy tree seedlings is not only important for maintaining a good nursery stock but also essential in establishing a healthy stand in the field for better productivity. The major diseases encountered in forest nurseries are discussed below.

Damping off:

- Among the nursery diseases, damping-off is the most prevalent and highly destructive disease and cause heavy loss of seedlings. This causes preemergence and post-emergence damping off depending on the stage of growth of seedlings when they are attacked.
- This disease is caused by various soil fungi such as *Pythium, Phytophthora, Fusarium* and *Rhizoctonia* of which the last two fungi are quiet prevalent in forest nurseries in India.
- High soil temperature, excessive soil moisture, high soil pH (alkaline), high nitrogen content, low light intensity due to shading, stiffy or clayey soil with poor.
- Post emergence damping off drainage, dense sowing are the conditions which favour the disease development in serious proportion.

***Control Measures*:** The disease has been managed through:

- Cultural practices aimed at favouring plant growth and discouraging the growth of plant pathogen
- Formalin is applied as soil fumigant to manage the disease. Also, seed dressing with fungicide (Bavistin) in certain cases found very effective.

Root rot :

- It is caused by *Rhizoctonia, Phytophthora, Fusarium* species. It causes weakening of roots, plants shrivel and ultimately dies.

Control Measures: Drenching with ***T. viride (20g/kg soil)*** + tebuconazole + trifloxystrobin (0.1%) or ***T. harzianum (20g/kg soil)*** + tebuconazole + trifloxystrobin (0.1%) was found to be effective.

a) Initiation of browning of collar portion and roots
b) few or none secondary root formation and drying
c) complete blackening of roots and necrosis

Leaf Web Blight

- It is caused by *Rhizoctonia solani*. The disease appears in the nursery after the regular monsoon rains set in.
- Development of greyish brown blotches which increase in size with the advancing fungal hyphae and ultimately engulf the entire leaf blade. The infected adjoining leaves get joined together by the fungal hyphae as if caught in a spider's web, hence the name web blight. The disease spreads through contact of the overlapping foliage.

Control Measures: The disease has been managed through integrated approach which includes measures such as sanitation and cultural practices. Application of Bavistin 0.1% is found effective.

***Alternaria* Leaf spot and blight:**

- It is caused by *Alternaria alternata*. It appears late in the growing season in the last week of October or early November. It attacks the leaves when the leaves become old and contain less soluble sugars.
- ***Control Measures:*** Application of Dithane M-45 (0.25%) at fortnightly intervals is found very effective.

Powdery Mildew:

- This disease is caused by *Odium, Erysiphae species*
- White floury patches seen on the surface of the leaves. These patches coalesce and cover the whole leaf lamina giving greyish white appearance. Severely infected leaves and leaflets defoliate prematurely.
- ***Control Measures:*** Foliar spray of Bavistin fungicidal solution (0.01%) is found to be effective in minimizing the disease.

Integrated Nursery Disease Management

Diseases are important limiting factors in the production of forest seedlings within nurseries. High moisture and nutrients supplied to nursery seedlings often promote proliferation of important pathogens. Selection of apparently healthy seeds/propagules for seedling production, Seed dressing with 0.2% Carbendazim/Methyl thiophanate/Benomyl/Thiram, sowing in sterilized/fumigated, clean beds and adequate watering, using sterilized budding knife, secateurs, and scissors during budding and grafting, transplanting seedling after root dip for 3-5 min in 0.02% Carbendazim solution, Frequent examination of seedling health and removal of diseased stocks are some of the methods of disease management.

