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Area-wide E-Pest Surveillance for Soybean in Maharashtra

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ABSTRACT

Soybean crop is grown in an area of 3.1 million ha in Maharashtra state of India. The Lepidopteron defoliators viz.*, semilooper (*Chrysodeixis acuta*) and tobacco caterpillar (*Spodoptera litura*) are the major pests of soybean across the state. The infestation of* S. litura *coupled with other leaf eating caterpillars on soybean in Vidharba region of Maharashtra during 2008-09 caused severe yield losses in an area of 0.75 million ha (Dhaliwal and Koul, 2010). Epidemics of* S. litura *again occurred during 2009-10 in an area of 1.46 million ha and caused production loss of 0.085 million tons, which led to the need of systematic area wide pest monitoring. Since regular and wide area pest monitoring is the cornerstone for pest management through which epidemic situations can be avoided by detecting damage prior to establish at a higher pest population. So to automate the process of pest monitoring and issuing timely advisories to the farmers, a web based pest surveillance system was developed and implemented for effective and regular pest monitoring in soybean in Maharashtra since 2009 by integrating the potential technical and administrative stakeholders of State and Central machinery involved in plant protection. Use of internet technologies helped in providing prompt and reliable pest reports to the concerned agencies and thus confirmed the operation of effective monitoring.*

Key words: E-surveillance, insect-pests, soybean

E-pest surveillance 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 the concerned farmers. Same information is also available for agricultural policy planners. The term 'E-pest surveillance system' encompasses computer-based storage, transfer, retrieval, sharing, and reporting of pest data for appropriate and timely decision-making for better pest management.

Why internet for pest surveillance?

The internet has become a very powerful information providing system for dissemination of pest management information. The internet has the potential for improving effectiveness and efficiency of pest management programmes being carried out across the country. Its ability to allow quick transfer of information and its ready access as well as the knowledge base assist the plant protection workers in advising farmers appropriately so as to save the crop from pest damage and economic losses by judicious use of timely intervention and relevant pest management inputs.

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The goal of using internet technology 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 dissemination of pest management strategies/options by pest management professionals. 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 internet technologies facilitates reporting of pest situations for different locations at a click of mouse and plays an important role in pest management decision making.

Status of internet based surveillance

Internationally, internet is widely being used for pest surveillance and modeling for forecasting in many counties such as Integrated Plant Protection Center (IPPC) of Oregon State University which has several online interactive resources including near real-time daily weather data, various degree-day products (calculators, phenology models, maps, and map calculator), and weather-based phenology models for pest management decision-making in the four Northwestern U.S. states (http://uspest.org/). Another example is the Codling Moth Information Support System (CMISS) (http://ipmnet.org/ codlingmoth/) which contains various knowledge bases, databases, phenology models, and links to worldwide resources on codling moth.