Healthy nursery

Nurseries showing root rot

फ्रासबीन फसल में रोग नियन्त्रण

डॉ० नरेन्द्र भरत
प्रधान वैज्ञानिक (पादप रोग विज्ञान)
बीज विज्ञान एवं प्रौद्योगिकी विभाग

फ्रासबीन एक ऐसी महत्वपूर्ण सब्जी फसल हैं जो कि पौष्टिकता से भरपूर तो है ही साथ-ही साथ यह फसल मिट्टी की गुणवत्ता भी बढ़ाती है। इसके पौधों की जड़ो में बसने वाले छोटे-छोटे राइजोबियम नामक मित्र जीवाणू वातावरण से नत्रजन को लेकर मिट्टी में मिलाते हैं तथा इसकी उपजाऊ शक्ति को बढ़ाते हैं। मध्य व निम्न पर्वतीय क्षेत्रों में फ्रासबीन मुख्यत: पैंसिलबीन की खेती नकदी फसल के रूप मे तेजी से बढ़ रही है। यद्यपि फ्रासबीन की खेती से किसान काफी लाभ कमा रहे हैं परन्तु कभी -कभी रोगों के प्रकोप के कारण फसल की पर्याप्त उपज नही ले पाते हैं। यहाँ पर फ्रासबीन की फसल में लगने वाले प्रमुख रोगों की पहचान व उनके एकिकृत नियन्त्रण की जानकारी दी जा रही है:

1. जड़ सड़न व झुलसा रोग

लक्षण: भूमि के साथ ही तने पर विशेष किस्म के लाल भूरे रंग के धंसे हुए धब्बे उभरते हैं। प्रकोप बढ़ने पर सारी जड़ें सड़ जाती हैं। पत्तों

पर लाल-भूरे रंग के धब्बे पड़ जाते हैं बाद में पत्ते झुलसे हुए प्रतीत होते हैं। फलियों पर भी लाल भूरे रंग के धब्बे उभरते हैं जिन पर नमी के मौसम में फफूँद उग जाती है। यह रोग रहाइजोक्टोनिया सोलेनाई नामक फफूँद से पनपता है जोकि संक्रमित मिट्टी व संक्रमित बीज द्वारा फैलता है।

नियन्त्रण: लम्बा फसल चक्र अपनायें। मिट्टी को गर्मियों में लगभग 40-50 दिनों तक सौर ऊर्जा द्वारा पौलीथीन से ढक कर उपचारित करें। स्वस्थ बीज का चयन करें तथा बीज को कार्बेण्डाजिम (2 ग्रा० /कि० ग्रा० बीज) या ट्राईकोडर्मा (10 ग्रा० /कि० ग्रा० बीज) से उपचारित करें। मिट्टी में सरसों या नीम की खली मिलाएँ। मल्च का प्रयोग करें। फसल पर कार्बेण्डाजिम (100 ग्रा०) या मैंकोजेब (250 ग्रा०) या इन दोनों के मिश्रण का 100 लीटर पाली में घोल कर छिड़काव 10-14 दिनों अन्तराल पर करें।

2. एन्थैकनोज़

लक्षण: – फलियों पर काले भूरे रंग के धब्बे जो बीच से हल्के रंग के होते है उभरते हैं। पत्तों की निचली सतह की शिरायें गहरे रंग की हो जाती है। यह रोग कोलैटोट्राइकम लिंडेम्युथियेनम नामक फफूँद द्वारा होता है। यह फफूँद संक्रमित बीजों तथा अवशेषों द्वारा फैलता है।

नियन्त्रण: दो-तीन वर्षीय फसल चक्र अपनाएँ। रोग मुक्त व स्वस्थ बीज का प्रयोग करें। बीज का उपचार कार्बेण्डाजिम या वैनोमिल (2 ग्रा० /कि० ग्रा०) से करें। रोग प्रभावित खेतों में फसल पर आरम्भ से ही 8-10 दिनों के अन्राल पर कार्बेण्डाजिम (100 ग्रा०) या मैंकोजेब (250 ग्रा०) या इनके मिश्रण का प्रति 100 लीटर पानी में छिड़काव करें।

3. कोणीय पत्ता धब्बा रोग

लक्षण: – पत्तों पर लाल-भूरें रंग के कोणीय धब्बे पड़ जाते हैं। अधिक प्रभावित पत्ते पीले भी पड़ जाते हैं। फलियों पर भी लाल भूरे धब्बे उभरते हैं तथा इनके अन्दर बीजों का रंग पीला हो जाता है। यह रोग स्यूडोसरकोस्पोरा ग्राइसियोला नामक फफूँद द्वारा होता है। यह फफूंद पौधों के संक्रमित भागों व बीज द्वारा फैलता है।

नियन्त्रण: – पौधों के संक्रमित भागों को इकट्ठा कर जला दें। दो या तीन वर्षीय फसल चक्र अपनाएँ। स्वस्थ बीज का प्रयोग करें। जब रोग के लक्षण नजर आऐ तो फसल पर कार्बेण्डाजिम (100 ग्रा०) या बैनोमिल (100 ग्रा०) प्रति 100 लीटर पानी का छिड़काव 10-14 दिनों के अन्तराल पर करें।

4. रतुआ

लक्षण: – यह रोग पैंसिल बीन की प्रजातियों पर अधिक पाया गया है। पत्तों पर पीले उभरे हुये छोटे-छोटे धब्बे उभरते हैं। बाद में धब्बे लाल भूरे रंग के जंग की तरह दिखाई पड़ते हैं तथा इनके चारो ओर पीला घेरा बन जाता है। यह रोग यूरोमाइसिस अपेंडीकुलेटस नामक फफूँद से होता है।

नियन्त्रण: – पौधों के रोग ग्रसित भागों को इकट्ठा कर जला दें। जहाँ रोग का प्रकोप अधिक हो वहाँ पैंसिल बीन न उगाएँ। फसल पर रोग के लक्षण नजर आने पर हैक्साकोनेजोल (100 ग्रा०) या प्रोपीकोनेजोल (100 ग्रा०) या डाइफैनोकोनेजोल (50 ग्रा०) प्रति 100 लीटर पानी का छिड़काव 10-14 दिनों के अन्तराल पर करें।

5. जीवाणू झुलसा रोग

लक्षण: – पत्तों पर छोटे-छोटे पनीले धब्बे दिखाई देते हैं। पत्ते पीले पड जाते हैं तथा उन पर लाल धारियाँ व चिन्ह उभर जाते हैं। यह रोग जैंथोमोनाज एक्जोनोपोडिस प्रजाति फैजियोलाइ नामक जीवाणू द्वारा होता है। यह जीवाणू संक्रमिल बीजों व अन्य अवशेषों तथा खरपवरों द्वारा फेलाता है।

नियन्त्रण: – रोग ग्रस्त पौधों व उनके अवशेषों को तथा खरपतवारों को नष्ट करें। फसल चक्र अपनाएँ रोगमुक्त व स्वस्थ बीज का ही प्रयोग करें। बीजों का उपचार स्ट्रैप्टोसाइक्लिन (1 ग्रा०) तथा कैप्टान (25 ग्रा०) के मिश्रण को 10 लीटर पानी में घोल कर लगभग चार घण्टे तथा बीजों को इसमें डालें फिर बीजाई करें।

6. चित्तीदार रोग

लक्षण: – संक्रमित पौधों के पत्तों पर हल्के हरे व पीले रगं के आकार से उभर जाते हैं। ऐसे पत्ते मुड़ व सिकुड़ भी जाते हैं। यह रोग बीषाणु द्वारा पनपता है तथा बीषाणु तेले नामक कीट तथा संक्रमित बीज द्वारा फैलता है।

नियन्त्रण: – रोग प्रतिरोधी किस्मों का प्रयोग करें। खेत के बीच में व चारों ओर मक्की के पौधे - उगायें। स्वस्थ बीज का प्रयोग करें। समय से पहले बीजाई करें। संक्रमित पौधों को देखते की उखाड़ दें व नष्ट कर दें। फसल चक्र अपनाएँ। रोग वाहक कीट के नियन्त्रण के लिए मैलाथियान (100 मि० ली०) प्रति 100 लीटर पाली के घोल का छिड़काव करें।