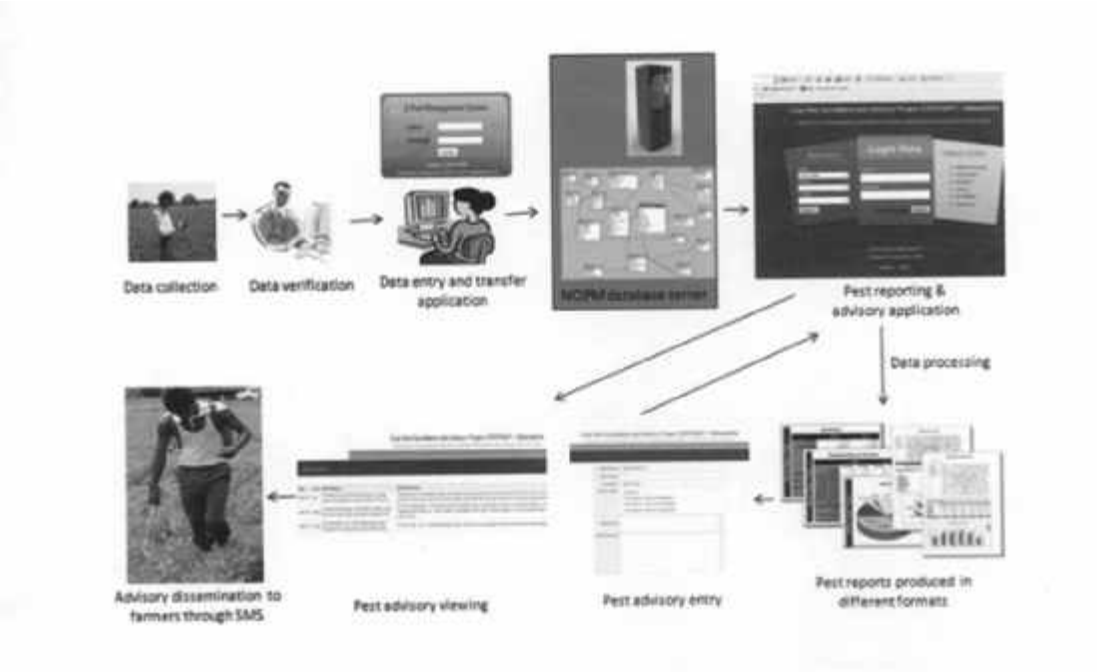
Decision support systems for interactive pest modeling and market information are being rapidly developed by many countries and made available on the internet *e.g.,* the Pacific Northwest IPM Weather Data and Degree-Days Website. At this site, daily temperature and precipitation data are gathered from 380 public and private weather stations and linked directly to pest phenology models for 22 insects, 2 diseases, and 2 crop species. Plant production information system developed by the Danish Agricultural Research and Advisory Organizations for pest and disease warnings based on weather data-driven forecast models is available. Decision support systems and expert systems have been developed in the field of pest management but no system existed for Internet Based surveillance system in the country. NCIPM took the initiative in collaboration with Maharashtra State Department of Agriculture in developing an internet based surveillance system for Soybean and Cotton from 2009 and its success has been demonstrated.

MATERIAL AND METHODS

Preparations for pest surveillance

An elaborate preparation is necessary for successful pest surveillance and thus it improves the efficiency of the activity. Preparation included training of pest scouts, field selection, sampling plan and materials required such as data books, set of guidelines, electronic devices, software, *etc*. Before starting scouting, a well thought sampling plan was prepared which to include crop distribution in the area, field selection, field size, route through the fields, selection of spots in the field and finally the number of plants to be surveyed from different spots. The sample plan outlined the procedure to draw a sample to estimate the population of different pests or the crop damage. Pest scout was given access to published information and portable handouts on guidelines for crop pest surveillance. Completely randomized

plan for pest surveillance was adopted so that each spot in a field had equal chance of scouting. The scouts were educated about the identification of pests and their sampling plan and its execution. A well thought time schedule for taking pest observations was made considering pest biology and crop growth. Each filed selected was under surveillance once a week. Information such as crop variety, agronomic practices, pesticides applied, *etc*. was 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.