रसायनिक कीटनाशकों/फफूंदनाशकों के जहरीलेपन का प्रभाव व बचाव

मीनू गुप्ता
सब्जी विज्ञान विभाग

किसी कीट अथवा फफूंद को नष्ट करने के लिए प्रयोग किये जाने वाले रसायनों का प्रभाव उसके साथ अन्य जीवों जैसे मनुष्य, जानवर तथा मधुमक्खी आदि पर पड़ता है तो उसे कीटनाशी विषैलापन या जहरीलापन कहते हैं। यह विषैलापन उस कीटनाशी का किसी जीव, मानव शरीर या उसके भागों अथवा पर्यावरण को हानि पहुँचाने की क्षमता है। यह जहरीलापन कीटनाशी की मात्रा तथा उसके संसर्ग के समय पर निर्भर करता है। भारत जैसे विकासशील देश में कीटनाशी विषैलेपन का थोड़े समय के लिए बहुत अधिक संसर्ग भी बहुत चिंता का विषय है। भारत सरकार की किसानों को कीटनाशकों के सही प्रयोग तथा उनके विषैलेपन से बचने के लिए समय-समय पर जागरूक करती रहती है। इस आलेखन में भी किसानों के लिए कीटनाशी रसायनों के जहरीलेपन के विषन में जानकारी दी जा रही है।

1. कीटनाशी रसायनों का जहरीलेपन के आधार पर वर्गीकरण: – कीटनाशी रसायनों को किसनों की सुविधा के लिए विषैलेपन के आधार पर वर्गीकृत किया गया है जिसका उल्लेख उसके लेबल पर कुछ चिन्हों द्वारा अंकित किया जाता है जो इस प्रकार हैं:

क्र० सं.	वर्ग	रंग	चिन्ह
1.	अत्यंत विषैला	लाल	
2.	अत्यधिक विषैला	पीला	
3.	मामूली रुप से विषाक्त	नीला	
4.	थोड़ा विषैला	हरा	

2. विषैलेपन का प्रकार:

(i) तीव्र विषैलापन/जीर्ण विषैलापन

तीव्र विषैलापन: – ऐसे कीटनाशी जिनके एक बार में थोड़ी देर के संसर्ग से कोई मनुष्य, जानवर या पौधा अत्यधिक संक्रमित हो जाता है। इन कीटनाशी रसायनों का बहुत कम मात्रा में अवशोषित करना भी घातक होता है।

जीर्ण विषैलापन: – यह विषैलापन किसी कीटनाशी के लंबे समय तक संसर्ग के प्रभाव से होता है। यह जहरीलापन आम जनता के लिए चिंता का विषय है क्योंकि इनका प्रभाव खाद्य उत्पादों, पानी तथा हवा पर भी होता हैं

3. प्रवेश के मार्ग: शरीर में कीटनाशी विशेष मार्गो से ही प्रवेश कर सकते हैं।

(i) त्वचा से प्रवेश: – कीटनाशी रसायन त्वचा द्वारा अवशोषित किये जा सकते हैं। पानी आधारित कीटनाशियों की अपेक्षा तैलीय या पेस्ट वाले कीटनाशी शीघ्रता से शीषित हो जाते हैं। आँखें, कान, सिर की त्वचा व बाल तथा जननांग शरीर के अन्य भागों की अपेक्षा शीघ्र सीखते हैं। जब त्वचा इस रसाायनों को सोख लेती है तो ये खून के प्रवाह में मिलकर पूरे शरीर में चले जाते है।

(ii) साँस से प्रवेश: – डस्ट, स्प्रे धुँध या धुँआ साँस के साथ हमारे फेफडों में प्रवेश कर जाता है। साँस द्वारा प्रवेश मिश्रण बनाते हुए, धूमीकरण करते हुए या छिड़काव करते हुए हो सकता है। बड़े कण गले तथा श्वास नली की सतह पर ठहर जाते हैं परन्तु छोटे कण सीधे फेफड़ों में प्रवेश कर लेते हैं और इस तरह खून के प्रवाह में चले जाते हैं।

(iii) मुँह से प्रवेश: – मुँह से कीटनाशी तभी प्रवेश करते हैं जब खाने से पहले हाथों को अच्छी तरह न धोया जाए या गलती से अथवा जानबूझकर निगल लिया जाये। इस प्रकार निगला पदार्थ खून में मिलकर पूरे शरीर में सम्मिलित हो जाता है।

4. विषैलेपन की निर्भरता: विषैलेपन का प्रभाव हरेक व्यक्ति में भिन्न होता है जो निम्न बातों पर निर्भर करता है:

(i) स्वास्थ्य की स्थिति: – कमजोर स्वास्थ्य वाले व्यक्ति अधिक संवेदनशील होते हैं।

(ii) उम्र: – छोटे तथा अधिक उम्र वाले व्यक्ति अति संवेदनशील होते है।

(iii) लिंग: – महिलाएँ अधिक संवेदनशील होती है।

(iv) शरीर का आकार: – कीटनाशी की मात्रा का प्रभाव शरीर के भार से सीधे संबंधित है।

5. जहरीलेपन के प्रभाव

(I) स्थानीय या प्रणालीगत: – ये दोनों प्रभाव भी एक रसायन द्वारा हो सकते हैं। स्थानीय प्रभाव पदार्थ के साथ संपर्क में आने के स्थान पर

होता हैं जैसे कि त्वचा में सूजन, श्लेष्मा झिल्ली में जलन आदि। प्रणालीगत प्रभाव शुरूआती संपर्क के स्थान से दूर होता है जब कीटनाशी पूरे शरीर में फैल जाता है।

(ii) तत्काल या विलंबित: (ये दोनों प्रभाव भी एक रसायन द्वारा हो सकते हैं।) तत्काल विषैले प्रभाव संसर्ग के थोड़ी देर बाद ही दिखाई देते हैं जैसेकि मिश्रण बनाते हुए साँस में चले जाने से बार-बार छींके आना। विलंबित प्रभाव संसर्ग के काफी समय बाद दिखाई देते हैं जैसेकि कैंसर करने वाले पदार्थ के संसर्ग के कई वर्षो बाद टयूमर होना ।

(iii) परिवर्तनीय या अपरिवर्तनीय: परिवर्तनीय प्रभाव स्थायी नहीं होते हैं तथा इन्हें बदला अथवा ठीक किया जा सकता है जैसे कि त्वचा पर चकत्ते, उल्टी होना, आँखों में जलन, चक्कर आना आदि। अपरिवर्तनीय प्रभाव स्थायी होते हैं तथा इन्हें एक बार होने पर बदला नहीं जा सकता जैसेकि केंसर, जन्म दोष आदि। इसके अतिरिक्त जरहीलापन जीवों में प्रजनन, अजात वंशजों में जन्म दोष, जीवित ऊतकों में कैंसर, दिमाग तथा तंत्रिका तंत्र में विषैलापन तथा प्रतिरक्षा दमन आदि प्रभाव उत्पन्न करता है।

6. जहरीलेपन के लक्षण

कीटनाशी रसायनों के अनुचित प्रयोग से विषैलापन हो सकता है जिसका हम पर प्रतिकूल प्रभाव पड़ता है। ये प्रतिकूल प्रभाव सिर दर्द से लेकर अचेत अवस्था तथा ऐंठन तक हो सकते हैं जोकि विषैलेपन के हल्के, मध्यम या अति अवस्थाओं वाले लक्षणों से पहचाने जाते हैं।