Schematic representation of internet based pest surveillance system

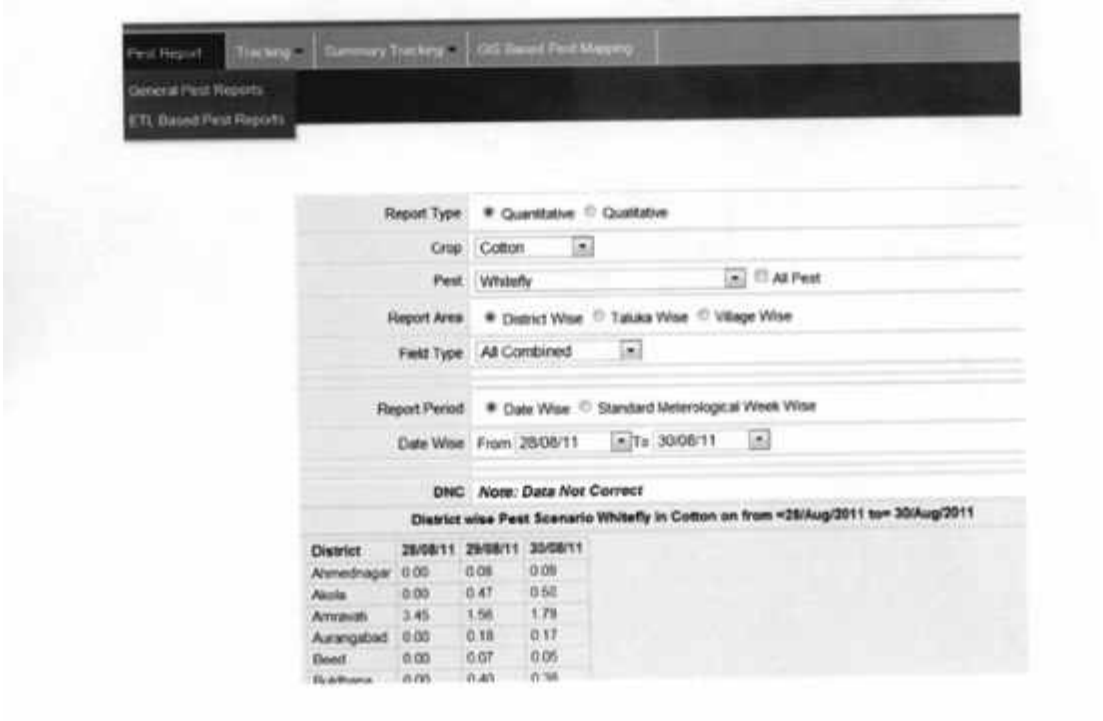
Development of internet based surveillance system

Different software components of internet based 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. A three tier architecture based system consisting of database for information storage; an offline application for pest data capture and data upload into database; an online application for pest reporting and advisory was developed. The different reports such as present and past pest situations could be viewed by experts. The State Agricultural Universities issued real time pest advisory for different locations for further spread it to the farmers. The information flow chart shown depicts the Internet Based surveillance

system implemented in Maharashtra.

Database: The database was designed and developed for storage of interrelated pest information using SQL Sever 2000. The database consisted of 120 data fields to store data on various parameters. Various tables and views were created for different domain-specific information. Relationships were established among these tables for data normalization. Various stored procedures were generated in the database to execute different tasks.

Data entry and uploading module: Login details were created for data entry operators and pest monitors. The application is a standalone application for entry of details of fields, crop pests and other information. Data is uploaded after verification and subsequently transferred to centralized database through XML.



Pest reporting and advisory module

The main purpose of pest reporting is to communicate immediate or potential danger. Immediate or potential danger normally arises from the occurrence, outbreak or spread of a pest. The provision of reliable and prompt pest reports confirms the operation of effective surveillance. Pest reporting allowed necessary pest management requirements and actions to be taken. Pest reports contain information on the identity of the pest, location, pest status, and nature of the immediate or potential danger. Online application is developed using ASP.net technology as user interface which provides plant protection experts the reports for issuing advisories to different stakeholders. System generates pest reports in different formats such as tabular, graphical

or GIS maps. Both current as well as temporal pest reports are produced. The system has provision for producing pest reports for village(s)/taluka(s)/district(s) having pest(s) population above or equal to the pest ETL during selected dates that require/s attention of pest management experts. On the basis of pest situation of a particular location, pest experts feed the advisory for state agencies to further spread it to the farmers for making appropriate and timely decisions for pest management, if required. Accurate information on pest status facilitates technical justification of measures and helps to minimize losses due to pest incidence, thereby reducing the fears of their serious buildups.

RESULTS AND DISCUSSION

Impact of e-pest surveillance system– a glimpse

Constant and timely watch over pest scenario of the crop with the help of E-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. Table 1 indicates the quantum of data inputs by the field monitoring staff through the pest monitoring units of each division and the advisories issues based on the ETL for different pests of soybean and other crops for the year 2012-13. The quantum of advisories shows the effective flow of pest management advisories to farmers in the target crops (Table 1).