विषैलेपन के लक्षणों की विभिन्न अवस्थाएँ

क्र० सं०	हल्की अवस्था	मध्यम अवस्था	अति अवस्था
1.	सिरदर्द	उल्टी होना	ऐंठन
2.	उल्टी होना	धुँधला दिखना	साँस रुकना
3.	चक्कर आना	पेट में मरोड़	बेहोश होना
4.	थकावट	तेज नब्ज का चलना	नब्ज का न मिलना
5.	त्वचा, आँख गले व नाक में जलन	साँस लेने में मुश्किल, संकुचित पुतलियाँ	
6.	पसीना आना	अत्यधिक पसीना आना	
7.	भूख न लगना	कांपना तथा माँसपेशियों का हिलना	

7. कीटनाशी के जहरीलेपन पर प्राथमिक चिकित्सा

कीटनाशी शरीर में विभिन्न मार्गो जैसेकि त्वचा, मुँह या साँस द्वारा प्रवेश करते हैं। अत: प्राथमिक चिकित्सा भी इसी आधार पर दी जानी चाहिए।

(I) कीटनाशी का त्वचा या कपड़ों पर छलकना: – सारे कपड़े जल्दी से उतार दें तथा त्वचा को साबुन और पानी से अच्छी तरह धो लें। दूषित कपड़ों को अन्य कपड़ों से अलग धोयें। बहुत ही ज्यादा दूषित कपड़ों को फेंक दें।

(ii) साँस द्वारा कीटनाशी का प्रवेश: – सबसे पहले प्रभावित व्यक्ति को ताजा हवा में लाएँ। उसे लिटा दें तथा उसके कपड़े ढील कर दें। उसे गर्म रखें तथा शीघ्र अति डॉक्टर को बुलायें।

(iii) कीटनाशी का निगलना: – प्रभावित व्यक्ति को उल्टी के लिए प्रेरित न करें। यद्यपि निगले हुए विष का उल्टी करना अच्छा है परन्तु यदि प्रभावित व्यक्ति बेहाश है या उसे ऐंठन है तो उसे उल्टी करने के लिए प्रेरित न करें। यदि कीनाशी के लेबल पर "इमलसिफायेबल कॉन्स्ट्रेट" लिखा है तो उल्टी के लिए बिल्कुल भी प्ररित न करें।

8. कीटनाशी के पिषैलेपन के लिए प्रतिकारक

(i) विश्वव्यापी प्रतिकारक: – 7 ग्राम एक्टिवेटिड चारकॉल + 3. 5 ग्राम मैग्निशियम ऑक्साइड + 3.5 ग्राम टैनिक एसिड को आधा गिलास गर्म पानी में घोल कर पिलाएँ। इसके बाद नमक वाला पानी पिलाएँ।

(ii) विणेष प्रतिकारक

- कार्बोमेट जहरीलेपन के लिए एट्रोपीन (2-4 मि. ग्रा.) का प्रयोग करें।
- ऐंठन के लिए डायजेपाम का प्रयोग करें।
- जिंक फास्फाइड विषैलेपन के लिए पेट दर्द में मॉरफीन दें तथा घुलनशीन विटामिन (K) दें।

फ्रोग आई पत्ता धब्बा रोग – सेब व नाशपाती में उभरती समस्या

नीलम कुमारी व भूपेश कुमार गुप्ता
पादप रोग विज्ञान विभाग

सेब व नाशपाती दोनों ही फल प्रदेश की औद्यानिकी आर्थिकी की रीढ की हड्डी कहे जाते हैं। दोनों ही फलों में विभिन्न प्रकार के पत्ता धब्बा रोग पाए जाते है, जैसे कि स्कैब रोग (वैंचुरिया इनएक्वैलिस), असामयिक पतझड़ (मारसोनिना कोरेनेरिया), अल्टरनेरिया पत्ता धब्बा रोग (अल्टरनेरिया माली), नाशपाती स्कैब (वैंचुरिया पाईरिना) तथा फ्रोग आई पत्ता धब्बा रोग (बोटरियो स्फैइरा स्पेशिज) पिछले तीन सालों में शिमला जिला के रोहडू, चिड़गांव व जुब्बल विकास खडों के सर्वे के दौरान ये देखा गया कि फ्रोग आई पत्ता धब्बा रोग सेब व नाशपाती में नया उभरता हुआ रोग है जिसका प्रकोप 26-33 प्रतिशत बागीचों में देखा गया। हालांकि इसकी गंभीरता 5-7 प्रतिशत ही पाई गई। सेब के फलों में काली सड़न भी पिछले तीन-चार सालों से रोहडू, जुब्बल व चिड़गांव विकास खण्डों में कुछ स्थानों पर देखी गई है। 2020 में देखा गया कि अधिक वर्षा होने से जहां स्कैब रोग एक बार फिर से प्रदेश में अपने पांव प्रसार रहा है वहीं फ्रोग आई पत्ता धब्बा रोग भी तेजी से उभर कर सामने आ रहा है।

लक्षण: फ्रोग आई पत्ता धब्बा रोग के लक्षण शुरू में छोटे गोलाकार बैंगनी रंग के धब्बों के रूप में पत्तों पर देखे जा सकते है जो कि बाद में 0.3 से 0.6 से. मी. व्यास के आकार के बन जाते हैं। धब्बे का मध्य भाग गहरा भूरे रंग का हो जाता है तथा बाहरी किनारों पर बैंगनी रंग, धब्बे को मेंढक की आंख की शक्ल प्रदान करता है। नाशपाती में भी इसी से मिलते जुलते थोडें बेढगे आकार के धब्बे पाए जाते है।

इन पत्तों के धब्बों को सुक्ष्मदर्शी यंत्र में देखने पर गहरी रंगत वाले अण्डाकार फफूंद के रोगाणु (कोनिडिया) देखे गए। नाशपाती के फलों के अग्रभाग में पाए जाने वाले काले धब्बों में भी इसी प्रकार के कोनिडिया देखे गए। फलों के अग्रभाग में अत्यधिक कलिमा होने की स्थिति में अपरिपक्व फल भी झड़ जाते है। 2020 में मई महीने मे ही सेब में इसी तरह के कोनिडिया देखे गए।

प्रबन्धन: –

1. सर्दियों में नीचे गिरी हुई पत्तियों को इक्ट्ठा करके जला दें। पेड़ों पर पतझड़ से पूर्व व नीचे गिरी पत्तियों पर 5 प्रतिशत यूरिया का छिड़काव करने से भी इनके सड़ने में मदद मिल सकती है।
2. पत्ता धब्बा रोगों के प्रबन्धन के लिए विश्वविद्यालय द्वारा अनुमोदित साल 2020 की विभागीय छिड़काव सारणी में मैन्कोजेब या प्रोपिनेब (600 ग्रा) या डिफैनोकोनाजोल (30 मि. ली.) या हैक्साकोनाजोल (100 मि. ली.) या टैबूकोनाजोल 50 प्रतिशत + ट्राईफलोक्सीस्ट्रोबिन 25 प्रतिशत WG (80 ग्रा.) या मेटीराम 55 प्रतिशत + पाइराक्लोस्ट्रोबिन 5 प्रतिशत WG (300 ग्रा.) इत्यादि फफूंदनाशी प्रति 200 ली. पानी के अनुसार स्कैब, अल्टरनेरिया व पाउडरी मिल्डसू इत्यादि के लिए अनुमोदित किए गए है। यदि छिड़काव सारणी का पूर्ण रूप से पालन किया जाए तो इन सभी बिमारियों के साथ - साथ फ्रोग आई पत्ता धब्बा रोग पर भी नियन्त्रण पाया जा सकता है।