Table 1. Data entries and pest management advisories for soybean and other crops (2012-13)

Division	Data entries (Nos)		Pest management advisories (Nos)	
	Pest scouts	Pest monitors	Issued by SAUs	Sent to farmers
Amravati	158959	10786	15168	5501374
Aurangabad	69401	4571	4087	3553576
Kolhapur	27104	2859	2752	4472977
Latur	96501	10274	7052	3801373
Nagpur	111066	9444	21186	4166152
Nasik	84127	5083	5793	5481458
Pune	31001	3775	4659	7661055
Thane	48912	3980	1818	1352864
Total	**627071**	**50772**	**62515**	**35990829**

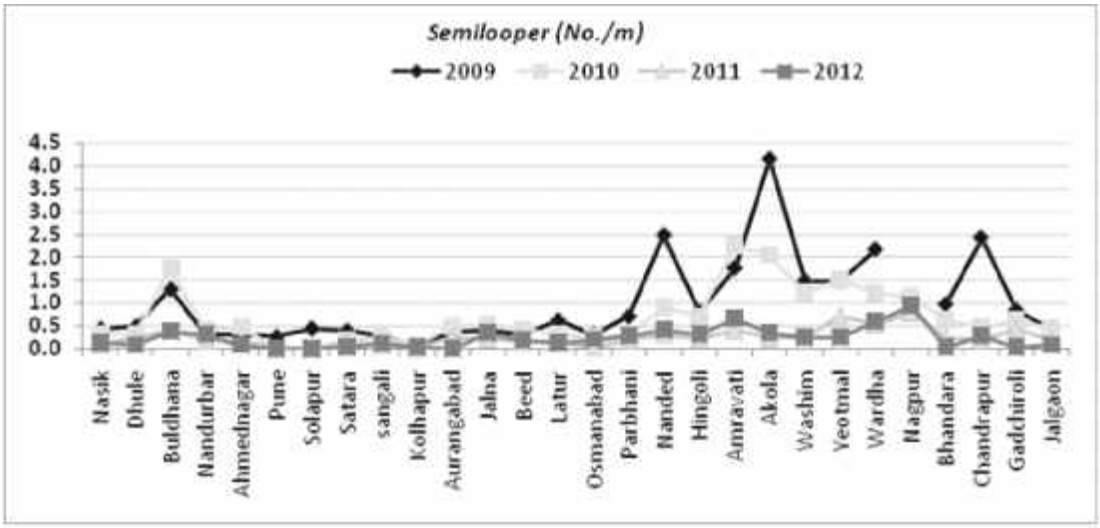


Fig.1 Spatio-temporal status of semilooper on Soybean at Maharashtra

ICT based surveillance resulted not only knowing the current pest status and issuance of real time need based pest management options but also in elucidating the pest scenario over seasons and across locations. Comparison of scenario of mean incidence of *semi* looper across districts over 4 year period indicated decreasing levels (2009>2010>2011 and 2012) after the epidemic year of 2008 (Fig.1).

Area wide coverage facilitates record of pest affected area in relation to the cultivated area under the crop and also makes possible the plant protection inputs used against the pests. The pest affected area in soybean under pest surveillance gets implemented with scientifically based pest management practices over wider area which in turn aids in increased production and productivity of the crops *per se* in the region (Table 2). The database also provides potential utility for development of prediction rules and models.

Table 2. Scenario of crop yields during the CROPSAP implementation seasons

Crop	Production (Lakh MT)			Productivity (kg/ha)		
	Normal (03-04 to 07-08)	2011-12	2012-13	Normal (03-04 to 07-08)	2011-12	2012-13
Soybean	27.01	39.69	46.90	1204	1319	15 31

(Source: SDA, Maharshtra)

While the technological inputs relating to crop production inclusive of crop protection are yield enhancing, the information and communication technology (ICT) tools aid in rapid dissemination of information related them facilitating their adoption at the growers' level. CROPSAP has been the first successful programme at the National level demonstrating the area wide (statewide) 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. Such a programme once implemented the uses are of multiple type for the researchers and planners alike while the farmers continue to get the real time pest based management advisories for use at field level creating exemplified opportunities for increasing and improving the production and productivity of the crops at regional level.

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