NEWS DESK

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FARMING HERO

सरदार हरपाल सिंह बाजवा – खुम्ब उत्पादन से कृषि उद्यमी

डॉ. एस. पी. गोयल, पूर्व प्रधानाचार्य
कृषि महाविद्यालय कौल (हरियाणा)

सरदार हरपाल सिंह बाजवा, गाँव भौर सैयदाँ, जिला कुरूक्षेत्र (हरियाणा) ने सन् 1995 में कृषि विज्ञान केन्द्र, कुरूक्षेत्र से खुम्ब उत्पादन पर प्रशिक्षण प्राप्त करके एक अस्थायी खुम्ब भवन में 22,000 रूपये की लागत से खुम्ब उत्पादन शुरू किया। उन्होनें अपनी मेहनत व सूझबूझ से खुम्ब उत्पादन व्यवसाय को बढाया व वर्ष 2012–13 में बाजवा खुम्बफार्म पर पाश्चुरीकृत कम्पोस्ट इकाई व आधुनिक खुम्ब स्पॉन प्रयोगशाला की स्थापना की। इस समन्वित खुम्ब इकाई का मुख्य उद्देश्य हरियाणा व अन्य प्रान्तों के खुम्ब उत्पादकों को समय पर उच्च क्वालिटी का स्पॉन पाश्चुरीकृत कम्पोस्ट केसिंग मिश्रण व स्पॉन उपलब्ध करवाना था। समन्वित खुम्ब इकाई को स्थापित करने व सफलतापूर्वक चलाने में चौधरी चरण सिंह हरियाणा कृषि विश्वविद्यालय, हिसार, उद्यान विभाग, हरियाणा, खुम्ब अनुसंधान निदेशालय, सोलन, उद्यान व वानिकी विश्वविद्यालय, सोलन आदि संस्थानों की अहम् भूमिका रही। बाजवा समन्वित खुम्ब इकाई हरियाणा, पंजाब, उत्तराखंड, हिमाचल प्रदेश, राजस्थान, उत्तरप्रदेश व जम्मूकश्मीर के खुम्ब उत्पादकों को स्पॉन पाश्चुरीकृत कम्पोस्ट व केसिंग मिश्रण उनके दरवाजे पर उपलब्ध करवाता है। जिससे हजारों खुम्ब उत्पादकों की आय व रोजगार में अभूतपूर्व वृद्धि हुई है। आज बाजवा समन्वित खुम्ब इकाई में प्रतिदिन 250 क्विंटल पाश्चुरीकृत कम्पोस्ट, 20 क्विंटल स्पॉन का उत्पादन हो रहा है। इस फार्म पर रोजाना आसपास के गाँवों की करीब 150 भूमिहीन ग्रामीण महिलाएं काम करती है। स्पॉन प्रयोगशाला की उत्पादन क्षमता 3000 क्विंटल प्रति वर्ष है जो कि भारतवर्ष में सबसे बड़ी स्पॉन की प्रयोगशाला है। प्रति वर्ष हजारों किसान बाजवा खुम्ब फार्म पर खुम्ब उत्पादन के हर पहलू पर प्रैक्टिकल प्रशिक्षण निःशुल्क प्राप्त करते हैं। सभी किसानों को पाठन सामग्री भी उपलब्ध करवाई जा रही हैं। वर्ष 2019–20 में, कश्मीर घाटी में किसानों को पाश्चुरीकृत कम्पोस्ट, केसिंग मिश्रण व तकनीक उनके घर पर उपलब्ध करवाई गई है ताकि वहाँ का युवा वर्ग खुम्ब उत्पादन को रोजगार के रूप में अपनाएं। पहली बार कश्मीर घाटी में सफेद बटन खुम्ब का उत्पादन शुरू हो गया है।

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